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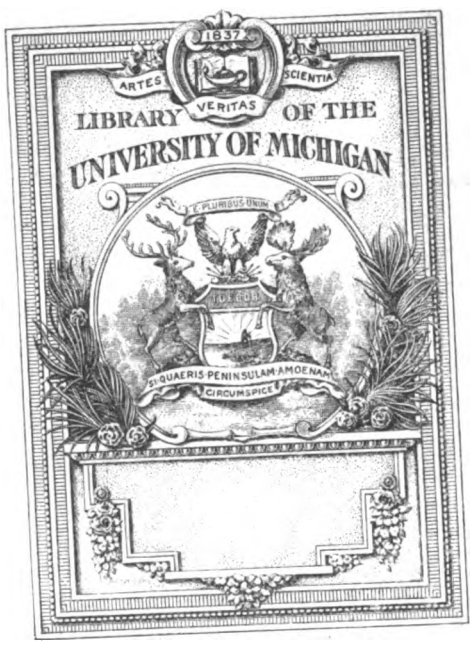

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INDEX TO VOLUME XLIII.

ELECTRICAL REVIEW

JULY 4 TO DECEMBER 26, 1903

Articles marked * are illustrated; (E) indicates "Editorial;" (P) indicates notes under "Recent Electrical Patents;" (R) indicates "Review of Current Engineering Literature."

A

Acceleration of steam locomotives (R). 787
Accumulator cars in Wales. 184
Address to the engineering section of the British Association for the Advancement of Science, by Charles Hawkesley. 556
Administration buildings at the St. Louis Exposition*. 660
Advantages of steam turbines for textile mills, by Austin Dodge*. 532
Advisory committee of the building fund of the American Institute of Electrical Engineers. 699
Air friction. 589
Alcohol from acetylene. 228
Alternating-current motors for variable speed, by W. I. Slichter. 50
Alternating currents, new material for simple (R). 126
Alternating currents, the production and distribution of, for large city systems, by Richard McCulloch*. 350
Alternator, a remarkable, by E. Guarini* 359
Aluminum as an electrical conductor, the use of, by J. B. C. Kershaw. 470
Aluminum conductors for electric transmission lines (R). 413
American Association for the Advancement of Science. 943
American Electrochemical Society, exhibit of the. 146, 189, 316, 327
American Electrotherapeutic Association 256
American Institute of Electrical Engineers. 224, 445, 478, 523, 632, 659, 717, 784, 938, 940
American Society for Testing Materials, the. 50
American Street Railway Association, the convention of the (E). 306, 332, 756
American Telegraphers' Tournament Association. 490
Anglo-Belgian telephone cable, the. 96
Animal mechanics and motor vehicle designs. 617
Anniversary of the death of William Gilbert. 927
Annual meeting of the Electrical Trades' Society of New York. 819, 875
Annual meeting of the Indiana Electrical Association. 521
Annual report of the Meriden Railroad Company. 562
Annual report of the United States Commissioner of Education. 819
Annual report of the Western Union Telegraph Company, the. 605
Anti-hunting device (P)*. 905
Arc lamp, new type (P)*. 788
Are dynamos ill-tempered? (E). 462
Arrangement for operating electric fans (P)*. 905
Artificial Niagara at St. Louis. 491
Asymmetry of a mercury break (R). 412
Asynchronous motors, measurement of the efficiency of (R). 22
Automatic control of electric cars. 195
Automatic regulator for electric generators (P)*. 125
Automobile blue book, official. 224
Automobile cars for railways. 639
Automobile industry in Great Britain, the. 739
Automobile record, a new. 182
Auto record, a new. 699
Auvert train lighting system (R). 329

B

Ball bearings for electric motors. 83
Baltimore & Ohio Railroad, new electric locomotive for*. 254
Basis for the comparison of dynamo design, a (R). 484
Bath electric tramways, England. 86
Bearings for electric meters (P)*. 229
Behavior of a red colloidal gold solution toward an electric current (R). 869
Berlin, cheap electric light for. 220
Berlin-Zossen high-speed railway, latest development on, by Frank C. Perkins*. 767
Best conditions for refining copper (E). 498
Boehm train lighting system, the (R). 524
Boma-Leopoldville and Leopoldville-Equateur telegraph line (R). 942

Book Reviews.

"A Few Remarks." 56
Alternating-Current Transformer. 192
American Street Railway Investments. 56
American Telegraphy, and Encyclopædia, of the Telegraph. 717
Arithmetic of Electricity. 876
Care and Handling of Electric Plants. 908
Continuous-Current Dynamos and Motors. 402
Cours d'Electricite. 876
Electrical Engineering. 451
Electrical Engineering Measuring Instruments. 669
Electrical Engineers' Pocketbook. 876
Electrical Influence Machines. 231
Electric Toy Making. 876
Engineering Preliminaries for an Interurban Electric Railway. 624
Fowler's Mechanical Engineers' Pocketbook. 738
Friction and Lubrication. 785
Home Mechanics for Amateurs. 785
Radium. 192
Secondary Batteries. 192
Telephony. 128
The Practical Application of the Rœntgen Ray in Therapeutics and Diagnosis. 402
Whittaker's Electrical Engineers' Pocketbook. 738, 876
Wireless Telegraphy. 876
Booster controllers (P). 20
Braking tests of cars and automobiles. 866
Breakdowns of electrical machinery. 521
Brick, the manufacture of. 277
British engineering standards committee 188
British Institution of Electrical Engineers. 900
British Institution of Electrical Engineers, journal of the. 184
British light railway system, a*. 41
British patent record for the year 1902. 157
British standards in electrical engineering (E). 727
Brooklyn Engineers' Club, eighth annual dinner of the. 940
Brooklyn Institute of Arts and Sciences. 469
Brooklyn Rapid Transit men to receive instruction in electrical engineering 560
Brooklyn Rapid Transit Company makes changes in its transfer system. 808
Brown-Boveri-Parsons turbo-generators (R). 868
Brussels, Belgium, electrical installation of the city of, by Enrico Bignami*. 221
Brussels, Belgium, tramways, the central station of the, by Emile Guarini*. 688
Brussels electric tramways, the (R). 158

C

Cable laying in Manila and a trip around the world, by Lewis G. Martin*. 700
Cables, two simple methods of locating faults in, by Edwin F. Northrup*. 278
Calcutta, India, the electric supply of (R). 942
California installations, some typical, by J. H. Rusby*. 77
Canadian Society of Civil Engineers. 663, 687, 892
Capacity of a Geissler tube in a magnetic field, the (R). 787
Cape Town industrial exhibition. 780
Carbides, by Alex. A. Beadle. 851
Castings, electric process of making. 62
Cathode-ray alternating-current wave indicator, by Harris J. Ryan*. 176, 225
Cause of the earth's magnetism, the (R) 484
Central electric power stations for gold mines. 308
Central London Railway, new motor cars of the. 330
Central station auxiliary plant (R). 669
Central station battery, the (R). 713
Central station of the Brussels, Belgium, tramways, by Emile Guarini*. 688
Chelsea generating station (R). 262
Chemical valency, electrical conductivity and hardness of metals (R). 600
Chicago Telephone Company opens new branch exchange. 629
Chlorine smelting with electrolysis*. 194
Chromite in 1902, production of. 224
City and interurban system of the Schenectady Railway Company*. 280
Clamping device for holding electric metal-working machines (P)*. 289
Coal-handling machinery driven by electric motors, by D. A. Willey*. 394
Coal storage under water. 808
Coating for glass or fabrics (P)*. 819
Coherer for wireless telegraph system, a new (P)*. 748
Coherers for wireless telegraphy. 263
Coherers, new properties of (R). 328
Colliery exhibition, the, by Sydney F. Walker. 228
Colorado Electric Light, Power and Railway Association. 686
Combined use of alternating and direct current for central station work, the, by F. C. Caldwell. 781
Commencement time (E). 305
Commercial vehicle contest. 216
Committee of the American Institute of Electrical Engineers appointed to prepare an exhibit for St. Louis fair. 360
Committee on photometric value of arc lamps. A correction. 807
Committee on steam turbines of the National Electric Light Association 907
Commutating alternating-current motors (E). 920
Commutator, a new (P). 864
Comparative behavior of floating and booster-controlled batteries on fluctuating loads, by Lamar Lyndon. 770, 815
Comparison formulæ for dynamo electric machines (R). 751
Compensation and compounding of alternating-current generators (R). 712
Compensation of asynchronous motors (R). 443
Composition of matter for battery electrolyte (P). 483
Concerning wireless telegraph transmitters (R). 907
Conditions governing the rise of temperature of electric railway motors in service, by Dr. C. T. Hutchinson 656, 695
Conductivity of mercury vapor, by Peter Cooper Hewitt*. 902
Congress of Applied Chemistry, fifth international, by J. B. C. Kershaw. 80
Conservatism desirable in electrical applications (E). 799
Consolidation of electric light companies in Milan. 826
Contact-maker for electric signs (P)*. 631
Contact voltages. 703
Controller for electric hoists (P)*. 93
Control of electric motors, a new system for the (P)*. 864

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Conventions.

American Electrochemical Society.. 446
American Electrotherapeutic Association.....413, 451, 490
American Institute of Electrical Engineers.....15, 35
American Railway Master Mechanics 21
American Railway Mechanical and Electrical Association..... 368
American Society of Mechanical Engineers.....21, 662, 777, 867
American Street Railway Association.....246, 299, 361
Association of Edison Illuminating Companies.....164, 261, 404
British Association for the Advancement of Science..... 514
Independent Telephone Association of Southern Indiana.....669, 756
International Association of Municipal Electricians, the.....299, 373
Interstate Independent Telephone Association.....766, 814, 870
Master Car Builders' Association... 21
National Electrical Contractors' Association* 57, 119
Ohio Electric Light Association... 375, 571, 597
Old-Time Telegraphers and United States Military Telegraph Corps.. 562
Society for the Promotion of Engineering Education, annual meeting of the..... 84
Street Railway Association of the State of New York..... 563
Twentieth annual convention of the American Institute of Electrical Engineers.....15, 35
Convention group, the*..... 28
Convention of the Interstate Independent Telephone Association (E).... 800
Convention, the street railway (E).... 338
Copper production in Hungary..... 21
Correction from Dr. E. F. Northrup.... 358
Cost of water power (R)..... 868

D

Damage to shade trees by electrical conductors (E)..... 542
Dam to give Chicago power..... 454
Danger of shock to firemen through squirting at high-tension mains (R) 329
Data for a 3,750-kilowatt alternator (R) 751
Dayton, Ohio, Home Telephone Company* 582
Decorative lighting (E)..... 681
Dedication of an engineering building at the Iowa State College..... 151
Demonstration of the Cooper Hewitt mercurial vapor lamp at the Technology Club, New York city..... 897
Department of machinery, Louisiana Purchase Exposition..... 406
Department of machinery, and the power plant of the St. Louis exposition 579
Depreciation, a question in (R)..... 413
Derailment of cars, a device for preventing the..... 858
Detinning process, a new (R)..... 196
Developments at Niagara Falls for the utilization of its power, by Orrin E. Dunlap* 344
Development in the engine room, by J. H. Perkins..... 741
Dielectric hysteresis..... 652
Diesel engine, the, by H. Ade Clark*... 314
Double-frequency generator, a (R)..... 600
Drainage by electricity..... 807
Dust, the prevention of electrically deposited (R)..... 23
Dynamo electric machinery (R)..... 156
Dynamo electric machine, coil for (P)*. 190
"Dynelectron," the..... 850

E

Economics in electrical illumination (E) 305
Edison interests at West Orange, N. J., the* 185
Edison Portland Cement Company, the (E) 920
Edison Portland Cement Company, the.* 929
Edison standard cell for automobiles, report on the, by W. Hibbert..... 862
Edison storage battery, the situation regarding 198
Edison storage battery, a successful automobile trip with an..... 635
Education of engineers, problems in the (E) 105
Effect of impurities on commercial copper (R)..... 943
Effect of vacuum on the steam turbine. 483
Effect of radium on the conductivity of liquids (E)..... 681
Efficient high-pressure water-power transmission plant, an, by G. J. Henry, Jr., and J. N. Le Conte*... 472
Electric automobile batteries for quick charge rates (R)..... 820
Electric bakers' oven, an..... 927
Electric brake (P)*..... 61
Electric car equipment, by L. B. Stillwell 605
Electric car lines in Germany..... 465
Electric car on the Marienfelde-Zossen line breaks all speed records..... 558
Electric convection..... 858
Electric drilling, the cost of (R)..... 231
Electric furnace (P)*..... 788
Electric fuse or cutout (P)*..... 941
Electric incubator (P)*..... 941
Electric light and power stations..... 867
Electric lighting of railway systems (R) 95
Electric lighting systems of Fulda, Germany (R)..... 906
Electric lights on railway trains in Germany and Austria..... 373
Electric motor (P)*..... 411
Electric motor controller (P)*..... 289
Electric power applications in the mines of Europe (R)..... 196
Electric power for mining purposes, by George Scarfe..... 343
Electric power from space (E)..... 462
Electric power in modern German and English iron and steel plants, by Frank C. Perkins*..... 309
Electric railway at La Mure, France, the 811
Electric railways in the United States.. 548
Electric railway tests at the Louisiana Purchase Exposition..... 756
Electric resistance of hydraulic cement (R) 442
Electric shock..... 401
Electric sleigh, an..... 662
Electric time switch (P)*..... 157
Electric towing on canals (R)..... 601
Electric traction in the United Kingdom 148
Electric trucks (E)..... 106
Electrical wiring fire risk (R)..... 601
Electrical advertising element (P)*.... 703
Electrical committee of the Underwriters' National Electrical Association 846
Electrical conductivity of mercury vapor (E) 884
Electrical currents, a new device for producing* 850
Electrical dispersion of fogs (E)..... 835
Electrical distribution in the engine room, by W. F. Raber..... 744
Electrical driving of winding gears.... 164
Electrical driving of winding gears, by F. Hird*..... 317
Electrical energy direct from coal (E). 837
Electrical fire hazard, the (E)..... 541
Electrical furnace (P)*..... 191
Electrical heater and ventilator..... 256
Electrical hoisting in mines (E)..... 137
Electrical installation at Durham, N. C.. 204
Electrical instruments (E)..... 389
Electrical measuring instrument (P)*.. 260
Electrical mining notes, by Sydney F. Walker.....152, 183, 702, 745, 810
Electrical motors for centrifugal pumps and fans, by Aug. J. Bowie, Jr.*.... 511
Electrical notes from India..... 511
Electrical notes from Great Britain, by A. Webster.....52, 313, 706
Electrical phenomena..... 756
Electrical power for farming work (E). 210
Electrical power installation of the Industrial Works, of Bay City, Mich.* 257
Electrical progress in the nineteenth century 766
Electrical progress in Russia..... 479
Electrical Trades' Society, of New York, the.....819, 875
Electrically driven mining plants (R).. 442
Electrically operated mine hoists (E).. 497
Electricity and smokeless peat (E)..... 883
Electricity as an agent for health (E).. 339
Electricity in coast fortifications (E)... 273
Electricity on the farm (R)..... 485
Electricity in gold extraction (E)..... 462
Electricity in placer mining, by James E. Johnston..... 188
Electricity for pumping stations for drainage and sewerage in southern states (E)..... 390
Electricity in Siberia (E)..... 835
Electricity supply in Milan (R)..... 600
Electricity in the United States Government service, by J. E. Price*..... 616
Electrified Mersey railway at work (R). 634
Electrode, with plurality of conductors (P)* 819
Electrogalvanizing, a new process for... 855
Electrolysis and technical competency (E) 425
Electrolysis in bridge structures, by George T. Hanchett..... 765
Electrolysis, the present position of the theory of..... 860
Electrolytic copper refining, by Wilder D. Bancroft..... 435
Electrolytic drilling (E)..... 800
Electrolytic drilling and slotting process (R) 750
Electrolytic manufacture of vanadium and its alloys (R)..... 158
Electrolytic preparation of metallic powders (R)..... 786
Electromechanical compounding of generators (R)..... 525
Electrometallurgy of zinc (R)..... 412
Electroplating, new process of (P)..... 229
Electrotechnical industry of Germany.. 846
Electrotechnical Institute of Montefiore. 615
Elimination of platinum in incandescent lamps 479
Energy of electrolysis, the (E)..... 497
Energy, natural sources of (R)..... 230
Energy losses in electric cars (R)..... 23
Energy transformations in the synchronous converter, by W. S. Franklin.. 44
Engine economy and equipment, by E. J. Bechtel 742
Engineering and physical problems (E) 33
Engineers' Club at Philadelphia, proceedings of the..... 257
Engineers' Society of Western Pennsylvania, proceedings of the.....192, 265
Engineer, what an employer may expect from the young (E)..... 273
Equipment of an electric car (E)..... 425
Erie Railroad Company experimenting with telephones..... 415
Europe, electrical notes from, by C. L. Durand...62, 258, 438, 555, 707, 805, 898
European lighting practice, some notes on the commercial features of..... 664
European electrically operated cranes, by Frank C. Perkins*..... 467
Experiments for improving the construction of practical standards for electrical measurements.....649, 683
Experiments for lessening noise on elevated railways..... 605
Experiments on selective wireless telegraphy (R)..... 634
Expansion of the telephone, the (E).... 679
Extensive dredging operations by the United States Government..... 864

F

Factors which affect the energy losses in armature cores, by J. W. Esterline and C. E. Reid*..... 149
Fan dynamometer, a (R)..... 126
Fan motors (E)..... 73
Faraday Society, meeting of the..... 179
Ferrosilicon in France..... 219
Field telephone switchboard of the United States Signal Corps (R).... 820
Finzi single-phase alternating-current traction motor, by Enrico Bignami* 853
Fireproof cars (E)..... 389
Fireproof car for the Paris Metropolitan, new, by C. L. Durand*..... 491

Digitized by Google

Fire protection at the St. Louis World's Fair 655
Flux for arc lamp carbons (P)*..... 818
Foreign students at German universities 407
Foundry development, an interesting*.. 621
Foundry exhibit at St. Louis Exposition. 581
Franklin Institute, the journal of the.....288, 469
Free lectures under the Department of Education for the city of New York 604
Freight development by interurban roads, by E. F. Seixas..... 709
Friction between iron and wood (R)... 442
Friction gear for electric motors (P)*.. 93
Frontier Telephone Company, Buffalo, N. Y., the, by Virgil Hayden*..... 922
Fuel and boiler exhibit, a (E)..... 497
Function of the fuse on an electric car (E) 611

G

Galvanic battery in Germany, new..... 256
Garuti process for the industrial electrolysis of water, the (R)..... 230
Gas engine and gas turbine, the, by George E. Walsh..... 307
Gas engine and three-phase alternator at Laar power plant, by Frank C. Perkins* 651
Gas engine *versus* the steam turbine, by John J. Beggs..... 399
Gasoline automobile handbook..... 639
General Electric Company in international agreement..... 766
Generating sets for the new electricity works, at Manchester, England (R). 525
Generator, a novel..... 433
German arc lamp, a small..... 256
German electrical notes..... 747
German telegraph and telephone statistics* 279
Geneva Telephone Company, the*..... 18
Glass globes, method of frosting (P)*.. 191
Glass manufacture, the use of electricity in, by J. B. C. Kershaw*..... 735
Glass vessels and quartz vessels, by Dr. John Trowbridge*..... 682
Glowers, new method of making electric lamp (P)*..... 290
Gola lightning arrester (R)..... 942
Good telephone talking..... 485
Governor and anti-hunting device (P)*. 748
Great Britain, news from.....52, 313, 706
Grounded and ungrounded transmission circuits (E)..... 171
Grounded and ungrounded transmission circuits, by J. S. Peck*..... 177
Ground detector (P)*..... 20
Growing industry, a (E)..... 106
Growth of electric central stations, the (E) 883
Gutta-percha in the Philippines..... 227
Gutta-percha from New Guinea..... 561

H

Hampshire, England, electric railways, the (R)..... 329
Hanger for electric lamps, a novel (P)* 703
Hard drawn copper wire, by Francis W. Jones 739
Heat absorbed in the electrolysis of silver salts, and the principle of maximum work (R)..... 196
Heater for cars, an electric (P)*..... 705
Heating and ventilating equipment of the works and offices of the Pennsylvania Steel Company, at Steelton, Pa. 151
Heating effect of radium, the (E)..... 765
Heating effect of radium emanation (R) 906
Heating of railway cars (R)..... 751
Helium and radium (E)..... 801
Hertzian waves in wireless telegraphy, on (R)..... 94
High-lift centrifugal pumping plant for the De Beers mines (R)..... 820
High-speed electric car tests (E)..... 541
High-speed electric railway problems, by A. H. Armstrong*..... 7
High-speed electric traction on railways. 195
High-speed experiments in Germany, forthcoming 179
High-speed railway trials..... 662
High-speed trains (E)..... 613
Hoisting Motor (P)..... 191
Home Telephone Company, Dayton, Ohio* 582
How the United States Government uses electricity, by J. E. Price*.... 776
Hudson River Telephone Company, meeting of the directors of the.... 789
Hydraulic unit, a suggested, by Ralph L. Montagu..... 465

I

Ill-considered reports (E)..... 764
Illuminating material discovered, a new 144
Important decision on Tesla split-phase patents 397
Improvement in automobile design..... 790
Independent Telephone Association of Southern Indiana..... 629
Independent telephone directory..... 901
India, electrical conditions in, by A. C. Hobble 110
Induction coils, new winding for*..... 663
Induction machines, and a new type of polyphase generator (R).....127, 158
Induction motors, controller for (P)*... 261
Industrial electrochemistry and electrometallurgy (E)..... 799
Industrial electrochemistry and electrometallurgy, by J. B. C. Kershaw...809, 861, 889, 925

INDUSTRIAL SECTION.

Adjustable desk telephone device, C. W. M. Co.*..... 530
Adjustable round split dies and hand taps, S. & H. Co.*..... 790
Air-blast transformers, W. E. & Mfg. Co.* 418
Allis-Chalmers Company's new standard Reynolds-Corliss engine* 827
Alternating-current series arc lamp, A.-B. Co.*..... 25
Ammeter, the Vulcan, G. & P..... 670
Angle wall sockets, M.-S. Co.*..... 908
Arc lamp, a small, A. L. Co..... 672
Arc lamp, a new type of shunt-feed enclosed, W. F. W.*..... 265
Artificial gutta-percha, new..... 295
Automatic block signals for electric railways, P. S. Co.*..... 948
Automatic oil filtering and oiling system, C. Mfg. Co.*..... 415
Automatic telephone switchboard, latest type, A. E. Co.*..... 823
Automatic time switch, A. T. S. Co.* 874
Automatic track switch for electric roads, A. A. S. Co.*..... 911
Battery telephone, a new type, J. H. B. & Co.*..... 489
Beacon, a 30,000 candle-power, S. S.-W.* 944
Belleville Portland Cement Company, W. E. & Mfg. Co..... 164
Break finder and ground locater, M. B. F. Co.*..... 379
Boiler cleaner, a new form of, G. S. Co.* 453
Cable bracket frame, a new, G. M. Gest* 68
Cable joint, double conical, E. C. J. & A. Co.*..... 296
Car-heaters, electric, J. M. Co.*.... 296
Central energy subscriber's set, a new, F. T. Co.*..... 265
Coherer for wireless signaling, a new, T. E. C. W. T.-T. Co.*..... 672
Columbia electric five-ton truck, E. V. Co.*..... 132
Combination arc and incandescent headlight, G. E. Mfg. Co.*..... 416
Commutator, a large, W. E. & Mfg. Co.* 129
Conduit elbow former, a new type of, L. H. C.*..... 716
Conduit systems, G. M. G.*..... 827
Current interrupter, a new, E.-S. I. Co.* 909
Curtis turbine in Chicago electric light station, the..... 265
Desk lamps, new designs in, McL. W. & Co.*..... 604
Direct-current engine type generators, W. E. & Mfg. Co.*..... 163
Direct-current meters, development in, E. S. H.*..... 202
Dispersion lenses for searchlight projectors, C. & F. Co.*..... 639

INDUSTRIAL SECTION. (*Continued.*)

Doubleday-Hill Electric Company, the* 100
Dry battery fan motors, E.-M. Elec. Co.* 97
"Duplex" telephone, a new, C. T. & E. Co.*..... 529
Electric automobiles, S. B. Mfg. Co.* 714
Electric car lighting system, an, K. E. & R. S. Co..... 487
Electric elevators, O. E. Co.*..... 294
Electric flashlight, a handy, E. C. W. 719
Electric heating and cooking apparatus, P. E. Co.*..... 791
Electric lighting specialties, new, B. E. Co.*..... 910
Electric traveling cranes and hoists, C. C. & C. Co.*..... 637
Electric vehicles to handle United States mail in Philadelphia..... 755
Electrical company reorganizes, F. E. Co..... 874
Electrical holiday decorations, G. E. Co.* 719
Electrical testing laboratory, an, L. T. B.*..... 375
Electrolytic generator, large-capacity, H.-C. E. Co.*..... 716
Electromagnetic railway coupling.. 672
Electro-visual thermo-gage, M. T.-G. Co.* 792
Elevator alarm system, an, N. A. B. & E. Co..... 910
Enclosed fuse, a new, A. E. F. Co.*.. 752
Enclosed fuse protective devices, H. W. J.-M. Co.*..... 330
Engine, a new type of successful oil-burning, G. P. Co.*..... 376
Engine-type railway generators, S. E. Mfg. Co.*..... 26
Exhibitors at the Interstate Independent Telephone Association convention 875
Exhibitors at the American Street Railway convention..... 381
Expanding sleeve, an improved solid, J. S. B. & Co.*..... 828
Express annunciator, an electric, J. H. R.*..... 98
Fault detector*..... 66
Field regulator, a new type of, C.-H. Co.* 526
Fifty-one-inch boring and turning mill, with motor drive, C.-W. Co.* 908
Fire-alarm system, automatic, C. A. F.-A. Co.*..... 379
Floor outlet box, a new, G. I. Co.*.. 946
Gear-shaper with motor drive, C.-W. Co.* 718
General engineering company, a, C. G. E. Co..... 129
Gold Car Heating and Lighting Company 24
Grate, a new form of, M. G. Co.*... 235
Guy anchors, a severe test for, W. N. M. & Bro.*..... 264
Guy anchors for pole line construction, M. A. Co.*..... 100
Heating and ventilating telephone exchanges, B. F. S. Co..... 66
Heavy service electric truck, N.-B.-P. Co.* 486
Heavy service overhead electric traveling crane, N.-B.-P. Co.*..... 822
High-potential oil switches, H. C.-B. Co.* 909
Hornsby-Akroyd internal combustion engine, De La V. R. M. Co.*.. 27
Hot-wire voltmeters and ammeters, S. E. Mfg. Co.*..... 200
Igniter, an automatic, D. E. Mfg. Co.* 264
Incandescent lamp, new type, E. A. Co.* 24
Incandescent lamp, a new type of, M.-A. E. Co.*..... 129
Incandescent lamp, new type of, G. E. Co.*..... 161
Incandescent lamps, a new departure in, B. M. Co.*..... 331
Incandescent lamp catalogue, S. E. Mfg. Co.*..... 530

Digitized by Google

Industrial Section. (*Continued.*)
Incandescent lamp, new type of, D. L. Co.* ... 531
Incandescent lamps, new types of, R.-W. Mfg. Co.* ... 671
Incandescent lamp meter, an, T. E. E. Co ... 793
Incandescent lights, effective decoration with, E. Co.* ... 160
Induction motors, new type, S. E. Mfg. Co.* ... 130
Insulated bridle or distributing rings, J. S. B. & Co.* ... 718
Key push-button switch, a new ... 949
Lathe, a heavy turret, C.-W. Co.* ... 828
Lawrence-Hall Electric Company, the* ... 417
Lightning arresters, a new development in, G. E. Co.* ... 162
Light-weight motor, a, W. P. Co.* ... 488
Lock push switch, a new, H. & H. Mfg. Co.* ... 945
Machine *versus* hand numbering in metals, B. M. Co.* ... 823
Magneto series or bridging telephone, new, V.-B. Co.* ... 488
Mechanical and electrical equipment of a cotton mill, B. F. S. Co. 98
Mercury vapor lamp, new Cooper Hewitt, C.-H. E. Co.* ... 333
Mining, electricity in, W. E. & Mfg. Co. ... 64
Money orders by wireless telegraphy 264
Motor-driven bolt cutters, R. M. & T. Co.* ... 487
Motor-driven double-head bolt cutters, R. M. & T. Co.* ... 636
Motor-driven fire pumps, G. E. Co ... 791
Motor-driven grinders, R. Mfg. Co.* ... 162
Motor-driven machine tools, N. M. T. W.* ... 603
Motor-driven milling machine, B. & S. Co.* ... 568
Motor-driven plate planer, W. E. & Mfg. Co.* ... 97
Motor grinders, direct-current, E. E. Mfg. Co.* ... 790
Motor starters, W. L. E. Co.* ... 714
Motor-starting rheostats, C.-H. Co ... 331
Municipal steam turbine plant, Anderson, Ind., W. E. & Mfg. Co.* ... 267
National electrical contractors, group* ... 204
Pole-changer, a new type of, I. E. S. Co.* ... 638
Pole-raising wagon and construction apparatus, W. H. A. & S.* ... 234
Power-house of the Valley Counties Power Company, A. D. Co ... 671
Power plant accidents, C. E.-S. Co ... 873
Quick-break switches, L. & S. Co.* ... 530
Rapidity in telephone line construction, G. E. Co.* ... 829
Recent illustrated trade literature, G. E. Co ... 571
Receptacle, a new flush, T. E. Mfg. Co.* ... 872
Recording wattmeter for alternating-current circuits, S. I. Co.* ... 452
Reflector lamp, a new type of, F. E. M. Co ... 526
Reflector, a new form of, P. S. and R. Co.* ... 874
Refrigerating machine, a novel use for a, L. T. B.* ... 829
Reorganization of the Standard Vitrified Conduit Company ... 378
Seattle water-wheel installation, P. W.-W. Co.* ... 568
Self-ignition for internal combustion motors ... 160
Signal system for electric railways, a new, U. S. Co.* ... 569
Sign, an attractive electric, C. S. Co. 235
Single-phase motor, a, F., Ltd.* ... 717
Sleet cutter and contact for third-rail systems, K. E. & R. S. Co.* ... 913
Slow and medium speed direct-current motors, E. E. Mfg. Co.* ... 602
Slow and moderate speed motors, G. E. Co.* ... 754
Small engine-generator set, a, C.-W. Co.* ... 419
Snap switch and cutout, combined, H. & H. Mfg. Co.* ... 296

Industrial Section. (*Continued.*)
Sprague flexible metallic conduit for the interborough subway cars, S. E. Co ... 267
Spring binding post, F. T. Co ... 910
Statement from Mr. Milo G. Kellogg to the customers of the Kellogg Switchboard and Supply Co ... 673
Steam trap, a new form of, M.-Y. Co ... 454
Steam turbines for factory driving. 608
Steam turbine and electrical power machinery for Philadelphia subway, W. E. & Mfg. Co ... 28
Steel tie, a new form of, C. De C ... 753
Stombaugh guy anchors, W. M. N. & Bro.* ... 416
Stone pipe for underground conduits, A. S. C. Co.* ... 99
Storage battery equipment in a large St. Louis dry goods company's building, E. S. B. Co.* ... 232
Subway and arc light system of Cincinnati, Ohio, G. M. G ... 160
Switchboard indicating instruments, S. E. Mfg. Co.* ... 232
Synchronism indicator, a, G. E. Co.* 872
Telephone apparatus, new, E. G. L. Co.* ... 380
Telephone apparatus under construction, K. S. & S. Co ... 417
Telephone specialties, some new, E. E. Co.* ... 202
Telephone Specialties, some new, De V. T. Mfg. Co.* ... 67
Telpherage in coal handling, U. T. Co.* ... 824
Terminal for copper-tipped fuse links, C. F. W. Mfg. Co.* ... 63
Test methods in steam turbine construction, W. A. B. Co ... 97
Test run of combination gasoline-electric truck, F. M. V. Co.* ... 526
Thermo-call button, a, A. T.-C. Co.* 98
Trafford city, Pa., W. E. & Mfg. Co.. 673
Transformer for polyphase circuits, K. E. Co.* ... 636
Transmitter, straight-bridge, E. G. L. Co.* ... 873
Tray type storage battery, S. T. P. B. Co ... 380
Triplex blocks for hoisting service, Y. & T. Co.* ... 570
Trolley catcher, a simple form of, J. & M.* ... 378
Turbine, the "New American," D. G. I. W. Co.* ... 374
Turret lathe, motor driven, C.-W. Co.* ... 670
Twenty-two thousand horse-power in steam turbines for Pennsylvania Railroad ... 486
Vacuum drying and evaporating apparatus ... 490
Voltage regulators for generators, new types of, G. E. Co* ... 946
Volt-ammeter, a new automatic, A.-K. M. W.* ... 377
Wattmeters, a carload of, S. I. Co.* 164
Wattmeters, a large shipment of, S. I. Co ... 528
Westinghouse Electric and Manufacturing Company's balance sheet.. 454
Westinghouse mining locomotives for De Beer's consolidated mines.. 131
Westinghouse "turret" system of electropneumatic control, W. A. B. Co.* ... 527
Wireless cluster incandescent lamp fixtures, B. E. Mfg. Co.* ... 826
Wireless railway company ... 944
Wireless telegraph apparatus, C. E. C. W. T.-T. Co.* ... 414
Wireless telegraphy, a new record for, De F. W. T. Co ... 453
Wireless telephone and telegraph factory, T. E. C. W. T. & T. Co.*.. 203
World's record for coal hoisting, C. W. H. Co.* ... 489
Worthington plant, the new, H. R. W.* ... 828
Zimdars & Hunt panel board, a new* 68
Influence machines, a method of reversing (R) ... 751
Influence of a magnetic field upon the pitch of tuning forks (R) ... 868
Injuries to shade trees from electrolysis 560
Institute meeting, the (E) ... 461
Insulating bars (P)* ... 819
Insulating material, a new (P) ... 818
Interest in Institute local sections (E). 728
International Association of Municipal Electricians, the ... 267
International congress of electricity.... 451
International conference on wireless telegraphy ... 253, 320
International electrical congress, the (E) ... 169
International electrical congress, preliminary programme ... 635
International electrical congress, progress of the (E) ... 612
International electrical congress, the... 694
Interurban electric traction systems, by P. M. Lincoln ... 893
Invisible radiation, new phenomena of (E) ... 919
Iron losses (R) ... 668
Italian 30,000-volt power transmission, an (R) ... 328
Italian tramways ... 224

J

Jewett city, Ct., municipal electric lighting plant at* ... 297
Journal de Chimie Physique ... 548
Journal of the Western Society of Engineers ... 99
Judicial protection against legislative regulation of rates for public service (E) ... 498

K

Kalgoorlie, Western Australia, the electric tramways of, by S. W. Childs.. 588
Kull system of train lighting, the ... 100

L

Lachine Rapids power-house of the Lachine Rapids Hydraulic and Land Company, by R. S. Kelsch* ... 729
Languages and the telephone (E) ... 339
Largest storage battery in Canada, the (R) ... 443
Laying the new Block Island cable* ... 431
Lecture before automobile club ... 757
Light telegraphy ... 749
Lightning arresters on transmission lines, by Alton D. Adams ... 500
Locating faults in cables, two simple methods of, by Edwin F. Northrup* 278
Locomotives or motor cars? (R) ... 668
London Metropolitan Electric Supply Company's installations (R) ... 869
London municipal telephones ... 744
London underground electric railways power station at Chelsea (R) ... 869
Long-distance transmission line ... 747

M

Magnetic detector for Hertzian waves, adapted for quantitative work, a new form of, by J. A. Fleming ... 92
Magnetic effect of electric convection, the (E) ... 801
Magnetic experiments on metals ... 751
Magnetic iron sand in Java ... 940
Magnetic rotation of the plane of polarization, the (R) ... 196
Magnetic storm, the ... 757
Making an integrating wattmeter* ... 841
Manchester corporation, the new electricity works of the (R) ... 94, 127, 197
Manchester section of the British Institution of Electrical Engineers, the. 28
Manhattan elevated railroad, the profitable electrification of the (E) ... 427
Manufacture of incandescent lamps ... 413
Marconi system and the yacht races, the ... 291
Marconi, an interview with Mr ... 325
Matter and electricity (E) ... 241
Measurements of the frequency of very rapidly alternating currents (R).. 821
Measuring the variation of current in a coil during commutation (R) ... 262

Digitized by Google

Mechanical plant in the Newark, N. J., free public library*..... 214
Mechanism for driving dynamos on railway trucks (P)*..... 749
Mediterranean system of electric traction in the neighborhood of Nice and hydraulic plant of Mescla, by C. L. Durand*..... 180
Meeting of the American Electrochemical Society, the (E)..... 425
Meeting of the British Association, the (E)..... 497
Meeting of the underwriters' electrical committee (E)..... 837
Memorial to James Watt..... 548
Memorial to Dr. Robert H. Thurston... 694
Mercury coherer, the real inventor of the (R)..... 94
Metallic oxides as conductors of electricity (E)..... 920
Metallurgy of zinc (R)..... 196
Meter, a new form of (P)*..... 522
Meter performance (E)..... 611
Method for determining rates and prices for electric power, by Frank B. Perry*..... 885
Method of attaching leading-in wires in incandescent lamps (P)*..... 630
Method for finding the efficiency of series motors, a, by Ernest Wilson* 521
Method for preventing fluctuations in rotary devices (R)*..... 666
Method of producing insulated electric conductors (P)*..... 631
Method of recovering tin from scraps of tinned iron (P)*..... 410
Method of treating lead plate used in secondary battery (P)*..... 411
Methods of combining resistances, by Edwin F. Northrup*.....3, 75
Methods of measuring radiant efficiencies (R)..... 712
"Michigan Technic," the..... 99
Michigan Telephone Company, the..... 14
Midsummer number, the (E)..... 169
Misuse of physics by biologists and engineers, the, by W. S. Franklin..... 802
Modern views on matter (E)..... 137
Modern views on matter—the realization of a dream, by Sir William Crookes.....142, 171
Money value of technical training, the, by James M. Dodge..... 839
Morgan steam power plant, by C. P. Newton* 145
Motive power for coal-cutting machines (R) 524
Motor cars for railways..... 653
Motor cars as railway feeders..... 411
Motor car reliability tests in England (R) 600
Motor control, a novel (P)*..... 705
Motor control, a system of (P)*..... 749
Moulding cleat (P)*..... 441
Mountain climbing railways, by George E. Walsh..... 926
Mountain electric road in Switzerland and the Sublin hydraulic plant, by Frank C. Perkins*..... 506
Municipal ownership, reasons and remedies for (E)..... 391
Musical arc, the (R)..... 525

N

N-rays, important properties of (E).... 241
National Association of Electrical Contractors, the (E)..... 34
National Electric Light Association's report of municipal lighting statistics. 121
National Electric Light Association.590, 783, 816
Newark, N. J., mechanical plant of the free public library at*..... 214
New methods in fuel economy, by George E. Walsh..... 464
New Orleans drainage system, the electrical equipment of the, by William Mayo Venable*..... 5
New South Wales railway and tramway ambulance corps..... 481
New York Electrical Society.....629, 757, 875, 928
New York telephone service, the growth of the..... 863
New York Times, a new building for the 55
Niagara Falls, developments at, for the utilization of its power, by Orrin E. Dunlap*..... 344
Night school courses in electrical engineering 469
Nitrates by electricity..... 434
Nitric acid by electrical discharges, the production of (R)..... 159
North-Eastern Railway, England, electric traction on the (R)..... 95
North-Eastern Railway system, the.... 199
Norwood, Ohio, telephone exchange, the, by J. E. Peavey*..... 49
Note on some theoretical considerations in the construction of resistance furnaces, by Francis A. J. Fitzgerald 444
Notes on certain three-wire systems, by Charles T. Mosman*..... 627
Notes on electrical engineering..... 694
Notes on steam turbine electric generating plants..... 775
Notes on X-light, by William Rollins*..86, 120, 154, 193, 561, 711, 778, 847

O

OBITUARY.
Barton, Mr. Charles C..... 71
Bramwell, Sir Frederick..... 951
Chalmers, Mr. Thomas..... 135
Daniels, Mr. John C..... 677
Elkins, Mr. William L..... 720
Frenyear, Mr. T. C..... 951
Hesse, Mr. J. A..... 71
Honey, Mr. Albert A..... 916
Morss, Mr. Charles Anthony..... 207
Pond, Major James B..... 32
Raney, Mr. H. C..... 387
Spencer, Mr. Herbert..... 951
Stieringer, Mr. Luther..... 135
Thurston, Dr. Robert H..... 677
Wise, Mr. Albert J..... 916
Occasional instability of all matter, note on the probable (R)..... 22
Oil engine, a new..... 279
Oil engines for electrical use, by George E. Walsh 403
Operation of a commutator in oil, the*. 899
130 miles an hour..... 808
Oscillating fan (P)*..... 61
Oscillation galvanometer for measuring electromagnet rays (R)..... 485
Oscillograph, a simple..... 620
Osmium lamps (E)..... 723
Outlet box (P)*..... 789
Overhead high-tension distributing systems in suburban districts, by George H. Lukes..... 934

P

Pacific cable, the (E)..... 33
Pacific cable, the..... 40
Pacific Coast Electric Transmission Association 927
Paper-insulated cables..... 487
Parallel working of alternators, by B. Hopkinson* 517
Paris, surface-contact systems in (E).. 306
Paris Metropolitan Electric, the accident in the subway of the..... 253
Paris tunnel disaster (E)..... 242
Paris traction lines, surface contact system on the, by C. L. Durand*..... 321
Parsons steam turbine, expiration of the British patent on the (E)... 242
Parsons steam turbines in the United States and Canada..... 871
Permanency of the atom, the..... 504
Peru electrical enterprises..... 117
Philadelphia branch, American Institute of Electrical Engineers...747, 943
Photometric value of arc lamps, report of the National Electric Light Association committee* 590
Photometric tests of the chemical brightness of magnesium and phosphorus (R) 787
Pino hydroscope, the (R)..... 22
Plant growth, the effect of electricity on 360
Platinum, a new interest in..... 698
Platinum in 1902, production of..... 192
Plea for better English in science, a (R) 713
Plowing, the use of electric power in, by Emile Guarini..... 173
Polarization of Rœntgen rays..... 401
Polyphase induction motors, an interesting application of (E)..... 542
Polyphase pumping station at Bakou, Russia (R) 750
PORTRAITS.
Anderson, Mr. D. M..... 60
Barnard, Mr. B. S..... 378
Barriett, Mr. S. L..... 334
Childs, Mr. S. W..... 607
Cooke, Mr. E. T..... 58
Eidlitz, Mr. Charles L..... 57
Ely, Mr. W. Caryl..... 367
Gray, Mr. W. I.....59, 122
Hall, Mr. W. A..... 417
Herr, Dr. H. S..... 815
Hilton, Mr. James..... 59
How, Mr. John K..... 60
Hull, Senator C. E..... 815
Hutchins, Mr. Jere C..... 367
Hutchinson, Mr. A. L..... 815
Lawrence, Mr. F. D..... 417
Lawton, Mr. E. M..... 60
Layne, Mr. J. W..... 815
Loeb, Mr. H. A..... 59
Mackay, Mr. John W..... 593
Mathieu, Mr. George R..... 58
McCarthy, Mr. E. D..... 59
McCleary, Mr. E.....59, 119
Morton, Mr. W. H.....58, 123
Newbery, Mr. E. F..... 60
Raney, Mr. H. C.....387, 814
Rex, Mr. O..... 816
Sanborn, Mr. G. M..... 60
Sterns, Mr. J. C..... 123
Possible method of reducing the time of exposure in making X-light photographs, by William Rollins..... 490
Possible restriction of electrical imports (E) 680
Power developments at Niagara Falls. 193
Power for lighting cars (E)..... 801
Power for traction in a large city (E).. 884
Powerful electromagnets (R)..... 412
Power measurements on alternating-current circuits, by R. B. Williamson* 217, 250
Power plant at Hamilton, Canada, the.. 199
Practical standards for electrical measurements (E) 646
Practical standards for electrical measurement, experiments for improving 649
Practical utilization of the passive state of ions, a, by Charles F. Burgess 434
Practical telephone engineering, by W. W. Handy*.....107, 139
Preliminary report of the electric light and power plants of the United States for the year ending June 30, 1902 213
Preventing disturbances to telegraph and telephone systems caused by using the earth as a return (R)... 601
Problem in railway operation successfully solved, a (E)..... 105
Problems that are facing the electrical engineer of to-day, and the qualities of mind and character which are needed to meet them, by J. G. White 147
Process for manufacturing tubes of magnesia with a coating of carbon for use in incandescent lamps (R) 412
Process of producing active material and electrodes for storage batteries (P)* 482
Production of coke in 1902..... 417
Production of copper in 1902, the.... 293
Production of high potentials from alternating currents (R)..... 412
Production of lead in 1902..... 564
Production of petroleum in 1902..... 587
Production of rubber, the..... 586
Production of zinc in 1902..... 503
Professor Ayrton to lecture before the New York Electrical Society..... 562
Profitable electrification of the Manhattan Elevated Railroad (E).... 427
Prony brake controller, a, by James H. Taylor 587
Proper qualifications of electrical engineering school graduates from a manufacturer's standpoint, by L. A. Osborne 116

Digitized by Google

phecy of transatlantic telephony... 757
posed electric railway in Switzerland 483
posed transmission for pumping purposes, a (R)..... 94
chasing a play by wireless telegraphy 505

Q

alities needed in electrical engineers (E) 137

R

diant efficiency of the Nernst lamp (R) 942
dium, an experiment on the change of, with time (R)..... 126
dium, a notable observation with (R) 22
dium and cancer (R)..... 786
dium and plants (R)..... 786
dium emanation, heating effects of (R) 750
dium for creating consumption (E). 242
dium industry..... 888
dium, the effect of, on the conductivity of liquids (E)..... 681
dium, the heating effect of (E)..... 764
ailroad employés carnival..... 445
ailway, a sliding..... 663
ailway cross-ties (R)..... 634
aising the voltage (E)..... 764
and Central Electric Works, the (R) 159
ange-finder (P)* 327
apid cutting steel..... 693
apid submarine cabling..... 892
ecent developments in Niagara power (R) 868
ecent development of the Metropolitan Electric Supply Company's installations (R) 820
ecent steam turbine developments, by W. L. R. Emmet..... 399
ecent work on thorium (R)..... 38
eception committee of the American Institute of Electrical Engineers.. 561
ecovery of gold in combination with tellurium and selenium..... 430
ectifier, a new..... 432
eduction in cable rates to the Orient. 329
efining lead bullion by electrolysis... 288
efuse destructors 605
egulating device (P)*..... 941
egulating mechanism (P)*..... 905
egulations for electric cars and automobiles in Leipsic, Germany..... 7
egulation of transmitted power, by Alton D. Adams*..... 340
eichsanstalt, the work of the (R).... 820
elation of science to common life, the, by J. M. MacFarlane..... 275
elative cost of public lighting by gas and electricity (R)..... 786
elative value of illuminants (E).... 578
emodeling electric light plants (E).. 680
eport on the Edison storage battery (E) 836
eport of the Mexico Electric Tramways, Ltd..... 409
epublic of Paraguay to subvention engineering students 626
esignation of Mr. Calvin W. Rice.... 123
esults of the application of electrical traction to the Wannseebahn, Berlin 671
heostat, a liquid..... 699
heostat, a new form of water..... 433
heostat, simple type of (P)*..... 156
heostat, a new type of (P)*..... 666
ight of way, the, by H. H. Vreeland... 408
oyal Commission on London Traffic, the, by A. Webster..... 615
ubber production and trade of Brazil 227

S

aut-Mortier electrical power transmission plant in France, by Frank C. Perkins* 247
cheme, an attractive (E)..... 106
chenectady Railway Company's system, the (E) 274
chenectady Railway Company, the city and interurban system*..... 280
cience abstracts 316
econd annual report of the Allis-Chalmers Company, the..... 12
eeing at a distance by electricity (R).. 787
elective wireless telegraphy (E)..... 577
elenium and a new form of photo-telegraph 401
harpener for edged tools (P)*..... 865
hipments of rubber from Para..... 115
hop testing of motors and generators for commercial service (E)..... 645
hop testing of motors and generators for commercial service, by B. B. Abry....392, 428, 580, 615, 647, 691, 859
hould technical courses be broadened or specialized? (E)..... 138
iberia, electricity in, by L. W. L.*..... 856
iemen's-Schückert multiple unit system of electric train control, by Emile Guarini* 890
imultaneous telephony and telegraphy, a new system of (R)..... 712
inging arc, theory of a (R)..... 23
ingle-phase traction motor..... 561
ingle-phase repulsion motors, on, by William Cramp* 545
ingle-phase repulsion motors, by R. M. Gaston 663
ingle-phase traction experiments (R). 906
ir Hiram Maxim announces a new invention 437
ituation of the electrical industries (E) 921
leeper, the electric (E)..... 337
nap switch (P)*..... 522
ome elements inherent in automatic telephony which make it popular, by Joseph B. Baker..... 838
ome phases of technical education (E) 646
outh Africa, electric railway possibilities in 511
pain, electric tramways in..... 246
pain, electrical developments in..... 232
pain, gas and electricity in..... 252
peaking flames 443
pectrophotometric study of the luminous radiation from the Nernst lamp glower under varying current density (R) 230
peed and public safety (E)..... 209
peed and public safety, by Dr. Louis Bell 211
peed of X-rays determined by M. Blondlot, by C. L. Durand*..... 543
tandard-gauge electric railway in Prussia, the first..... 277
tandardization of apparatus, the, by J. C. Kelsey..... 936
tanley Instrument Company's works*. 841
tate laws affecting automobiles..... 175
tation economy and management, a symposium 740
tatistics of electric railways in France (R) 634
team, Gas and Fuels Building at the St. Louis Exposition..... 505
team records, by George Hayler, Jr.... 740
team turbine, a new marine..... 409
team turbine, an interesting application of the (E)..... 1
team turbine electric generating plants, notes on..... 775
team turbines, improved governor for 401
team turbine patent, a new*..... 866
terilization of water by ozone..... 112
terilization of water by oxygen compounds of chlorine (R)..... 197
tone wireless telegraphy system*.... 594
torage battery (P)..... 630
torage battery in substations, the (E) 74
torage battery in its relation to United States fortifications, the (R)..... 262
torage battery, the indication of the (E) 763
treet-car operation (E)..... 73
treet Railway Association of the State of New York..... 360
treet Railways of Leipzig..... 291
ubmarine cable, a long-distance telephone (E) 1
ubmarine cables of the world..... 224
ubstation dangers and their prevention, some (R)..... 230
ubstation telephone circuits (P)*.... 124
urface contact systems in Paris (E) 306
urface-contact system on the Paris traction lines, by C. L. Durand*.. 321
urface-contact system accepted..... 558
uspended electric railway* 109
uspension hoist, a new electrically driven (P)* 704
usquehanna development, the..... 908
usquehanna river development, some data relative to the..... 407
winburne's electric locomotive (R)... 906
wiss vertical turbines, by Frank C. Perkins* 85
witches for opening high-potential circuits under load (R)..... 907
witching for accumulator plants..... 858
witching transmission circuits, by Alton D. Adams..... 243
ydney, Australia, the electric tramways of (R)..... 158
ynchronizing apparatus (P)*..... 157
ystem of controlling electric cars (P)* 326
ystems of mains laying (R)..... 126

T

angential traction (R)..... 668
angential water-wheel efficiencies.... 277
echnical education in the United States 625
echnical education, the value of (E).. 836
echnical education—what it should be (R) 713
echnical institute for London, a..... 109
echnical press, index of the..... 291
echnology Quarterly 117
elechirograph, the* 13
elegraphone, the (R)..... 263
elephone and the technical school, the, by J. C. Kelsey..... 54
elephone engineering, practical..... 139
elephone, uses of the..... 92
elephone line between London and Belgium, the 88
elephone engineering, practical, by W. W. Handy*.....107, 139
elephone transmitter (P)*..... 326
elephone exchange system (P)*..... 440
elephone exhibit at the Cincinnati Fall Festival, by J. E. Peavey*... 589
elephone exchange, a novel (P)*.... 865
elephone systems and the fire hazard.. 852
elephone and telegraph construction for the new Republic of Panama.. 850
elephone, the expansion of the (E).. 679
elephone, the 817
elpher (P) 229
emperature rise in railway motors (E) 645
erminal for electric lamp glowers (P)* 818
esting of electric generators by air calorimetry, the..... 888
esting a new air brake in Germany.. 264
ests of electric traction by simple alternating currents (R)..... 442
ests on variable speed motors (R).... 484
hermal cutout or fuse for electric circuit (P)* 522
hird-rail danger, Mr. Westinghouse on the 935
hird rail on electric railways, position and protection of the..... 213
hree-phase power transmission plant, using high-tension motors, by Frank C. Perkins* 113
hree-phase switch gear (R)..... 668
hreshold illuminating device for elevators (P)* 482
imber treating plants (R)..... 713
otal and free energy of the lead accumulator, by R. A. Lehfeldt..... 618
racing alternating-current waves (E) 170
rack construction and maintenance, by T. W. Wilson..... 654
rackless trolley, the (E)..... 273
raining of apprentices in an engineering works, the (R)..... 906
rain lighting by oil engine units, by L. T. Brown..... 477
rain resistance formula, a rational, by John Balch Blood..... 89
ransformers (E) 2
ransformer data 250
ransmission of energy to the sugar refinery, at Cambrai, France (R).... 524

Digitized by Google

Treatment of pulmonary tuberculosis with high-frequency currents and intra-laryngeal injection of antiseptics 750
Trial of the Diesel oil engine (R)..... 669
Tungsten, molybdenum, uranium and vanadium in 1902..... 227
Turbine developments, recent steam, by W. L. R. Emmet..... 399
Turbine operated with gas engine exhaust 892
Twentieth annual convention of the American Institute of Electrical Engineers (E) 34
Two modern developments (E)..... 390
Two new books..... 774
Typewriting machine (P)*..... 93

U

Underground conduit, a new method of constructing 738
Underground Electric Railways Company, of London..... 662
Underground telegraphs 653
Union Railway Company, New York, new substation for..... 96
Universal Exposition Handbook..... 816
Use of capacities as multipliers in connection with electrostatic voltmeters on alternating-current circuits, by E. W. Marchant and G. W. Worrall* 559
Utilization of electric motors by a terminal company* 266
Utilization of furnace gases for the production of electrical energy, the (R) 231

V

Value of station records, the, by A. C. Blinn 742
Velocity of objects floating in water, the 56
Velocity of objects floating in water (E) 34
Ventilating equipment for a Turkish cruiser 56
Vindication of the storage battery, the (E) 763
Vizzola, Italy, electric power plant (R) 22
Volta, tribute to..... 666

W

Water powers on the Chippewa river... 867
Water powers on the Kennebec river.... 846
Water-tube boilers on shipboard, tests of (R) 262
Wehnelt interrupter, a new electrolyte for the (R)..... 786
Weights of German continuous-current machines 780
Welding, improvements in electric track, by George E. Walsh..... 111
Western power and lighting plants, two, by J. H. Rusby*..... 480
Western Union Telegraph Company's annual report (E)..... 577
Westinghouse Foundry Company, at Trafford City, Pa., the new plant of the* 549
Wind-driven generators..... 407
Winding gears, the electrical driving of, by F. Hird*..... 317
Wireless incident, an interesting (R).. 96
Wireless telegraphy, a test of selective.. 148
Wireless telegraphy around the Pacific.. 116
Wireless telegraphy between France and England 757
Wireless telegraphy for automatic fire-alarm stations*..... 155
Wireless telegraphy in China..... 693
Wireless telegraphy, interference in (E) 307
Wireless telegraphy in the war game (E) 209
Wireless telegraphy notes..... 876
Wireless telegraphy, purchasing a play by..... 505
Wireless telegraph experiments..... 822
Wireless telegraph in Guadeloupe..... 92
Wireless telegraph incident, a (E)..... 74
Wireless telegraph system (P)..... 190
Wireless telegraph system, the Stone*.. 594
Wireless telegraph system (P)*..... 667
Wireless telegraph system (P)*..... 789
Wireless telegraph tests..... 694
Wireless telephony, the probabilities of (E) 169
Wittefeld system of train lighting, the (R) 484
Where Philadelphia leads (E)..... 728
Why engineers should advertise, by G. H. Gibson..... 118
World's Fair and the technical press.. 521
World's Fair bulletin..... 793
World's steel industry, development of the 246

Z

Zambesi power scheme, the..... 437

AUTHORS OF ARTICLES IN VOL. XLIII OF THE ELECTRICAL REVIEW

Abry, Bertrand B., Shop Testing of Motors and Generators for Commercial Service* 392, 428, 580, 613, 647, 691, 859
Ackerman, A. S. E., Pneumatic and Electric Locomotives in and about Coal Mines 320
Adams, Alton D., Switching Transmission Circuits 243
Regulation of Transmitted Power*... 340
Lightning Arresters on Transmission Lines 500
Armstrong, A. H., High-Speed Electric Railway Problems* 7
Baker, Joseph B., Some Elements Inherent in Automatic Telephony Which Make It Popular..... 838
Bancroft, Wilder D., Electrolytic Copper Refining 435
Beadle, Alex A., Carbides..... 851
Bechtel, E. J., Engine Economy and Equipment 743
Beggs, John I., The Gas Engine *versus* the Steam Turbine..... 399
Bell, Dr. Louis, Speed and Public Safety 211
Bignami, Enrico, Electrical Installation of the City of Brussels, Belgium* 221
Conference on Wireless Telegraphy.. 320
The Finzi Single-Phase Alternating-Current Traction Motor*..... 853
Blinn, A. C., The Value of Station Records 742
Blood, John Balch, A Rational Train Resistance Formula 89
Bowie, August J., Jr., Electrical Motors for Centrifugal Pumps and Fans*.. 511
Brown, L. T., Train Lighting by Oil Engine Units 477
Burgess, Charles F., Practical Utilization of the Passive State of Iron... 434
Caldwell, F. C., The Combined Use of Alternating and Direct-Current for Central Station Work..... 781
Childs, S. W., The Electric Tramways of Kalgoorlie, Western Australia.. 588
Clark, H. Ade, The Diesel Engine..... 314
Cramp, William, On Single-Phase Repulsion Motors* 545
Crookes, Sir William, Modern Views on Matter—the Realization of a Dream 142, 171
Dodge, Austin, Advantages of Steam Turbines for Textile Mills..... 532
Dodge, James M., The Money Value of Technical Training 839
Dunlap, Orrin E., Developments at Niagara Falls for the Utilization of Its Power* 344
Durand, C. L., Electrical Notes from Europe*..62, 258, 543, 555, 701, 805, 898
Mediterranean System of Electric Traction in the Neighborhood of Nice, and Hydraulic Plant of Mescla* 180
Surface Contact Systems on the Paris Traction Lines* 321
New Fireproof Cars for the Paris Metropolitan* 491
Mountain Electric Road in Switzerland, and the Sublin Hydraulic Power Plant* 506
Speed of X-rays Determined by M. Blondlot 543
Emmet, W. L. R., Recent Steam Turbine Developments 399
Esterline, Walter, and Reid, C. E., Factors Which Affect the Energy Losses in Armature Cores*..... 149
Fitzgerald, Francis A. J., Note on Some Theoretical Considerations in the Construction of Resistance Furnaces 444
Fleming, J. A., A New Form of Magnetic Detector for Hertzian Waves, Adapted for Quantitative Work*... 92
Franklin, Wm. S., Energy Transformations in the Synchronous Converter* 44
The Misuse of Physics by Biologists and Engineers..... 802
Gaston, R. M., Single-Phase Repulsion Motors 663
Gibson, George H., Why Engineers Should Advertise 118
Guarini, Emile, Use of Electric Power in Plowing, the*..... 173
A Remarkable Alternator..... 359
The Central Station of the Brussels, Belgium, Tramways* 688
The Siemens-Schückert System of Multiple Unit Train Control*.. 891
Hanchett, George T., Electrolysis of Bridge Structures 765
Handy, William W., Practical Telephone Engineering* 107, 139
Hawkesley, Charles, Address to the Engineering Section of the British Association for the Advancement of Science 556
Hayden, Virgil, The Exchange of the Frontier Telephone Company*..... 922
Hayler, George, Jr., Steam Records.... 740
Henry, G. J., and Le Conte, J. N., An Efficient High-Pressure Water-Power Transmission Plant* 472
Hewitt, Peter Cooper, The Conductivity of Mercury Vapor*..... 902
Hibbert, W., Report on the Edison Standard Cell for Automobiles.... 862
Hird, F., The Electrical Driving of Winding Gears* 317

Digitized by Google

AUTHORS OF ARTICLES IN VOL. XLIII OF THE ELECTRICAL REVIEW—Continued

obble, Arthur C., Electrical Conditions in India 110
opkinson, B., The Parallel Working of Alternators* 517
itchinson, Dr. Cary T., The Condition Governing the Rise of Temperature of Electric Railway Motors in Service* 656, 695
ohnston, James E., Electricity in Placer Mining* 188
ones, Francis W., Hard Drawn Copper Wire 738
elsch, R. S., The Lachine Rapids Power-House of the Lachine Rapids Hydraulic and Land Company, Limited, Montreal* 729
Kelsey, J. C., Telephone and the Technical School, the..... 54
Standardization of Apparatus.....936
Kershaw, John B. C., Fifth International Congress for Applied Chemistry, Held in Berlin, June 2 to 8, 1903.. 80
The Use of Aluminum as an Electrical Conductor 470
The Use of Electricity for Glass Manufacture* 735
Industrial Electrochemisty and Electrometallurgy.....809, 861, 889, 925
Le Conte, J. N., and Henry, G. J., Jr., An Efficient High-Pressure Water Power Transmission Plant*..... 472
Lehfeldt, R. A., Total and Free Energy of the Lead Accumulator*..... 618
Lincoln, P. M., Interurban Electric Traction Systems* 893
Lodian, L. W., Electricity in Siberia... 856
Lukes George H., Overhead High-Tension Distributing Systems in Suburban Districts 934
Lyndon, Lamar, The Comparative Behavior of Floating and Booster-Controlled Batteries on Fluctuating Loads* 770, 815
MacFarlane, J. M., The Relation of Science to Common Life..... 275
Mailloux, C. O., The Gas Engine *versus* the Steam Turbine..... 399
Marchant, E. W., and Worrall, G. W., On the Use of Capacities as Multipliers in Connection with Electrostatic Voltmeters on Alternating-Current Circuits* 559
Martin, Lewis G., Cable Laying in Manila, and a Trip Around the World* 700
Matthews, Charles P., A Correction on Report of Committee on Photometric Value of Arc Lamps of the National Electric Light Association 807
McCulloch, Richard, The Production and Distribution of Alternating Current for Large City System..... 350
Montagu, Ralph, L. A., A Suggested Hydraulic Unit..... 465
Mosman, Charles T., Notes on Certain Three-Wire Systems 627
Newton, C. P., Morgan Steam Power Plant* 145
Northrup, Edwin F., Methods of Combining Resistances* 3, 75
Two Simple Methods of Locating Faults in Cables*..... 278
Osborne, L. A., Proper Qualifications of Electrical School Graduates from the Manufacturer's Standpoint..... 116
Peavey, J. E., Norwood, Ohio, Telephone Exchange, the* 49
The Telephone Exhibit at the Cincinnati Fall Festival..... 589
Peck, J. S., Grounded and Ungrounded Transmission Circuits* 177
Perkins, Frank C., Swiss Vertical Turbines* 85
Three-Phase Power Transmission Plant Using High-Tension Motors* 113
Recently Installed Saut-Mortier Electrical Power Transmission Plant in France, the*..... 247
Electric Power in Modern German and English Iron and Steel Plants* 309
European Electrically Operated Cranes* 467
Gas Engines and Three-Phase Power Plant at Laar*..... 651
Perkins, J. H., Development in the Engine Room 741
Perry, Frank B., A Method for Determining Prices and Rates for Electric Power* 885
Price, J. E., Electricity in the United States Government Service*..... 616
How the United States Government Uses Electricity* 776
Raber, W. F., Electrical Distribution in the Engine Room..... 744
Reid, C. E., and Esterline, Walter, Factors Which Affect the Energy Losses in Armature Cores, the*..... 149
Rollins, William, Notes on X-Light*, 86, 120, 154, 193, 490, 561, 711, 778, 847
Rusby, J. H., Some Typical California Installations* 77
Two Western Power and Lighting Plants* 480
Ryan, Harris J., Cathode Ray Alternating-Current Wave Indicator, the.176, 225
Scarfe, George, Electric Power for Mining Purposes 343
Siexas, E. F., Freight Development by Interurban Roads 709
Slichter, W. I., Alternating-Current Motors for Variable Speed..... 50
Stillwell, L. B., Electric Car Equipment 605
Trowbridge Dr. John, Glass Vessels and Quartz Vessels* 682
Venable, William Mayo, Electrical Equipment of the New Orleans Drainage System* 5
Vreeland, H. H., The Right of Way... 408
Walker, Sydney F., Colliery Exhibition, the 228
Electrical Mining Notes, 152, 183, 712, 745, 810
Walsh, George E., Improvements in Electric Track Welding 111
The Gas Engine and the Gas Turbine 307
Oil Engines for Electrical Use..... 403
New Methods in Fuel Economy.... 464
Mountain Climbing Railways..... 926
Webster, A., A British Light Railway System* 41
The British Association for the Advancement of Science..... 514
The Royal Commission on London Traffic 615
Electrical Notes from Great Britain, 52, 313, 706
Westinghouse, George B., "On the Third-Rail Danger" 935
White, J. G., Problems That Are Facing the Electrical Engineer of To-day and the Qualities of Mind and Character Which Are Needed to Meet Them 146
Willey, D. A., Coal Handling Machinery Driven by Electric Motors*..... 394
Williams, Arthur S., Some Notes on the Commercial Features of European Lighting Practice..... 664
Williamson, R. B., Power Measurements on Alternating-Current Circuits* 217, 250
Wilson, Ernest, A Method for Finding the Efficiency of Series Motors*.... 521
Wilson, T. W., Track Construction and Maintenance 654
Worrall, C. W., and Marchant, E. W., On the Use of Capacities as Multipliers in Connection with Electrostatic Voltmeters on Alternating-Current Circuits* 559

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A LONG-DISTANCE SUBMARINE TELEPHONE CABLE.

The Anglo-Belgian telephone cable was opened for service on June 8. This cable forms the submarine portion of the London-Brussels telephone line, the entire length of which is 245 miles. The cable forms 54.2 miles of this, and is the longest submarine telephone cable which has yet been laid. The cable consists of four stranded conductors, each insulated with gutta-percha armored with brass sheathing and steel wire.

An Unloaded Cable.

Although this cable is comparatively short, compared with submarine telegraph cables and overhead telephone circuits, it nevertheless marks a noteworthy advance in submarine telephony. No attempts were made to improve the quality of this cable by the use of inductances distributed along it, although the latter construction would have furnished a much better talking circuit. Tests of the latter construction have been made both in this country and abroad, which have clearly demonstrated the value of this system, and although the difficulties of constructing and laying this type of cable are not slight, they will undoubtedly be overcome as soon as the demand for submarine telephony makes this necessary.

AN INTERESTING APPLICATION OF THE STEAM TURBINE.

The steam turbine, as a prime mover, has received a good deal of attention of late, and its advantages have been thoroughly discussed. One of these advantages is the ability to use the expansive force of steam down to a very low absolute pressure. The reciprocating engine is limited in this respect by the enormous increase in volume of steam as the pressure decreases, and for this reason this type of engine is not able to take full advantage of a high vacuum. The low-pressure cylinder would be much too large, and friction and other losses correspondingly increased. In the turbine, however, the steam can be used to advantage with the highest degree of vacuum, and this property of the turbine was taken advantage of recently in an interesting installation.

The Accumulator System.

The system is described in a current issue of the *Engineering*, and was worked out by Professor A. Rateau, of the French Department of Mines, and has been installed in the Bruay mines, France. The problem here was to secure a more economical operation of the mining plant, but the solution is applicable to other industries where the conditions do not allow a reciprocating engine to work efficiently, and it seems inadvisable to install an entirely new plant. The plan used is to exhaust steam from the engines into a steam accumulator, where the heat is stored up and is utilized to furnish low-pressure steam as needed to steam turbines which exhaust into a condenser operating with a high vacuum.

Steam Accumulator.

The accumulator consists of a large iron cylinder, in which are placed, one above the other, a number of shallow cast-iron trays, circular in form and separated by narrow spaces for the passage of steam. The trays are kept nearly full of water and offer a large surface for the condensation of steam and for its rapid re-evaporation. This accumulator has as large a mass of metal and of water as possible.

Available Power.

In this particular case it was estimated that the mine engine, which was rated at 175 horse-power, was consuming about 100 pounds of steam per horse-power-hour, this poor showing being caused by the character of the work. It was estimated that a turbine drawing its steam from the accumulator at about atmospheric pressure and exhausting into a condenser with a pressure of about 2.13 pounds absolute, would consume about thirty-five pounds of steam per electrical horse-power. Allowing a loss of twenty per cent in the piping, it would seem that the exhaust steam from the 175-horse-power engine could be used to generate 400 electrical horse-power.

Application to Rolling Mill.

Professor Rateau also considers the case of a large rolling mill where it is not unusual to find a plant consuming 150,000 pounds of steam per horse-power-hour. The use of exhaust steam turbines in this case, it is estimated, would make available about 3,000 electrical horse-power.

In considering the advantages of this plan, the following points can be named. No additional boiler capacity is required, but against this should be set the cost of the steam accumulator, though these are much less expensive. The old plant is retained and no additional labor is necessitated at the boiler house. At the Bruay mines, a horizontal turbine unit has been installed, driving two continuous-current dynamos keyed to the steam shaft at from 1,500 to 1,800 revolutions per minute. These machines are each able to supply 450 amperes and 250 volts. Under test, this unit has shown a performance of 39.67 pounds of steam per electrical horse-

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power-hour, although the vacuum was only twenty-seven and one-half inches. The installation is most interesting as showing how the ability to pass large volumes of steam through the turbine may be taken advantage of.

TRANSFORMERS.

Electrical transformers are of various kinds and for various purposes. We have transformers for transforming from one potential to another, for transforming constant potential to constant current, for transforming an alternating current to direct current, or *vice versa*, and for transforming from an alternating current of one frequency to that of another.

The word "transformer" by common consent has been limited to that type of apparatus which transforms an alternating current from one potential to that of another. Where more definiteness seems desirable, it is customary to designate this type of apparatus as a static transformer, but there is very little chance for confusion in any case, as transformers intended for other purposes are always designated by some distinguishing term, such as rotary transformers or frequency transformers.

The static transformers may be further subdivided into the so-called constant-potential and constant-current types. The constant-potential transformer is one of the simplest electrical mechanisms, but the theory of its operation is somewhat complex. It depends for its action upon the laws of magnetic induction discovered by Henry and Faraday. It consists of an iron core upon which are wound two or more coils. In the type generally used in this country the iron core is in the form of a single or double ring. The action may be described in this way:

Action of the Transformer.

An alternating current is passed through one of these coils. This sets up in the iron which it surrounds a magnetic field, which, of course, varies with the current. Now, one of the most general laws of physics is that enunciated by Lentz, as a direct consequence of the law of the conservation of energy. This states that whenever any physical force produces an action, a reaction is set up which opposes the original force. Applying this law to the transformer, we apply an alternating electromotive force to the terminals of one of the coils. This sends through the coil an alternating current. The alternating current sets up an alternating magnetic field, and the alternating magnetic field sets up in the coil an alternating electromotive force which opposes the applied electromotive force. The result, of course, is to allow to pass only sufficient current to set up such a magnetic field as will induce this counter-electromotive force. Now, this alternating field sets up an electromotive force not only in the magnetizing or primary coil, but as well in any other coil wound on the same core. Since the electromotive force developed in either case depends only upon the strength of the magnetic field, the number of reverses per second and the number of turns of wires, the electromotive force of the secondary coil can be made anything desired by selecting a proper ratio of the number of turns in the two coils.

Reaction of the Secondary Current.

The electromotive force developed in the secondary coil may be used to supply current for any desired purpose, but when current is drawn from this coil the energy must, of course, be supplied by the primary coil, which naturally means that a greater primary current must flow. To explain this we again make use of Lentz's law. When a current is drawn from the secondary coil this tends to set up a magnetic field in opposition to that field which induces the secondary electromotive force. The result would be a weakened magnetic field in the core. This weakened field would not only lower the electromotive force induced in the secondary, but, as well, lower the counter-electromotive force in the primary, and an increased current would flow through the primary coil, bringing the magnetization back to its original value. The reaction of the secondary current is balanced by the increase in the primary current. The reactions then balance themselves in such a way that the power drawn from the secondary circuit is equal to that supplied to the primary, less the losses in the iron and copper of the transformers; and it is found that in a well-designed transformer the magnetization of the iron is practically constant, so that, given a constant applied electromotive force at the primary, a constant electromotive force is developed in the secondary. That a constant electromotive force is not delivered by the secondary is caused by the loss of potential, due to the resistance of the primary and secondary coils.

Leakage.

Another reaction appears, though to a slight degree in well-designed transformers. This is the magnetic leakage. Since the currents in the primary and secondary coils tend to set up opposing magnetic fields, a stray field may leak around through one coil without passing through the other.

Constant-Current Transformers.

This reaction has, however, been made use of in the so-called constant-current transformers. One of the early types of constant-current transformers provided a leakage or by-path for the magnetic lines, so that an increase of the current in the secondary coil forced more lines across this path and tended to lower the secondary electromotive force, and thus prevent a large increase of secondary current.

Later Type of Constant-Current Transformers.

The more recent types of constant-current transformers regulate in the same method by furnishing a leakage path, but accomplish this in a little different way. The primary coils and secondary coils of the transformers are mounted so that they may be moved together or apart. The iron circuit is long, allowing for this motion. The coils are then carefully suspended on rocker-arms, so that they tend to come together. Applying a constant potential to the primary coil, an electromotive force is set up in the secondary. As soon as any current is drawn from the secondary coil the repulsive action between the two currents flowing in the two coils forces them apart, and thus offers a path for leakage of the magnetic field between the two coils. The greater the current, of course the greater the repulsive force and the greater the distance between the coils. Transformers of this type are capable of very close regulation.

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METHODS OF COMBINING RESISTANCES—III.

BY EDWIN F. NORTHRUP.

PLUGGING IN OR DECADE METHODS.

Rheostats are commonly constructed to be operated on the decade plan, with either plug contacts or dial switches. In the ordinary plug decade arrangements there are either 9 or 10 one-ohm coils for the units place, 9 or 10 ten-ohm coils for the tens place, 9 or 10 one-hundred-ohm coils for the hundreds place, and so on. Each set of coils having the same value is designated a decade. In case there are a number of decades in a rheostat, it is not usually necessary to employ more than nine coils for each decade, except the decade of lowest denomination, where it is often advisable to use ten coils. By using ten coils in the decade of lowest denomination, the total resistance value of the rheostat is raised to an even 100, 1,000 or 10,000, according to the number of decades used. The extra coil enables the rheostat also to be more conveniently checked up by intercomparison of the different decades. Connections for an ordinary decade arrangement, as usually constructed, is shown in Fig. 17.

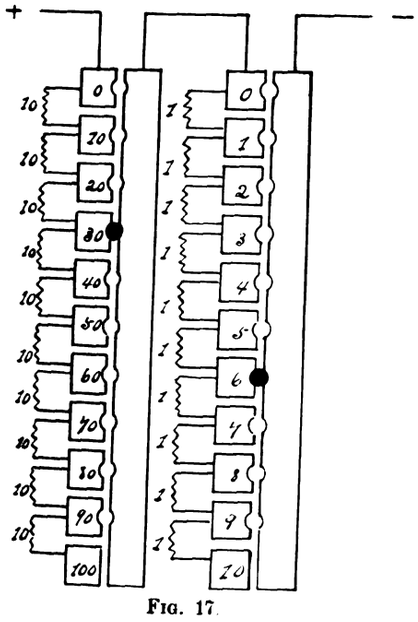

FIG. 17.

By reference to the diagram it is evident that any value from 0 to 10 in steps of one ohm (of a decade using unit coils) can be obtained by *inserting* between a bar and a block one, and only one, plug. It also appears, that if several decades are connected in series, any value up to the limit of the set can be read directly from the position of the plugs, without any mental effort whatever.

Besides the advantages of the decade arrangement above mentioned, the following may be added: The single plug used with each decade is never out of use, being either at the zero position or set at some value, and hence is not easily lost by being laid aside. The use of only one plug to the decade makes it easy to ascertain that this plug is tightly fitted in its place and making good contact. As only one block in a row is plugged at a time, the other blocks are not kept under a strain by having plugs tightly forced between them.

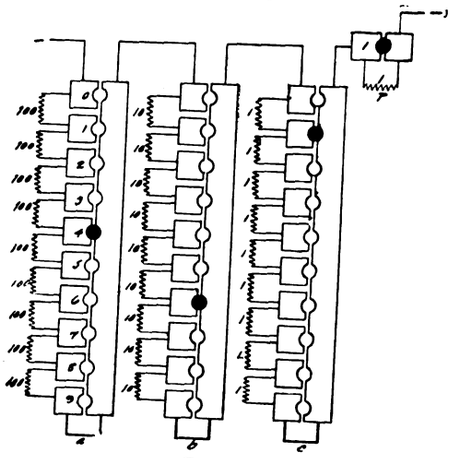

FIG. 18.

This strain of the blocks, which must exist in sets where a coil is put in circuit by removing a plug, tends to separate or loosen them, and often to warp the hard rubber upon which the blocks are mounted and to cause other plugs to loosen when some are pushed in tight. The decade plan alone permits of obtaining a succession of values in a simple manner with dial switches or sliding contacts.

The best way to construct a rheostat on the decade plan with nine coils to the decade is shown in Fig. 18.

Here all the coils of the set are connected in series so the circuit is never open when the plugs are removed. It is an advantage to have the permanent connections shown at *a*, *b* and *c*, for then all the coils of the decade can be thrown in circuit by simply removing a plug, it not being necessary to insert it again as would be the case if the connections *a*, *b* and *c* were not made. Moreover, if any plug makes a bad contact its effect is somewhat lessened by having this bad contact shunted with the remaining coils of the decade. Again there are occasions when violent deflections of a galvanometer are prevented by not having the circuit entirely open when the plug is taken out. The capacity of the arrangement, shown in Fig. 18, is raised to 1,000 by adding the extra one-ohm coil at P.

Any value can be instantly read, as 247, by observing the position of only as many plugs as there are decades. Adding the extra one-ohm coil permits of making the following checks of the resistance. All the ones equal a ten, all the tens plus all the ones equal one hundred, all the hundreds plus all the tens plus all the ones equal one thousand, and so on.

METHODS FOR ADDING TO THE ADVANTAGES OF THE DECADE. THE ADVANTAGES OF FEW COILS.

The advantages of decade arrangements of coils for rheostats are so numerous that their adoption would long ago have become universal, if it were not for the fact that a larger number of coils are required for a given range of values than are needed in the other methods described. As the chief expense in constructing precision rheostats is connected with the adjustment of the coils, there is a great saving by using only a few coils, as in Siemens plan or the 1 — 2 — 3 — 4 method. The ideal arrangement, especially for precision rheostats, where each of the coils must be adjusted to a high degree of precision, is to be found in a method which will combine the advantages of the decade arrangement with the use of very few coils —no more than are employed in the 1 — 2 — 3 — 4 or 1 — 2 — 2 — 5 or 1 — 1 — 3 — 5 arrangement.

With this ideal arrangement in view, two different methods have been devised; one due to M. Feussner and one to A. O. Beneke. Several other methods have been recently devised by the writer, which will be described after giving an explanation of the two mentioned above.

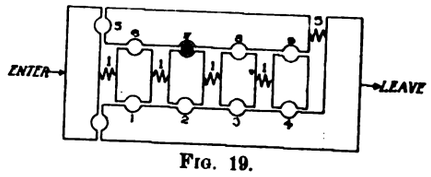

FIG. 19.

FEUSSNER'S METHOD.

In this method values from 0 to 9, in steps of one ohm, or any even multiples of these numbers, are obtained with four one-ohm and one five-ohm coils or even multiples of these. A reference to Fig. 19 will make the arrangement perfectly clear without further explanation.

Precision rheostats constructed on this plan, and chiefly used in connection with Wheatstone bridges, have been made by European instrument makers.

BENEKE'S METHOD.

This method is very similar to Feussner's. The plan of arranging the coils is easily understood by reference to Fig. 20.

The method employs six coils, and values 0 to 10, inclusive, are obtained.

The two above methods make a saving of about one-half the coils over the ordi-

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ethods of constructing decade rheo- and in this respect are superior. ollowing objections may be urged t these methods: The block con- on is rather expensive, the series are not arranged in straight rows, t a large number is not quite so y read from the position of the as in the ordinary decade ar- ment, the surface of the rub- between the blocks is not so got at to be cleaned, the ds are not adaptable to sliding con- or dial switch arrangements, and, y, it is possible to obtain the decade a still smaller number of coils.

THE WRITER'S METHODS.

describing these methods a al arrangement of the coils will first ven, and then a list of other arrange- s by which similar results may be ined.

3, 3^1 and 2-ohm coils are connected eries, as shown in Fig. 21.

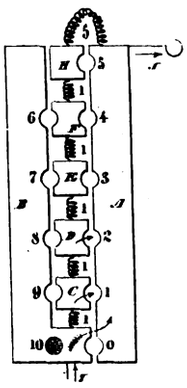

FIG. 20.

Let the terminals of the one-ohm coil d the two-ohm coil and the points of ion of the coils be numbered, (1), (2),), (4), (5), as indicated in Fig. 21. he current enters at the point (1) and ves at the point (5), traversing $1 + 3$ $3^1 + 2 = 9$ ohms in all.

This series may be multiplied by any ctor n, in which case the current trav- ses $n\ (1 + 3 + 3^1 + 2) = n\ 9$ ohms

If now the points (1) and (5) are con- ected, all the coils are short-circuited, nd the current traverses 0 resistance, if he points (2) and (5) are joined the 3, 3^1 and 2-ohm coils will be short-circuited nd the current traverses one ohm. By xtending this process, in which two points nd only *two points* are joined, it is pos- ible to obtain the regular succession of alues, n (0, 1, 2, 3, 4, 5, 6, 7, 8, 9), the ast value being obtained when no points re joined and the current passes through ll the coils in series. In the table below re given the points which must be con- nected in pairs for obtaining each of the above values and the coils which will be in circuit corresponding to each value.

Value.	Points Connected.	Coils Used.
0 =	(5 — 1)	0
1 =	(2 — 5)	1
2 =	(4 — 1)	2
3 =	(2 — 4)	1, 2
4 =	(3 — 5)	1, 3^1
5 =	(1 — 3)	3^1, 2
6 =	(2 — 3)	1, 3^1, 2
7 =	(5 — 4)	1, 3, 3^1
8 =	(1 — 2)	3, 3^1, 2
9 =	0	1, 3, 3^1, 2

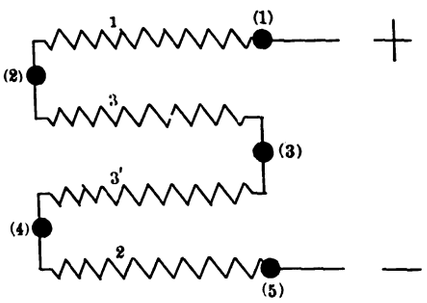

FIG. 21.

Suppose now we make two parallel rows of blocks, ten blocks in each row. Let the blocks be so arranged that opposite blocks can be connected together by the insertion of a plug. To the first pair of blocks let the points (1) and (5) of Fig. 21 be connected, to the second pair of blocks let the points (2) and (5) be joined, to the third pair the points (4) and (1), to the fourth pair the points (2) and (4), to the fifth pair the points (3) and (5), to the sixth pair the points (1) and (3), to the seventh pair the points

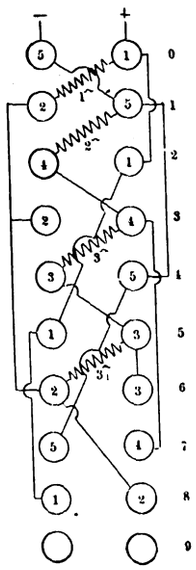

FIG. 22.

(2) and (3), to the eighth pair the points (5) and (4) and to the ninth pair the points (1) and (2). It is now evident that if a plug be inserted between the first pair of blocks 0 resistance will be obtained between the points (1) and (5), if the plug is inserted between the second pair of blocks the resistance will be one ohm. Thus all values from 0 to 9 can be obtained by traveling the plug down the double row of blocks.

Fig. 22 shows the arrangement of these two rows of blocks diagrammatically and the manner in which they would be connected up in actual practice.

The numbers, in the circles representing the blocks, correspond to the points (1) to (5) of Fig. 21. The numbers 0 to 9 to the right of the double row of blocks indicate the resistance values which would be obtained when a plug is inserted between any pair of blocks. Thus, inserting a plug between the blocks 1 — 5 the value is 0 resistance, inserting a plug between the blocks 2 — 5 the current traverses the one-ohm coil, inserting the plug between 4 — 1 the current traverses the

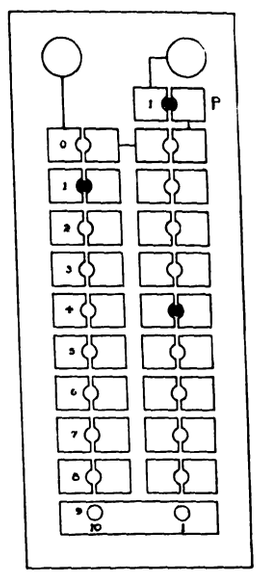

FIG. 23.

two-ohm coil. Again, if the plug is inserted between 5 — 4 it will be seen by carefully tracing the diagram that the current traverses the 1, 3, 3^1 ohm coils, giving seven ohms.

The value 9 is obtained when the plug is withdrawn or is disposed of by being inserted in the last pair of blocks which have no connections.

Fig. 23 gives a top view of a rheostat of two decades arranged on this plan.

In the decade of lowest denomination an extra one-ohm coil is added at P to make the rheostat read to an even 100.

In a rheostat constructed on this plan any value can be instantly read off by observing the position of as many plugs as there are decades. Further, it is only necessary to stamp one row of figures 0 to 9 on the left-hand row of blocks of the rheostat and to designate at the tops of the rows the different decades as the unit decade, the ten decade, etc.

(To be continued.)

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Electrical Equipment of the New Orleans Drainage System.

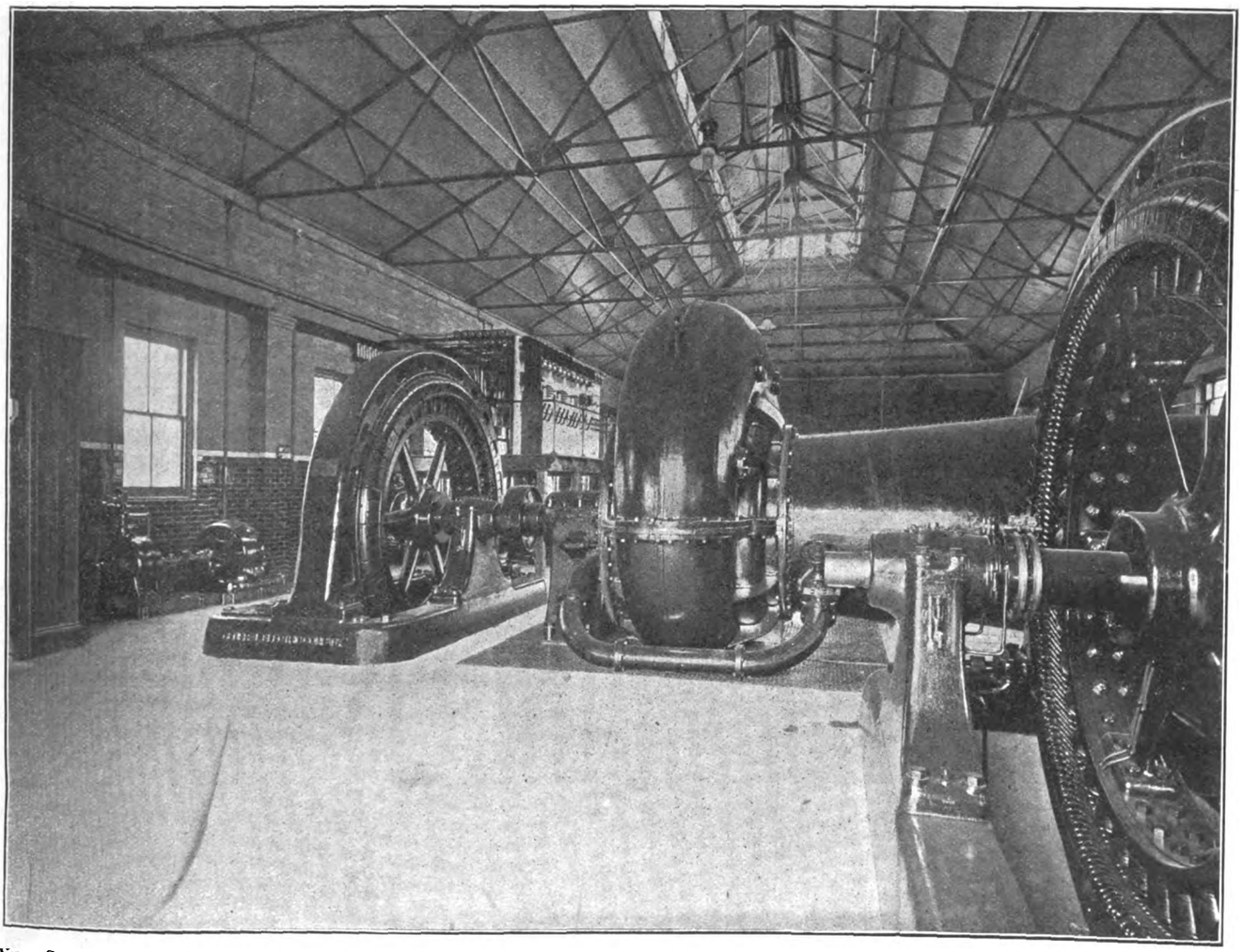
By William Mayo Venable.

THE city of New Orleans has just completed that portion of its drainage system which can be constructed with the funds that can be devoted to this purpose derived from the sale of public improvement bonds for water supply, sewerage and drainage. The various pumping stations in this drainage system are driven by electric power, which is supplied from a central power-house, located on the outskirts of the city. From an electrical viewpoint this system is unique. It is a very large equipment of three-phase machinery connected to large centrifugal and screw pumps, and operating under conditions which are entirely different from those which usually govern the operation of an electrical transmission system.

The chief condition which is radically different from those usually to be encountered is the extreme irregularity in time of operation. Power is required only during and after storms, excepting a small amount of power required to pump the constant duty drainage. As a result the larger portion of the plant must be kept in readiness for sudden operation, but is during far the greater portion of the time entirely idle. Under such conditions economy such as can be achieved in central stations carrying a comparatively steady load is out of the question, but a greater economy is effected than would be if the system were operated by steam without the intervention of electricity. This economy comes from the ability to concentrate the steam plant at one central station instead of distributing it at several pumping stations, and from the lesser number of regular employés required to operate a central station and substations equipped with electric motors over what would be required to operate corresponding pumping stations with the same number of engines as there are pumps.

At the present time only about one-half the machinery which it is ultimately intended to install has been put into operation. This is distributed among five pumping stations that have recently been built, with a very small equipment at a sixth station originally operated by steam, but recently equipped with an electrically driven pump. Of these pumping stations only one has a complete equipment at the present time, another station has three-quarters of its complete equipment, another two-fifths, another three-fifths and another two-fifths.

The electrical current used in this equipment is distributed on the three-phase system at twenty-five cycles per second and 3,150 volts. Central station is equipped with a number of three-phase gen-



VIEW SHOWING ONE LARGE PUMP AND TWO LARGE MOTORS IN PUMPING STATION NO. 3. THE SWITCHBOARD IS SHOWN IN THE REAR, AND A CENTRIFUGAL FIRE PUMP, OPERATED BY ELECTRICITY, IS SHOWN BENEATH THE WINDOW AT THE LEFT.

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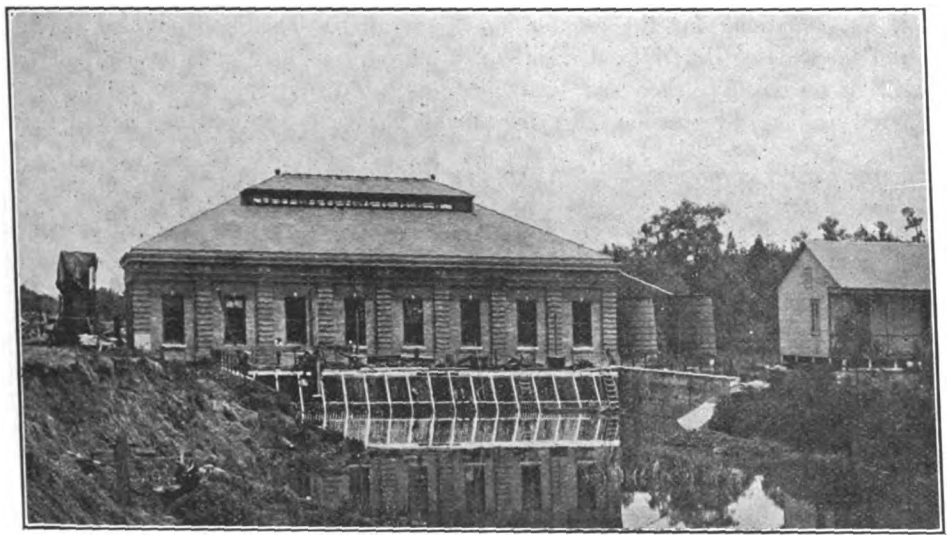
erators to deliver current to the lines and the bus-bars, and switches are so arranged that any generating unit can be used singly to supply current to any set of feeders leaving the station or in connection with any number of other units in multiple upon any combination of feeders. The generators are all of the usual type, mounted on horizontal shafts directconnected to steam engines. The regulation of the generators and engines varies with their size, but no difficulty is encountered in operating the units in multiple.

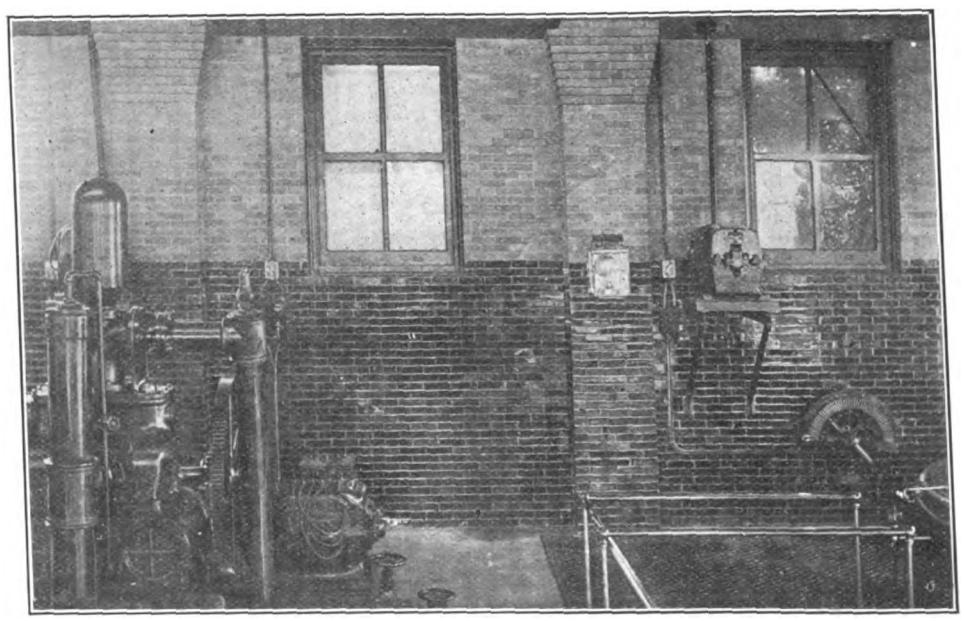


SUCTION SIDE OF PUMPING STATION NO. 6, WHERE THE WATER IN THE CANAL IS ABOUT TWELVE FEET DEEP. WHEN THE PUMPS ARE RUNNING THE WATER IS PUMPED LOWER. THE SCREEN IS TO PREVENT STUMPS FROM REACHING THE PUMPS.

Two sets of feeder lines run to each pumping station, where they may be connected to either of two sets of bus-bars or to both sets. These bus-bars run along the various panels of the switchboard, of which there is one for each motor connected to a drainage pump, and one for each of two rotary converters. These rotary converters are operated by the three-phase current taken from ordinary stationary induction transformers, where it has been reduced to a low voltage. The continuous-current side of the rotary transformers furnishes current at 125 volts, which is used to excite the moving fields of the large motors, to furnish light for the station and to operate various small motors at the station for the purpose of opening and closing gates, operating machine tools for repair work and pumping out the pits in which the large pumps are located whenever it is necessary to get at portions of these pumps, which are ordinarily under water.

Current from the line passes through fuse blocks and lightning arresters before reaching the bus-bars. The bus-bars are connected with any motor or the transformers by means of oil switches, and no connection is neccessary to start up any unit, but to throw in one set of these switches upon a set of bus-bars it is absolutely impossible to make any mistake or to do any harm in operating the board.

The motors at all of the stations are of the three-phase synchronous type and are direct-connected to the shafts which carry the moving parts of the centrifugal or screw pumps. In one of the stations these shafts are on a horizontal plane, and the pumps are above the floor line. At the other stations the shafts are vertical, the motors being above the floor line and the pumps in the bottom of pits especially constructed to receive them. This latter method has the advantage of higher efficiency, owing to the shorter water courses. It has also the advantage of not requiring any priming in order to put the pump in operation. On the other hand, it has the disadvantage of having the pump located below water level and consequently not so readily accessible for repairs, and the disadvantage of requiring gates on both the suction side and the discharge side of the station in order to keep the water out of the pumps and the pits when repairs are being made, and to keep the water from flowing back through the station when the pumps are idle. The most interesting feature of this equipment is the method of starting, the motors being synchronous they can not be started under a heavy load with the engines running at full speed. It is impossible to get them up to speed with no load unless the pits are pumped out. The method that is actually employed is to start pumps and engines together and bring them up to speed together. This has been found a very economical and satisfactory method. It is possible to start several pumps at the same time by this method, or to use one engine for picking up pumps successively and transferring each pump to the main bus-bars upon which many generators are operating in multiple as soon as the individual pump is brought up to speed. To shut down any pump all that is necessary is to open the main switch and close the gates. One station is provided with flap valves on its discharge side and other stations are soon to be provided with similar valves, so that it will be necessary only to open the switch in order to shut down any motor.



PUMP USED FOR PUMPING OUT THE PITS IN WHICH THE LARGE DRAINAGE PUMPS ARE PLACED WHEN IT IS NECESSARY TO DESCEND INTO THE PITS TO MAKE REPAIRS. THE MOTOR WHICH OPERATES THE GATE AT THE DISCHARGE SIDE OF THE STATION IS ALSO SHOWN ON A LEVEL WITH THE BASE OF THE WINDOW. A HORIZONTAL ROD RUNS THROUGH THE WALL FROM THE MOTOR TO THE GEAR PIT.

A discharge of 250 cubic feet of water per second at normal head has been taken

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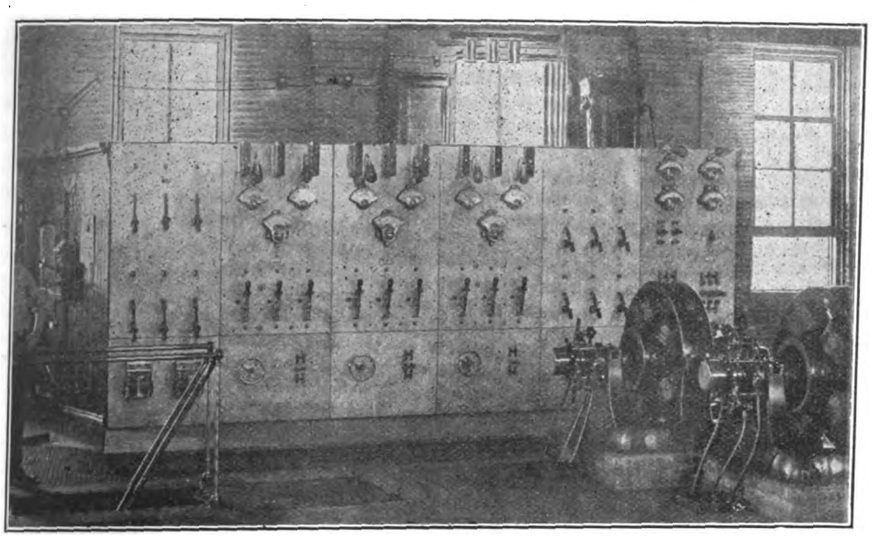
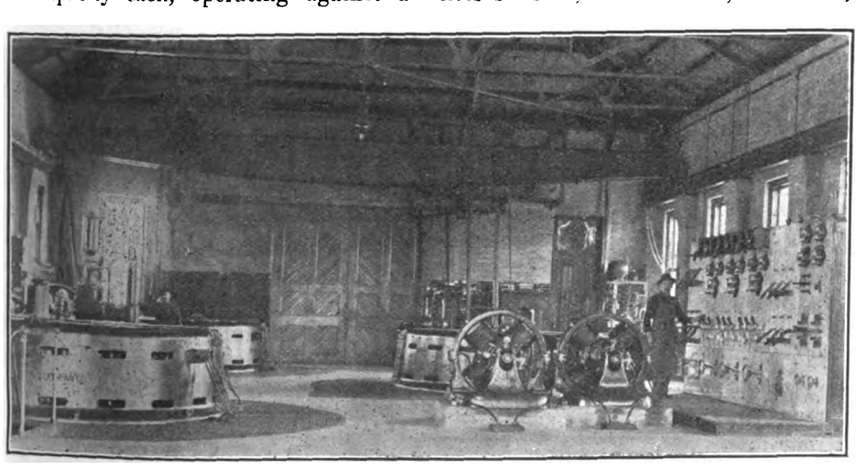
as the standard size for pumping units. The height to which this water is lifted at different stations varies. At pumping stations Nos. 6 and 7, which are equipped with submerged centrifugal pumps, this height is ten feet with a possibility of an increase to twelve or thirteen feet by speeding up the generators. Of course,



THE SWITCHBOARD AND ROTARY CONVERTERS AT PUMPING STATION NO. 7. ONE OF THE TRANSFORMERS WHICH LOWERS THE POTENTIAL FOR USE IN THE ROTARIES IS SEEN PROJECTING ABOVE THE TOP OF THE SWITCHBOARD.

at heads less than ten feet the pumps discharge very much more water, having a maximum discharge capacity of about 350 or 400 cubic feet at the lowest heads that are ever encountered. Pumping station No. 3 pumps against a head of eight feet under normal conditions. It has two pumps above the floor line, discharging at this head, and one constant duty pump which at present is capable of discharging at a head of sixteen feet, a total amount of seventy cubic feet per second. Pumping stations Nos. 1 and 2 are equipped with screw pumps of 250 cubic feet capacity each, operating against a



THE GENERAL ARRANGEMENT OF THE INTERIOR OF PUMPING STATION NO. 6.

head of five feet. There are three of these pumps at station No. 1 and two at station No. 2 at the present time, besides constant duty pumps of the centrifugal type of forty cubic feet capacity each and a lift of ten feet. The sizes of the motors required to operate these various units are as follows:

Each unit at stations Nos. 6 and 7.375 kilowatts.
" " " 3..... 300 "
" " " 2.....220 "

The pumping stations are scattered in various parts of the city at from one mile to five miles distance from the central power-house. Communication is established between all of the stations by a private telephone system carried upon the same poles as the power transmission lines, but there is also a separate communication between several of the pumping stations and the local telephone exchange.

Regulations for Electric Cars and Automobiles in Leipsic, Germany.

Consul B. H. Warner writes from Leipsic, Germany, the following communication: "Municipal ordinances prescribe that electric cars shall not run at a higher rate of speed than nine miles in the business sections, with trailers, 7.2 miles; in residential sections, 10.8 miles an hour, or nine miles with trailers, and in the suburbs, fifteen miles, or twelve miles with trailers. The penalty for exceeding the speed limit is a fine of $15 or imprisonment for fourteen days, or both. In case of an accident, a higher penalty may be inflicted."

HIGH-SPEED ELECTRIC RAILWAY PROBLEMS.[1]

BY A. H. ARMSTRONG.

Among the many questions to be considered in a new railway project, perhaps the one of primary importance is the question of a proper speed at which to run the road, as depending upon this factor is not only the first cost of the road, but its cost of operation and probable receipts. It is the purpose of this paper to touch briefly upon some of the fundamental relations existing between first cost of a railway system, its probable cost of operation and schedule speed, discussing also the probable traffic receipts to be secured with different methods of operation. In considering so broad a problem in a paper of this length, it will be necessary to omit detailed proof of many of the statements made, but the method of arriving at the conclusions will be outlined. Most of the data presented is obtained from a very elaborate series of experimental tests, so that the results obtained may be considered of direct practical application.

Owing to the wide field covered by the electric railway motor, it is not possible to consider all classes of railways and therefore this discussion is limited to the relatively high-speed roads. It is a mistaken idea that acceleration problems are met with only in city or elevated work where the stops are frequent. Although the so-called high-speed roads stop at comparatively infrequent intervals, the relation existing between stops and schedule speeds often calls for the most serious consideration of fractional speed running of the motors. Such roads really act as tributaries to large city street railway systems and must be able to operate over several miles of city tracks at slow schedule and with frequent stops, and also be adapted for operation at forty or fifty miles per hour, with infrequent stops on a private right of way.

While each road presents its own local characteristics, they can generally be divided into two broad classes, those having frequent stops and those having very few stops. Both classes of service will probably parallel one or more steam lines and must make a schedule speed that will compare favorably with that obtaining on the competing steam road. This high schedule speed must also be made with more frequent stops than given by the steam service, and in nearly all cases over a track which has many sharp curves,

[1] A paper presented at the twentieth annual convention of the American Institute of Electrical Engineers, Niagara Falls, N. Y., June 29 to July 3, 1903.

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which have the effect of still further increasing the number of stops. Interurban roads having very infrequent stops, say one stop in five or ten miles, private right of way, and an alignment free from curves of less than three degrees, can give a service equal or superior to any competing steam line, and can furthermore provide the frequent service which has proved one of the valuable assets of electric roads. Moreover, the generating station, feeder system, motor capacity and power consumption will be moderate in first cost. The problem of high-speed electric service therefore is a comparatively simple one, provided the alignment is free from sharp curves and the stops are very infrequent, and such a service can be operated at a less cost and will attract more traffic than the competing steam line with its anti-

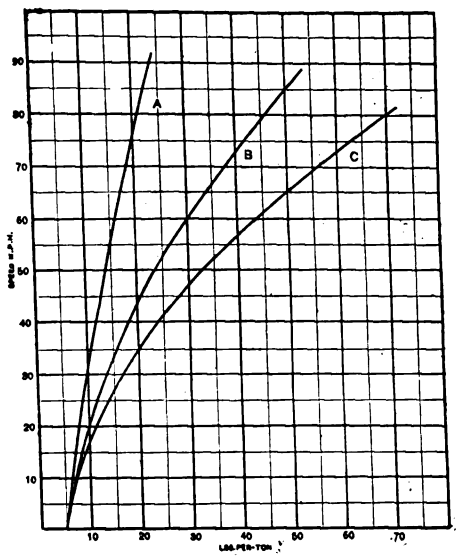

FIG. 1.—FRICTION CURVES.

quated method of operating with steam locomotives.

Suburban roads, however, that pick up their load at frequent intervals along the route and still have to compete with parallel steam lines, present problems much more difficult to solve from an economic standpoint. It is the custom of such roads to establish stopping points, say one mile or less apart, and stop at these points only on signal. During certain portions of the day, however, cars will be obliged to stop at nearly all these stations, and will either fall behind their schedule at such times or will have too much leeway during the remainder of the day when stops are much less frequent. Moreover, owing to the considerable city running at necessarily slow speeds, these suburban roads must make as good time as possible on the suburban route in order to bring the passengers from the more distant points within a reasonable time, including city running. In fact, such roads when paralleling steam lines operating on private right of way through the city, and moreover giving excellent service morning and night to commuters, are compelled to face very serious engineering and economic problems due to the tremendous amount of generating apparatus, line copper and motive power required to give equally good service.

A suburban road will develop a considerable amount of traffic, due to its frequent service, but there comes a time when such roads will extend beyond the zone of half-hour runs into the city and try to reach the outlying districts hitherto belonging exclusively to the steam lines. The frequent service will always be a valuable asset and one that can not be duplicated with the steam locomotive, except at higher cost of operation, but if it takes considerably longer to reach the city by means of the electric line than by the steam road with its better facilities for high speed, the electric line will fail to obtain the proportion of suburban business to which it has been accustomed in its more limited scope. In other words, it fails in its purpose, due to the frequent stops to which its previous popularity was due.

In considering the proper speed at which to operate a new electric line, it is necessary therefore to go very carefully into local details and especially canvass the competition with existing steam lines not only when operated in their present form, but also consider the possibility of their adopting electricity as a motive power.

In considering the possible speeds of a car or train of cars, the investigator is met with the necessity of obtaining some accurate data on the question of car and train friction. The greater part of the data now existing on this subject has been obtained with trains hauled by steam locomotives. Many of these results were obtained by draw-bar pull and hence neglected the wind-friction of the locomotive, and those taken by indicator diagrams are open to the objection that the steam locomotive is not square ended like a car and wind-friction results so obtained are not applicable to the operation of the train electrically without locomotive. Moreover, all these results were obtained with more than a single car in the train and do not apply to suburban electrical operation which almost universally uses single car trains. Tests are being made from time to time with electrically operated trains, and due to the refinement of the carefully calibrated voltmeter and ammeter it is possible to obtain wind-friction values at various speeds and with different number of cars in a train with greater accuracy than in the previous steam tests. These results are not at all complete and the only attempt known to the writer to obtain friction values with different number of cars was made by Mr. W. J. Davis, Jr., through the courtesy of the International Railway Company on its Buffalo & Lockport line in March, 1900. Using these tests as a basis, the writer has drawn up three friction curves in Fig. 1, designating them A, B and C.

The C curve will hold approximately for single car operation where the car weighs in the vicinity of forty tons. The B curve applies to the operation of two such cars in a train and the A curve to a train of such cars, say eight or more in a train. These curves are not published

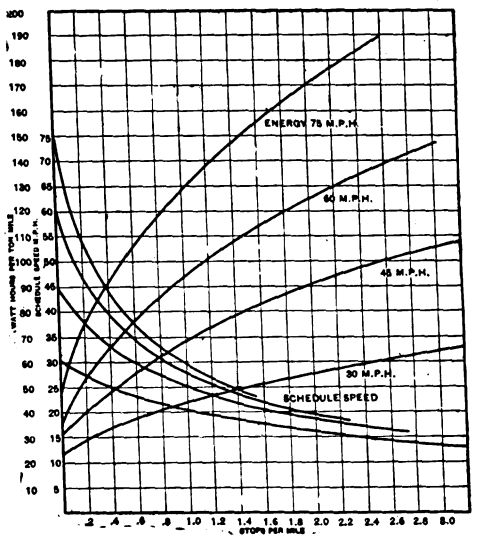

FIG. 2.—SPEED AND ENERGY CURVES.
A—FRICTION CURVE.

with the idea that they are correct, in fact the speeds at which they were obtained do not exceed sixty miles per hour, and hence extension beyond this speed is based upon a formula which will follow curve shape up to sixty miles per hour. As the results obtained by using them are not dependent upon their numerical values, intermediate points being easily interpolated, it is not of prime importance that the three friction curves given represent accurately the conditions as set forth. In fact, with the different shaped cars now in use and the different cross-section of cars having the same weight, etc., it is hardly possible to make one friction curve which would apply accurately to all cases. It is probable, however, that the curves given have the general shape and the numerical values applying to average conditions. The friction curves have been extended to maximum speeds approaching ninety miles per hour in order that questions of motor capacity, train energy, possible schedule speeds, etc., can be fol-

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lowed up to maximum speeds equal to or better than those in vogue on the present steam roads. As will be pointed out later in this paper, the consideration of the proper method of operating a railway service at these high maximum speeds leads to very interesting results as determining the size of trains and frequency of service to be adopted.

With the friction curves in Fig. 1 as a basis, the curves in Figs. 2, 3 and 4 have been calculated, showing the possible schedule speeds and energy consumption required for these speeds up to and including seventy-five miles per hour maximum. The method used in making up these curves is similar to that pointed out in a paper entitled "A Study of the Heating of Railway Motors," presented by the writer at the annual meeting of the Institute in 1902. As indicated in that paper, the rate of acceleration and rate of braking do not have a marked effect on the energy consumption or possible schedule speeds for these comparatively high-speed roads. The shape of the motor characteristic also is not a determining feature and can be neglected without introducing a possible error of more than a few per cent. The controlling factor in all of these curves is the friction curves, which includes track, rolling, journal and wind-friction.

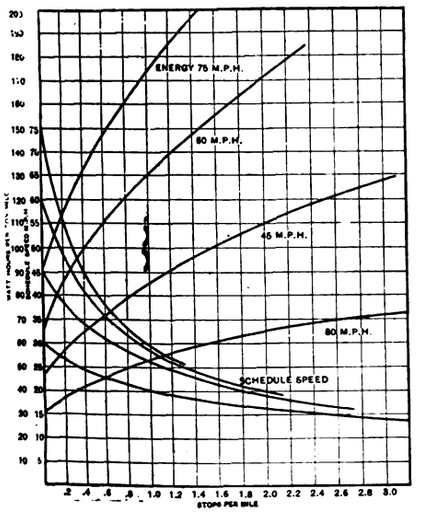

FIG. 3.—SPEED AND ENERGY CURVES. B—FRICTION CURVE.

The constants assumed in calculating the above curves are those pertaining to average high-speed suburban work as follows:

Gross accelerating rate	120 pounds per ton.
Braking effort (average)	120 " "
Duration of stop	15 seconds each.
Track assumed to be perfectly straight and level.	

In the above curves, due consideration is given all the losses occurring during acceleration with the standard series-parallel controller and direct-current motors. If the curves are to be used for alternating-current motors, allowance must be made for the difference in accelerating efficiency of the two types of motors and their methods of control. The inertia of the rotating parts of the equipment generally amounts to five per cent and this value is taken throughout, being perhaps a little high for the higher speeds and low for the lower speeds. The speed curve of a standard 125-horse-power motor is used throughout. The energy curves given are somewhat affected by the amount of coasting done, although this is not so determining a factor in this high-speed work as it is in slow-speed rapid transit accelerating problems. In order that the energy curves should be conservative, they are plotted with only ten seconds of coasting permitted and therefore the schedule speeds given are nearly the maximum possible, and the energy curves given are also practically the maximum possible with the maximum speeds assumed. Should power be shut off earlier and more coasting permitted, the energy consumption would have been decreased and the schedule speeds decreased somewhat also, especially with the more frequent stops per mile.

An inspection of these three sets of curves will bring out the very great effect of the wind-friction when using trains of one or two cars at very high speeds, in fact at seventy-five miles per hour maximum speed the operation of single car trains becomes impracticable with light forty-ton cars of standard construction, and even at sixty miles per hour is questionable. To quote from the curves, it requires an energy consumption of forty-seven watt-hours per ton-mile for a train of several cars, as against 137 watt-hours per ton-mile for a single car operating at seventy-five miles per hour without stops; that is, a single car operation would demand 3.7 times the energy per ton that would be required for the operation of a train of many similar cars. Even a two-car train will require but ninety-two watt-hours per ton-mile, or only sixty-seven per cent of the energy required per ton for single car operation. As these values are for constant-speed running, while more or less frequent stops would obtain, a comparison at, say, one stop in four miles would be nearer the actual results in practice. Here a single car requires 157 watt-hours per ton-mile, a two-car train requires 120 and a train of several cars seventy-nine watt-hours per ton-mile. The results would indicate that in a class of service calling for very high maximum speeds, the tendency of electric roads will be to follow steam railroad practice and operate trains of several cars at more infrequent intervals rather than follow present practice of suburban electric roads and run single cars at frequent intervals. It will be a question for local consideration whether sufficient additional traffic would be gained by the operation of single cars, say on half hour headway, or trains of two or three cars on one hour headway or more, the latter requiring but sixty or seventy per cent of the power per ton moved, and also effect a considerable saving in train crew expenses. As the maximum speed of the service is reduced the difference in energy consumption between single cars and trains of cars is also reduced, and at thirty miles per hour a single car will require but slightly more energy per ton than a train when operated at the frequent stops characteristic of low speed service.

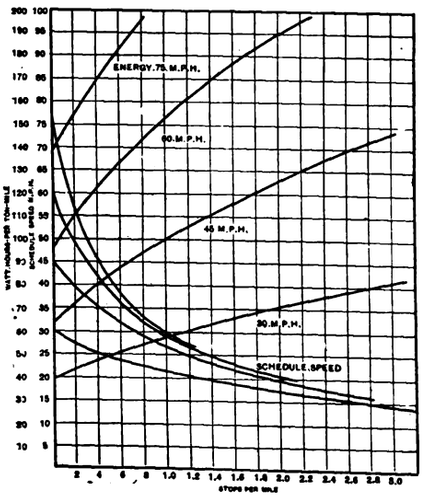

FIG. 4.—SPEED AND ENERGY CURVES. C—FRICTION CURVE.

Another very interesting feature which is well known but perhaps not fully appreciated is brought out by the curves of schedule speeds possible for different maximum speeds. Thus, with one stop in eight miles it is possible to make a schedule of sixty-one miles per hour with maximum speed of seventy-five miles per hour, and a schedule of twenty-eight miles per hour with maximum speed of thirty miles per hour. If stops be increased so that they average one per mile, however, the schedule speed possible with a maximum speed of seventy-five miles per hour is dropped to twenty-nine miles per hour, while the thirty miles per hour maximum speed permits of a schedule speed of twenty-two miles per hour. Thus while thirty miles is but forty per cent of the higher maximum speed it permits a schedule at one stop per mile of seventy-six per cent of that possible with seventy-five miles per hour maximum speed. The fal-

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lacy of using high-speed equipments for frequent stops is forcibly brought out by referring to the energy curves in Figs. 2, 3, and 4. With one stop per mile it requires 200 watt-hours per ton-mile with seventy-five-mile maximum speed equipment, and the thirty-mile maximum speed equipment can obtain seventy-six per cent of the same schedule with an expenditure of only 28.5 per cent of the energy. The two values taken for the maximum speed are the extreme, but serve the purpose of bringing out the tremendous price paid for high schedule speeds at frequent stops. The conditions of acceleration and braking are the same in both these equipments, while if higher schedule speeds were required with, say, one stop per mile, a higher rate of acceleration and, if practical, a higher rate of braking would be adopted. The difference in energy values would be considerably reduced thereby, but neither the average rate of acceleration nor the braking could

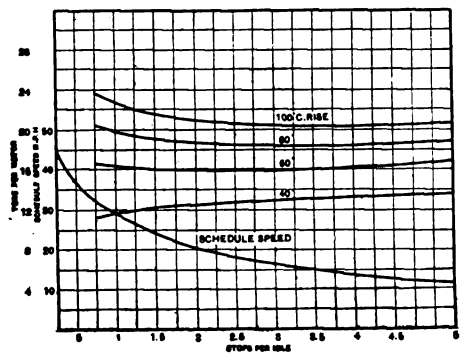

FIG. 5.—MOTOR CAPACITY CURVES, 125-HORSE-POWER MOTOR.
B—FRICTION CURVE.

be very largely increased without incurring the possibility of discomfort to passengers.

Before considering the application of the previous curves to a concrete case, it is necessary to include the effect of the different friction curves at high speeds upon the capacity of the motor equipment. In the paper by the writer at the last annual meeting of the Institute, the manner of fully determining the capacity of a motor for any service was indicated. The details of this method will not be gone into in the present paper, but for convenience a sample motor capacity curve of a 125-horse-power equipment operating at a maximum speed of forty-five miles per hour is shown in Fig. 5.

The means taken to determine the capacity of this motor is to obtain from a series of temperature runs made upon an experimental track the degrees rise per watt loss in different parts of the motor for different ratio losses for armature and field. It is obvious that so long as the motor losses and their distribution are the same, the temperature rise of the different parts of the motor will also be practically the same. This assurance that the car will travel at the same average speed, which is not necessarily the case owing to the fact that the same motor cycle could be obtained with a considerably different train cycle. A service capacity curve similar to Fig. 5 on the 125-horse-power motor is therefore not absolutely correct unless the thermal capacity curves be obtained from actual tests giving the same train cycle as that indicated. It is not necessary to conduct so elaborate a series of tests, as a sufficiently close result can be obtained for practical purposes by obtaining the experimental thermal capacity curves at moderate average speeds upon an experimental track, and assuming that the conditions of ventilation so obtained will hold true for all the schedule speeds. It is admitted that a source of error is thus introduced and that motor service capacity curves will read too conservative at the very high speeds and will possibly be too liberal at the lower speeds; but conservatism at speeds approaching seventy-five miles per hour could not be criticised as poor engineering, and the results given in following curves are therefore presented with full confidence that they will meet a long-felt want and will moreover be approximately correct for types of motors similar to those serving as basis of calculation and experiments.

An inspection of the curves given in Fig. 5 discloses the fact that for a given temperature rise the capacity in tons per motor is practically a fixed amount. For example, a temperature rise of sixty degrees centigrade will be obtained with approximately 16.2 tons per motor over a range extending from one stop in four miles to five stops per mile. It is thus sufficient to associate a given motor and gear ratio with a definite car weight which it can operate with a given temperature rise, and with any schedule speed which the number of stops per mile will permit. This at once affords a means of comparing motors of different capacity by means of the "tons per motor" which is permitted for, say, sixty degrees rise and a given maximum speed equipment. In presenting the curves in Fig. 6, the results of a large number of experiments and calculations are incorporated on motors of similar design giving the relation betwen the commercial one-hour rating of the motor and the number of tons which that motor will carry at maximum speeds of thirty, forty-five, sixty and seventy-five miles per hour. The curves of thirty and forty-five miles per hour are probably accurate, those at sixty miles per hour may be open to criticism of being conservative, and at seventy-five miles per hour with the superior ventilation afforded by the schedule speeds incident to such high maximum speeds, the motor capacity curves perhaps indicate too low a ton weight for sixty degrees rise. As no electric road as yet affords means of obtaining experimental values at this high maximum speed, the degree of error can not be determined and in any case should not exceed more than a possible maximum of fifteen per cent. Figs. 7 and 8 are plotted for sixty degrees also, but using friction curves B and C, so that by means of Figs. 6, 7 and 8 it is possible to determine the capacity of motor required for any maximum speed and any weight of train; while from Figs. 2, 3 and 4, the possible schedule speed and energy consumption can be obtained for any maximum speed and frequency of stops. The maximum speeds of thirty,

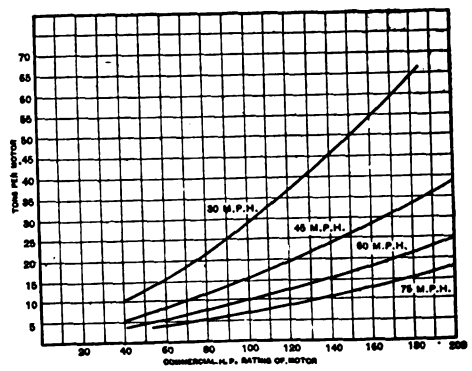

FIG. 6.—MOTOR CAPACITY, 60° C. RISE.
A—FRICTION CURVE.

forty-five, sixty and seventy-five miles per hour have been chosen as covering the present field of electric railroading, and intermediate values may be readily interpolated.

The relation between the commercial one-hour rating of a railway motor and its service capacity performance is very difficult to express. In fact, it is almost impossible to compare two motors, differing essentially in their mechanical design, as the stand-test of a motor has no direct bearing on its service performance with its different distribution of losses and better facilities for ventilation. It is necessary therefore to obtain by experiment the performance of each individual motor under conditions approximating service operation, and determine the relation of stand-test to service operation for the particular motor in question. By carrying on a series of exhaustive tests on each individual motor it becomes possible to plot the results of such tests in curve form and show the relation between stand-tests and service capacity, provided

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motors are of the same general design. Having obtained the capacity in tons per motor for different maximum speed equipments, the results were all found to follow the general law noted in Fig. 5; that is, the temperature rise was found to be practically constant over a wide range in stops per mile and schedule speed. With this simplification it becomes possible to compile curves 6, 7 and 8, giving the capacity motor required for any train weight, schedule and frequency of stops, the motors all being of similar design. These curves are all plotted with motors of the closed type, it being assumed that in miscellaneous operation advantage can not be taken of opening ventilators. Where motors can be operated partially or fully open, the capacity, especially at high speeds, will be considerably increased. It is probable, however, that motors operating at speeds approaching sixty to seventy miles per hour will be upon a surface

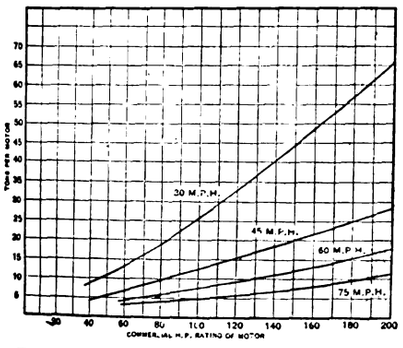

FIG. 7.—MOTOR CAPACITY, 60° C. RISE. B—FRICTION CURVE.

track where it would be advisable to protect the motor from dust and moisture, and thus operate closed.

The results brought out by curves 6, 7 and 8 are very instructive as determining the probable trend of very high-speed electric railroading where trains of one or more cars are used. For example, a forty-ton car equipped with four motors, thus giving ten tons per motor, will require a 133-horse-power motor for sixty-degree rise when operating a train of several cars at seventy-five miles per hour maximum speed, while the same weight of car would require a motor of at least 230 horse-power, if operated as a single car with the same temperature rise and similar design of motor. That is, the motive power is doubled in going from train to single-car service. Thus not only is train friction the determining feature of energy values, but it is the controlling feature as well of the motor capacity required to perform a given high-speed service.

As pointed out in the earlier part of this paper, it is not necessary that the friction curves A, B and C shall in themselves correctly give the numerical values for train, single-car and two-car work. The general shape of the curves is undoubtedly that pertaining to their respective size of train, and as the three curves are taken and subsequent calculations are all made upon a three-curve friction basis, it is relatively an easy matter to interpolate and obtain the energy, schedule speed and motor capacity required for any train-friction expressed in pounds per ton. The friction curves are of use therefore only in determining the fundamental values of train energy and motor capacity given in the subsequent curves, and the energy, schedule speed and motor capacity can be obtained from these curves whether the friction pertaining to the case in hand is, say, thirty-three pounds per ton at fifty miles per hour for single-car operation, or more or less than this value. The application of the motor and energy curve is therefore universal and it is only necessary to obtain sufficient experimental data of the particular type of car or train proposed to determine accurately its friction for a given maximum speed and obtain the various values required by interpolation in the curves given.

Having obtained the data upon which to base calculations for the proposed electric road, perhaps the best method of showing its application would be to take a concrete case. Let the distance from A to B be, say, 100 miles, or great enough to get over the consideration of location of substations in relation to the length of the line. Assume also that the proposed road will parallel a steam line, or that there are other reasons necessitating a high-schedule speed, and that stops will occur every four miles, will be of fifteen seconds' duration, and that the motors will be direct current supplied from substations fed from a single central generating station. It is desired to know the effect that single-car or train operation will have upon first cost and cost of operation.

It is assumed that the competing steam road will have a schedule speed in the vicinity of forty miles per hour. Such express trains as exceed this schedule will offer such very infrequent service, and will furthermore be so restricted to their through travel that they will not enter as a factor for consideration. By referring to Fig. 4 we find that a schedule speed of forty miles per hour can be obtained with a maximum speed approximately forty-eight miles per hour with one stop in four miles. The energy consumption will be eighty-two watt-hours per ton-mile and the motor capacity will consist of four 110-horse-power motors operating a single forty-ton car with a temperature rise of sixty degrees (Fig. 8). The energy consumed at the car will therefore be 131 kilowatts or 144 kilowatts at the substation bus-bar, allowing an average drop of ten per cent in the third rail. With a substation bus-bar potential at 600 volts, each car will average 240 amperes.

Assuming that the road will be double track with eighty-pound track rails and 100-pound third rail, the distance apart of the substations will be approximately thirteen miles with a maximum drop of 170 volts when two cars are passing midway between substations, one of which is accelerating. This drop is permissible, as it is momentary only. Each substation must be able to accelerate one car and supply another at full speed, or must give 850 amperes momentary output and a sustained output of 500 amperes. The

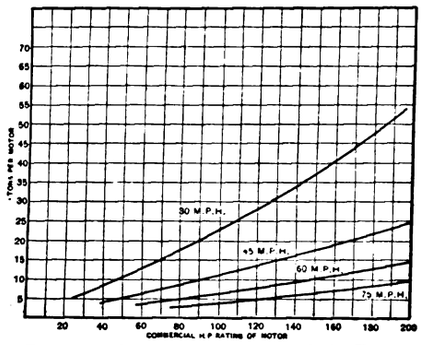

FIG. 8.—MOTOR CAPACITY, 60° C. RISE. C—FRICTION CURVE.

substation will therefore be called upon to deliver momentarily 510 kilowatts and should contain not less than one 300-kilowatt rotary converter and preferably two, one being a reserve. This size of converter is based upon the assumption that cars run always as single units and not in trains, and that converters can stand a momentary overload of 100 per cent. With half-hour service cars will be spaced twenty miles apart, so that there will be required a generator capacity of two cars every twenty miles (double track) or 340 kilowatts, assuming fifteen per cent loss in rotary converter substations and transmission line. The generating station capacity per mile of track will therefore be seventeen kilowatts, and the substation forty-six kilowatts with reserve, and twenty-three kilowatts with no reserve. Taking the cost of generating station in round numbers at $100 per kilowatt and substation at $35, the cost of a forty-ton car complete with four 110-horse-power motors, controllers, etc., at

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$9,000, we arrive at the following approximate cost for installing:

APPROXIMATE FIRST COST PER MILE, SINGLE-CAR TRAIN.

Generating station	$1,700
Substations with reserve	1,610
Equipment (plus 20% reserve)	1,120
Total	$4,430

The above total of $4,430 thus represents the approximate first cost of the various items noted when operating a single forty-ton car every half hour at forty miles per hour schedule speed and stopping fifteen seconds once in four miles. Following through the same process with two forty-ton cars operating on one-hour headway at forty miles per hour schedule with the same track and third-rail construction, we arrive at the following conclusions:

Watt-hours per ton-mile	68
Train energy at train (80 tons)	202 kilowatts.
Distance apart substations	9.1 miles.
Size of substation	two 400-kilowatt units.

Each train consisting of two forty-ton cars will consume 224 kilowatts at the substation, or 264 at the generating station, allowing the same percentage of loss as above. These trains making the same schedule speed at double the headway will be spaced forty miles apart and the generating capacity will therefore be 528 kilowatts every forty miles, or 13.2 kilowatts per mile. The substations, consisting of two 400-kilowatt units (with reserve) every 9.1 miles, will have capacity per mile of eighty-eight kilowatts. Expense for cars will be the same as before and the following approximate costs obtain:

APPROXIMATE FIRST COST PER MILE. TWO-CAR TRAIN.

Generating station	$1,320
Substations	3,080
Equipments	1,120
Total	$5,520

The first cost of the two-car train system will be $5,520 as against $4,430 with single-car train. The energy consumed for the two methods of operation is seventeen kilowatts per mile of track with single car as against 13.2 kilowatts per mile with two-car train. Thus, while the two-car train at one-hour headway will cost twenty-four and one-half per cent more to install (for the items mentioned only), it will consume but 72.5 per cent of the energy required to operate a single car individually.

The difference in power required is 3.8 kilowatts per mile of track. Assuming twelve hours per day operation at the above headway, the total kilowatt-hours per day will be 45.5, which at $0.007 per kilowatt-hour would be $116.50 per year, or ten per cent on $1,165. It would therefore pay to invest the $1,090 per mile of track difference in cost between one car and two-car operation, as found above, provided the same receipts could be secured with one-hour headway as with thirty-minute headway. The relation of traffic receipts and frequency of travel is a question which can only be determined experimentally, and while the desirability of the two-car service seems evident from the data at hand in the above case, it might result in a falling off of receipts to such an extent as to more than make up the saving in operating expenses. There is an additional saving in train crew expenses which was not entered into above, and which would amount to something more than half as much as the cost of power. With two-car operation, it is possible to reduce the motor capacity per car from four 110-horse-power motors to four motors of approximately ninety-five horse-power, thus reducing the cost of the equipment item. Owing to the fact, however, that it might be desired to operate a single car during certain parts of the day, which would result in overheating the smaller motor equipment, it would be more conservative to consider the same size of equipment whether one-car or two-car train were operated. With more than two cars in a train, advantage could be taken of the smaller equipment required, but it is probable that in two-car work this advantage of the smaller motor possible for two cars would only result in the cooler operation of these motors when operated in two-car trains and would show up therefore in the repair account rather than as a first cost. The substations with two-car trains being placed somewhat closer together would have a labor account per mile of track in excess of that for single-car operation. This may be balanced against the saving which would result from smaller crew expenses of the two-car train.

The above example serves to illustrate the very broad application of the foregoing curves. Although it has been necessary to assume a number of constants, acceleration, braking, coasting, etc., these constants are those pertaining to average operation and can vary considerably without making a serious difference in the results. The curves given are not therefore absolutely correct, but are sufficiently so for approximation purposes. For the slower speed work where stops are more frequent and where acceleration is a more important factor, it will be necessary to have more complete curves in order to determine the proper rate of acceleration to use, especially if the problem is one calling for very high-schedule speeds in relation to the number of stops.

As previously stated, it is not necessary that friction curves A, B and C should represent the actual friction in pounds per ton of train two-car and single-car work. Having the motor capacity and energy values for three different friction rates at a given maximum speed, it is possible to interpolate and secure the proper motor capacity and energy value for the friction value corresponding to the case in hand. The importance of the wind-friction as affecting electrical operation at a very high speed in a class of service which has followed along the lines of very small light trains of one or more cars, will probably lead to the construction of special cars reducing wind-friction to a minimum when the higher maximum speeds are put into commercial operation. No conclusive data are at hand upon the effect of different shaped car ends on single or two-car operation. When such data become available and special cars are constructed, their operation can be predicted from the foregoing curves by interpolation for the new friction values thus obtained.

The compilation of the above curves entailed a large amount of careful work, and the writer is very much indebted to Mr. E. F. Gould for his very valuable assistance.

The Second Annual Report of the Allis-Chalmers Company.

The second annual report of the Allis-Chalmers Company, for the fiscal year ending April 30, 1903, shows that the net profits, after deducting all expenses of manufacture and selling, and after making full provision for depreciation of buildings, plant and machinery and for possible bad debts, are $1,653,576.06. From this must be deducted the dividends declared on the preferred stock, which amounted to $1,137,500, leaving a surplus of $516,076.06.

Mr. James Stillman, of the National City Bank, New York city, and Mr. Charles Allis were made members of the Finance Committee. No other changes were made in the officials, committees or superintendents.

The executive officers of the Allis-Chalmers Company are: Chairman of board of directors, Elbert H. Gary, New York; president, Charles Allis, Chicago, Ill.; vice-president and treasurer, William J. Chalmers, Chicago, Ill.; second vice-president, Henry W. Hoyt, Chicago, Ill.; third vice-president, Philetus W. Gates, Chicago, Ill.; fourth vice-president and secretary, Joseph H. Seaman, New York; assistant secretary, Joseph O. Watkins, Chicago, Ill.

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The Telechirograph.

The telechirograph is a new telautographic apparatus which has been invented and developed by Herr Ernst K. Gruhn. Views of the apparatus are given in the accompanying illustrations. All of the mechanism, except the writing pencil, is contained within a polished hardwood box, thirteen by thirteen by fifteen inches. This contains the apparatus for transmitting, and that for receiving and recording messages.

To send a message, it is written on the blank, seen on the top of the box, by the stylus. The action of taking the stylus out of its rest automatically brings the recording apparatus at the other end of the line into service, and this reproduces exactly the marks made on the first blank. After a message is completed, the act of placing the stylus back in its holder throws the recording apparatus out of action, and starts a small motor operated

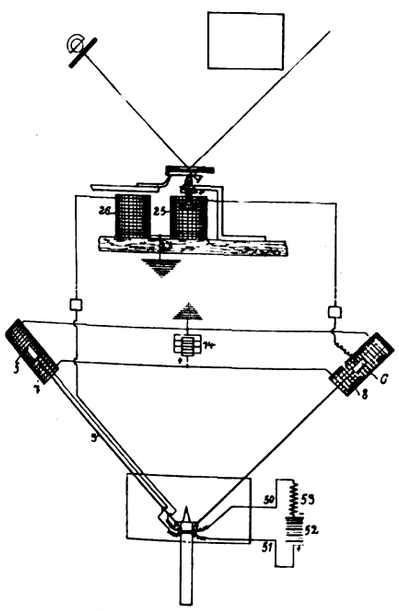
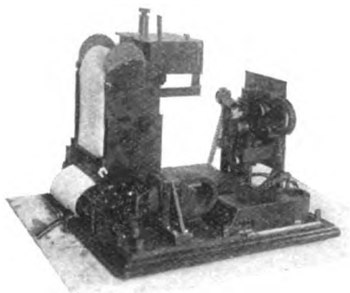


DIAGRAM OF CIRCUIT.

by an independent battery which delivers the message, and at the same time turns off a small incandescent lamp which was lighted when the stylus was picked up, and which is used in recording the message. The message is delivered from the slot in the side of the box, as seen in the illustration.

The principle of the apparatus is very simple. As the message is written by the stylus, the motion of this is decomposed into two components, at right angles to each other, and these two components act to send over the line corresponding electrical currents. At the other end of the line these currents are used to produce deflections in two planes at right angles to each other, of a small concave mirror, and by this means the two components are combined to give a record by means of a ray of light reflected upon a sensitized screen which is an exact reproduction of the original.

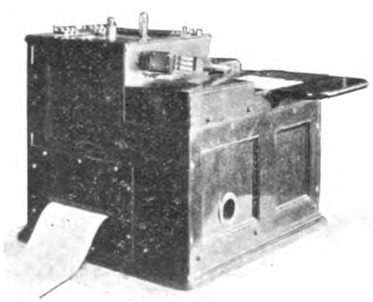
By referring to the diagram the method of operation will be made clear. Nos. 7 and 8 are two resistance coils, which are connected to the terminals of the battery 14. There is, then, a constant fall of potential through these two coils. Press-



THE TELECHIROGRAPH, WITH COVER REMOVED.

ing upon the sides of these coils, and in this way making contact at different parts of the coil, are two brushes 5 and 6. These brushes are fastened to the stylus by the bands 3, 4, and are also drawn toward the extreme end of the resistance coils by two light springs, not shown. From these two brushes wires are carried to the transmitting circuit. At the receiving end of the line these wires are connected to two coils 25 and 26, and the other ends of these coils are connected to the ground of a common return. One end of the battery is also connected to the ground or a return wire. Thus, the motion of the stylus is utilized to send over two lines two currents, which vary according to the components of motion, the variation being caused by the change in resistance of the circuits and the change in electromotive force applied to them.

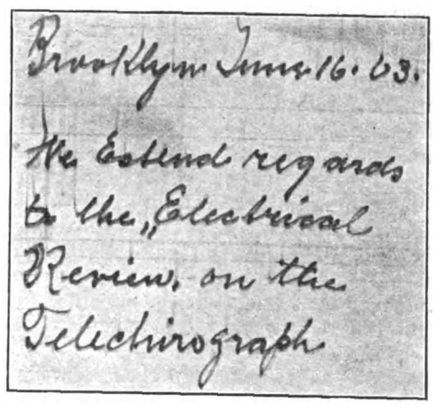
At the receiving station these two currents are passed through the two coils,



THE TELECHIROGRAPH.

and thus serve to attract suitably placed armatures. The mirror is cemented to a triangular piece of iron, and supported on three points, one being fixed and the other two attached to the two armatures. The mirror is concave and focuses a ray of light from a small incandescent lamp upon a strip of sensitized paper. The mirror then follows every motion of the armatures. In order that this motion may be proportional to the current passed, the iron core of the coils is rather short, so as to leave a considerable air-gap; and oscillations of the armature are prevented by suitable damping pistons attached to the armature, and moving in some viscous liquid.

The description so far given shows how every motion of the stylus is followed by the mirror; but in a practical instrument this is not sufficient, for no record should be made when the stylus is not pressed against the paper. To meet these requirements the stylus is arranged so that one transmitting circuit is open whenever the stylus is lifted from the paper. There are on it two sleeves, which are held apart by a light spring, to one of these is connected the wire from one of the moving brushes, and to the other, the wire leading to one transmitting line. Thus, when the stylus is pressed against the paper,



A MESSAGE TRANSMITTED AND RECORDED BY THE TELECHIROGRAPH.

the two sleeves come together and complete the circuit. When the stylus is lifted from the paper this circuit is not only opened, but an auxiliary battery, which is connected to the two sleeves, is connected into this circuit, and this serves to send through the line a current strong enough to throw the beam of light entirely off the sensitized strip.

The two resistance coils are made of insulated resistance wire, wound on a cylinder as close together as is possible; and then a strip of insulation is removed along the path of the brush, leaving the wire bare. This construction, of course, varies the resistance in small steps, and not perfectly uniformly; but this is satisfactory for all practical purposes. Moreover, since in an instrument of practical size the bands connecting the stylus and the two brushes must be rather short, distortion will be produced by the angularity of these bands. This distortion, the in-

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ventor states, is prevented by a corrective device, patents on which are pending, so that it can not be described now.

Two of these instruments are at present on exhibition in Brooklyn, where messages are sent and received from one room to another. The two instruments were first set up and operated in separate buildings, but as visitors desired to see both operations, it was found more convenient to bring them into the same building. It is stated, however, that they have been operated successfully between Dresden and Berlin, a distance of about 125 miles. They, of course, can be used to transmit drawings, as well as written messages. One of the illustrations shows the apparatus with the cover removed. This differs in some details from the description just given, but it serves to show the simplicity of the mechanism. To the left is seen the roll of sensitized paper. Below this, but not seen in the illustration, is the developing bath, and above, and just to the right of the roll, is a reservoir of developing solution. In front, on the left corner of the base, is a small magneto motor, which is automatically thrown into operation when the stylus is placed in its holder. This slowly unrolls the paper, passes it through the developing bath, and then through drying rolls, finally delivering it through the opening in the box, where it falls into the fixing bath. This operation takes, at present, about thirty-five seconds, but it can be done in considerably less time. To the right of the illustration can be seen the two deflecting coils and a telescope for throwing the beam of light. In this particular instrument two mirrors are used, one reproducing the horizontal components, and the other the vertical components of the original motion. The beam of light issuing from the small telescope strikes the first mirror, is reflected from this to the second, and thence on the sensitized paper. The beam of light has the advantage over a mechanical device in not possessing inertia, and the apparatus will record a message as rapidly as it can be written. Three transmitter lines are required, two outgoing and a common return, though the latter may be merely the protecting sheath of a two-conductor cable.

The instrument can be used over an ordinary telephone line, and can be arranged to be cut in and out of circuit by the act of removing or replacing the telephone receiver. It is thought that it will find application where it is necessary to have a written record, and in this way may supplement the telephone. It may also be useful in transmitting portraits and in other work of a similar character.

The telechirograph is covered by American and foreign patents. It is being developed in Germany by the Kopier Telegraph Gesellschaft, and in this country by the inventor, Herr Gruhn, and Mr. Max Herzka. The offices are at present at 44 Court street, Brooklyn, at the law office of Mr. Thomas Fitzhugh Lee, who is counsel for the company.

Union Engineering Building.

A formal organization of the joint committee representing the various bodies which have taken action with respect to the gift of one million dollars of Mr. Andrew Carnegie for a union building, was effected on the evening of June 18. The American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the Engineers' Club have taken final action and appointed their representatives upon a joint committee for accepting the gift. The American Institute of Mining Engineers has likewise taken action, in so far as its rules permit. Its council has appointed representatives subject to changes in the rules of the organization, which have been proposed by the council for adoption at the next general meeting. At the present time a letter ballot for ascertaining the attitude of the members is being taken which shows an overwhelming majority in favor of the plans proposed by the council.

The American Society of Civil Engineers at its recent meeting in Asheville referred the matter to its board of directors for recommendation, and directed that the matter be then presented to the members of the society for letter ballot.

At the meeting on June 18, the following were announced as representatives of the several bodies upon the joint committee:

American Institute of Mechanical Engineers—James M. Dodge, F. R. Hutton, Charles Wallace Hunt.

American Institute of Electrical Engineers—Charles F. Scott, B. J. Arnold, S. S. Wheeler.

American Institute of Mining Engineers—A. R. Ledoux, Charles Kirchoff, Timothy Dwight.

Engineers' Club—John C. Kafer, W. H. Fletcher, W. A. Redding.

Representatives of the American Society of Civil Engineers are requested to meet with the joint committee and take part in deliberations with regard to the plans to be adopted. The representatives who have served upon the conference committee are: Alfred Noble, W. J. Wilgus, George K. Pegram.

The joint committee was organized by the election of the following officers:

Chairman, Charles F. Scott; secretary, Professor F. R. Hutton. The chairman was directed to indicate to Mr. Carnegie the acceptance of his gift by the joint committee representing the several organizations.

The joint committee placed the immediate work of developing plans upon an executive committee of five, consisting of one member from each of the five organizations named in Mr. Carnegie's letter, as follows:

American Society of Civil Engineers, Mr. Alfred Noble.

American Society of Mechanical Engineers, Professor F. R. Hutton.

American Institute of Mining Engineers, Mr. A. R. Ledoux.

American Institute of Electrical Engineers, Mr. Charles F. Scott.

Engineers' Club, Mr. W. H. Fletcher.

The executive committee met on May 19 and organized by the election of Charles F. Scott, chairman, and F. R. Hutton, secretary. The committee laid out certain work to be undertaken by its several members, and will have meetings from time to time during the summer.

The following cablegram has been sent to Mr. Carnegie:

Andrew Carnegie, Skibo Castle.

Joint committee four organizations formally accepts generous gift union building. Executive committee in session sends greeting and reports progress.

SCOTT.

Michigan Telephone Company.

The annual meeting of the Michigan Telephone Company was held at the company's offices in Detroit on Monday, June 22. Vice-president H. J. Pettingill presided, in the absence of President Dexter. The report of the treasurer, read by Mr. George W. Leverett, of Boston, general counsel for the Western Telephone Company, showed that the earnings of the company for 1902 were $1,549,531. The expenses for the same period were $1,632,230, leaving a deficit of $82,699. The total deficit, as shown by the ledger balances December 31, 1902, amounts to $501,296. Loans and accounts payable on the same date amounted to $2,538,176. The statement was made that since the company has passed under the control of the Union Trust Company, as receiver, the present officers can not create any further debts. No salaries are being drawn by the executive officers, and the entire purpose of the meeting was to keep the organization together and to have officers to represent it in court. The debts for labor and material, for which the stockholders will be individually liable, were paid up to the time the receiver was appointed. A motion was made by Mr. Leverett to approve of the acts of the board of directors and executive committee for the past year. Upon the reading of the entire records from the time that the directors met in Boston after the last annual meeting for organization, the vote was cast and the acts ratified. The number of shares represented, either in person or by proxy, was 39,112. There was no opposition to the reelection of the old board, as follows: Mr. Philip Dexter, Mr. Frederick P. Fish, Mr. W. S. Hutchinson, Mr. H. J. Pettingill, Mr. Hugh McMillan, Mr. Thomas Sherwin and Mr. Dudley E. Waters.

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Twentieth Annual Convention of the American Institute of Electrical Engineers Held at Niagara Falls, June 29 to July 3, 1903.

Proceedings of First Two Days.

INSTITUTE AND PRESIDENT'S DAY, JUNE 29.

THE twentieth annual convention of the American Institute of Electrical Engineers was opened at 10.30 Monday morning, at Niagara Falls. The first session was well attended for a gathering beginning on Monday at a place which required nearly all in attendance to make a long railroad journey to reach. Many members from a distance made the trip during Sunday, reaching Niagara Falls Sunday night, and these, together with those who arrived on the morning trains, made a very creditable showing at breakfast at the International Hotel. Headquarters were opened at the Cataract House, and registration of members and guests began at once, about 200 registering the first day.

The weather was beautiful; a mild, bright, summer day. This was all the more welcome as the weather during the early morning hours was quite threatening and heavy rains fell farther to the east. The country was fresh and green.

Members were in attendance from all sections of the country, and were enthusiastic in anticipation of taking part in a convention which promised to be second to none in pleasurable features, as well as in the presentation of interesting and valuable papers.

The first session was called to order by President Charles F. Scott at 10.30 A. M. in the excellent auditorium of the Natural Food Company's building, which, through the courtesy of the Natural Food Company, had been tendered to the Institute as a meeting place throughout the convention. President Scott spoke of the advantages and attractions which had led to the selection of Niagara Falls as the meeting place, and introduced Mayor Hancock who, in welcoming the members of the Institute, gave a brief sketch of the old Niagara Falls before the days of the electrical development, and spoke of the rapid development of the town, where there are now about 25,000 inhabitants. He expressed his pleasure in tendering the freedom of the city and a whole bunch of keys to the members of the Institute.

President Scott expressed the obligations of the Institute to Dr. Samuel Sheldon, chairman of the committee on papers; to Professor G. F. Sever, chairman of committee of arrangements; to Mr. H. W. Buck, chairman of the local committee, for their interest and labor in providing for the success of the convention and the comfort of the members.

Secretary R. W. Pope read invitations to members and guests to visit the plants of the Niagara Falls Hydraulic Power and Manufacturing Company, from the Niagara Falls Power Company to a reception and to visit the plant, and from the Natural Food Company. The Niagara Club extended to all members of the Institute the privileges of the club-house.

President Scott delivered his presidential address, reviewing the work of the Institute for the past year. He said in part:

The work of the electrical engineer is unique. He deals with kinetic energy rather than static. His work lies in the field of action. His unit is the kilowatt, the unit of activity. The engineer has been defined as one skilled in the use of materials and forces of nature, but the electrical engineer is one who deals with the forces.

Electricity enters into other things as nothing else does. It is not a thing alone, and this explains the rapidity of its development, and its far-reaching application. He illustrated this by referring to the railway motor, which was first introduced as a clean substitute for the horse, but it had brought greater speed, larger cars and more comfort, and was now bringing about a redistribution of population. Similar changes have taken place in telegraphy and telephony, and he spoke of the newness of certain branches of electrical engineering, such as alternating-current transmission. This industry is only a few years old, but to-day plants are operating at 50,000 volts or more. The United States census shows that the mean rate of increase in the electrical industries is twenty per cent a year.

The technical schools have in this time shown a tremendous growth, but they are not yet able to supply the demand for trained men.

Electrical engineering is the centre about which all other branches cluster, because it more than any other comes in touch with the others. This point was illustrated by the New York subway where the primary object is to move trains, but where all the engineering connects with electricity and everything is adapted and contributes to the electrical equipment. For these reasons the electrical engineer, more than all others, should know more about and be in closer contact with other branches of engineering.

The Institute is the youngest of the engineering bodies, and it was for the members to decide in what way it could be made to contribute most to the welfare of its members and the world. It has no past to look back to. Shall it follow the lines taken by the older societies, or strike out for itself? What are the new conditions and how may these best be met? The Institute can not stand aside. It must be in and of the strenuous life. The efficiency must be increased. The local branches have accomplished much to this end during the past winter as these help distant members to take active part in the Institute matters. The membership has increased during the past year nearly 1,000, nearly sixty per cent of these members being between the ages of twenty-five and thirty-five, that is, in their active life and this meant much to the Institute. Seventy-five per cent of the new members has graduated from technical colleges in the last ten years. Figures were given showing the distribution of membership in the various lines of work.

President Scott spoke of the crystallization now going on in electrical engineering and referred to the work of the Institute committees on standards and transmission in this connection. This work will be of the highest value to the Institute and its members as bringing together the latest information.

The growth of the library was mentioned, and it was stated that a general index of the Institute transactions would be got out both in bound form and as a card index, which will be of great value in making the work of the Institute available.

President Scott, in referring to the $1,000,000 engineering building which has been offered to the engineering societies by Mr. Andrew Carnegie, gave a short sketch of the conditions which led up to the offer and stated that four out of five of the engineering bodies have accepted the gift and are now developing the plans. He spoke of Mr. Carnegie's ideal, which is to bring the various engineering bodies together so that each may benefit socially and professionally by the acquaintance of engineers in other lines of work. Co-

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peration among engineers is not less ecessary than in commercial life, but ndividual freedom and life must be pre-erved. Mr. Scott hoped the electrical ngineer would be the unifying medium.

Four things must be considered in the levelopment of the Institute.

1. Plans should be outlined to broaden the work of the Institute, making it unnecessary for other special bodies to be organized. Standing committees might be appointed to look out for the various lines of development.

2. Affiliations should be established with other societies, both in this country and abroad.

3. Local branches should cooperate with other local engineering bodies.

4. Cooperation with other national societies should be begun, with a view to establishing a national engineering congress which should consider questions of general engineering interest.

President Scott spoke of the spirit of the men who had given their time and thought to promoting the Institute affairs, as being of the greatest help.

To carry out the plans for the building, money is needed, and it seemed only just that those interests which have benefited most from electrical development, and which will benefit by the work of the Institute, should aid generously in carrying out these plans. However, all these things, building, books, etc., are only tools for the men and it is men that are needed and must be developed.

The advantage of having a social club convenient to the engineering building was thought to be considerable, and the commercial side of engineering was touched upon as an important phase not to be neglected.

President Scott's address was well received, and at the conclusion he called upon Professor W. S. Franklin to read his paper upon "The Energy Transformation in the Synchronous Converter."

In presenting this paper Professor Franklin said it had not been prepared as an Institute paper, but was the result of a private study. He did not attempt to abstract it, but called attention to his statement of the criterion which enables one to judge of the physical reality or unreality of the component parts into which a physical aggregate is resolved by mathematical analysis, and it suffices to state that this criterion shows the physical unreality of synchronous motor activity and direct-current generator activity as component parts of the activity of the synchronous converter.

The synchronous converter was then compared with the autotransformer, as in both machines energy is transformed both conductively and inductively. Figures were given showing to what extent the actions take place in converters having two, three, four and an infinite number of slip rings.

In the discussion Dr. Samuel Sheldon stated that there never could be but one current flowing in a circuit and that this is always in phase with itself. In analytical discussion it is correct to consider the two phases of a current, the wattless and the watted, but as a physical reality this will not do.

In the synchronous converter there must be both motor and generator activities and these exist respectively in those inductors in which the current is flowing in such a way as to set up the actions. This does not agree with Professor Franklin's statement.

Professor Sheldon had handled the problem by plotting time-current curves, using a straight line for the direct current and a suitable templet for the alternating current. This allowed treatment of any shape of wave. His work has given results which agree with Professor Franklin's calculations, and it has the advantage that real converters may be considered and not merely the theoretical case where the wave is sinusoidal. Professor Franklin explained that his statement was to the effect that as in the synchronous converter not all the elements are present, such as mechanical drive of the direct-current generator and mechanical output of the synchronous motor, it is not proper to treat it as a direct-current generator.

Mr. W. L. Waters read a paper entitled "Commercial Alternator Design." Different types were compared, and attention was called to the ventilation of the armature and field. He advocated large machines and the use of saturated fields to get good regulators.

It was suggested that the Institute revise the clause in specification for testing alternators and require them to be tested at zero power-factor, as this is easily done and shows the performance under the worst conditions.

Mr. D. B. Rushmore gave a brief abstract of a paper which will be given as a communication to the Institute later. He spoke of the peculiar conditions which are sometimes met in transmission work, where at times problems having nothing to do with the operation of a machine influence the design. The line characteristics are the most important and the water drive differs from the engine drive. Effects of lightning can not be disregarded.

The problem of securing good insulation is serious, and for transmission work the factor of safety must be higher than for other work. A low specific inductive capacity is desirable as well as a low dielectric hysteresis loss. Heat tends to bring about deterioration of insulating material, and this must be provided against. Mechanical strength is often necessary. The effect of star and delta connections was touched upon. Capacity tends to exaggerate the higher harmonics, and a case was mentioned where there was a cross-current of the third harmonic, equal to the full load current flowing in an armature. The advantages of the inductor type of machine were touched upon, it being stated that good regulation, say four per cent, could be obtained.

Emphasis was laid upon the difference between armature reaction and armature inductance. One or two ideas generally held of the armature reactions were questioned, and as a specific case experiments had shown that cross-magnetization did not weaken the field, although it is usually believed that with saturated pole tips one tip is weakened more than the other is strengthened.

The behavior of an alternator on short-circuit was alluded to with the statement that here there is a direct current superimposed upon the alternating current, the former slowly dying out.

Mr. R. D. Mershon thought that Mr. Waters's requirements were too severe. If a thirty-degree temperature rise is required it will have to be paid for. A forty-five-degree rise is good enough. He referred to several European machines he had inspected, and while praising the mechanical work, criticised the electrical part. He thought European switchboard practice bad, as no provision is made to disconnect a line when short-circuited, the whole station must be shut down.

Professor H. J. Ryan stated that the Institute Standardization Committee had under consideration a new clause covering the testing of alternators, and it hoped soon to be able to give it out.

In reply, Mr. Waters did not think it desirable to leave a machine in on short-circuit, and he did not think an inductor machine could be compared in dollars and cents to the revolving field type. He emphasized again that alternator design is a question of empirical rules and not of theory. It is no more expensive to give good ventilation than poor.

In the absence of Mr. Calvin W. Rice, who has left for a trip to Europe, his paper on the "Institute Branch Meetings, Their Organization, Development and Influence," was read by Professor W. E.

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Goldsborough. This reviewed the work of the Institute in establishing the local sections. Much credit should be given to President Scott for the success of this movement, which had done so much to increase the Institute membership. Suggestions for conducting these branches were given and the advantage to the local members and to the Institute were touched upon. Development could best be secured by making one man responsible.

Professor H. J. Ryan spoke of the great success which had attended the Cornell branch.

Professor W. E. Goldsborough told what had been accomplished at Purdue and at St. Louis, and Mr. Peter Junkersfeld spoke of the work of the Chicago branch.

In the afternoon the members visited the plant of the Niagara Falls Hydraulic Power and Manufacturing Company, where about 40,000 electrical horse-power is being developed for use in electrochemical and other works. Visits were also made to the plant of the Natural Food Company, where more than 1,000 kilowatts are used in electrical cooking ovens.

On Monday evening, at the auditorium of the Cataract House, Dr. Max von Recklinghausen made an interesting exhibit and gave an historical sketch of the mercury vapor lamp. He described the various types of lamps and accessories, and showed a number in operation.

Mr. Percy H. Thomas then described the Cooper Hewitt vapor converter for three-phase circuits, illustrating its action with diagrams showing how the alternating current could flow one way only, thus giving a direct current. He then passed to an interesting and important development in this work—the single-phase converter. When a two-phase current is passed through a simple converter, there is one part of the cycle when neither phase is forcing current through the converter. The negative electrode resistance then reestablishes itself, and the converter goes out of action. If, however, a small amount of current is kept flowing during this time, the negative electrode resistance can not re-form, and the converter acts continuously. Two types of apparatus were shown, both being glass globes about ten inches in diameter.

In the discussion of the converters, the high efficiency was pointed out. It is not yet known what is the limit in capacity, but the promise is given that these will be most important in railway work. Dr. von Recklinghausen then showed how the principle of the single-phase converter could be used in the alternating-current mercury vapor lamp, showing one in operation. This had three positive electrodes sealed into the upper bulb. The tube is about four feet long, and has a bulb at the base containing the mercury.

Mr. Thomas then described the application of the negative electrode resistance to a circuit-breaker for alternating currents. The apparatus would have a conducting metallic circuit enclosed within a mercury vapor globe. If an excessive current should pass, this would open the metallic circuit and establish a mercury vapor arc, but this arc would go out quietly, and not be reestablished when the current reached its zero value. It is thought that this apparatus might take the place of the elaborate oil-break switches.

ELECTRICAL DAY, TUESDAY, JUNE 30.

The Tuesday morning session was opened with the reading of a paper by Mr. A. H. Armstrong, on "High-Speed Electric Railway Problems." This paper brought out in detailed fashion the relation of energy consumption to wind-friction, and the peculiar conditions which prevail under different rates of acceleration and overall speeds. This paper appears in full on other pages of this issue of the ELECTRICAL REVIEW.

Mr. Frank L. Sessions then read his paper, entitled "Storage Battery Industrial Locomotives." This paper was discussed, in the main, by Mr. A. H. Berry, of New York, who laid special stress on the importance of the durability of the battery. Mr. Berry had run one battery for four years, and it was still in good condition. Charging the battery from a trolley circuit was not practical, due to the variations in voltage. While it was important to design the battery to give the best kind of service, special attention should be given to the construction of the locomotive, in order that friction losses might be abolished as far as possible. It seemed as if the efficiency given by the battery was low. When selling the battery, the customer should be given the charging rate of the battery. Means should be effected to protect the battery when connected for high speeds.

Mr. Elmer A. Sperry, of New York, emphasized the value of battery locomotives compared with compressed air, stating that the battery locomotive gave a higher efficiency and a greater capacity per pound for the battery. The storage battery locomotive was very useful in mining applications.

In reply, Mr. Sessions said that the efficiency was not of very great importance. The values he had given were only approximate. The battery could be charged practically from the trolley circuit. The charge rate depended upon the type. A special circuit-breaker was devised to protect the battery when connected for high speed.

The paper contributed by Mr. F. W. Carter, on "Predetermination in Railway Work," was read by Dr. Samuel Sheldon. Mr. C. O. Mailloux, of New York, described his method. This paper was considered a step in the right direction, as an equation is wanted connecting time values with speed values.

Dr. W. E. Goldsborough read a paper on "Car Run Tests," which he had compiled with Mr. P. E. Fansler.

Following this, Mr. E. F. Sherwood, of New York, described an interesting test on the Northern Texas Traction Company's cars, of three different types.

Dr. Samuel Sheldon read a paper on "Some Recommendations Concerning Electrical and Mechanical Specifications for Trolley Line Insulators." This paper was discussed with considerable interest, Mr. Joseph E. Sachs, of Hartford, Ct., contending several points. Surface leakage, he said, was to be seriously considered. The insulator must remain intact, though punctured. In testing, the insulator could be raised to the melting point, but at the expense of the insulation. The heat test might be carried too far. The test should be made under practical conditions, where the collection of dust and dirt would be taken into consideration. A large surface was necessary to prevent surface leakage.

Mr. Ralph D. Mershon suggested the use of direct current in testing, as better results could be obtained, with less heating. Tests that he had made showed this. On testing with alternating currents, the insulation would get hot and soft.

Replying, Dr. Sheldon said that the alternating current was correct for testing, as the test could be made in so short a time that no heating would result.

"The Storage Battery in Substations," by Dr. W. E. Goldsborough and P. E. Fansler, was read by Dr. Goldsborough. This paper was followed by a paper by Clarence Renshaw, on "Notes on the Operation of Railway Motors in Service."

Dr. C. T. Hutchinson described some curves showing the behavior of any motor under any condition. The computations from these had agreed with tests, and justified the method. This discussion was answered by Dr. Goldsborough. The test had been made to operate without battery, but the strain on the station had been too severe.

The attendance at the sessions was quite large, over 300 members being present.

In the afternoon a technical tour of inspection was made of the electrochemical and other electrical installations operated by Niagara Falls power, and the power-houses of the Niagara Falls Power Company.

In the evening there was a reception by the Niagara Falls Power Company, and a dance, under the auspices of the Local Committee, at the Cataract House.

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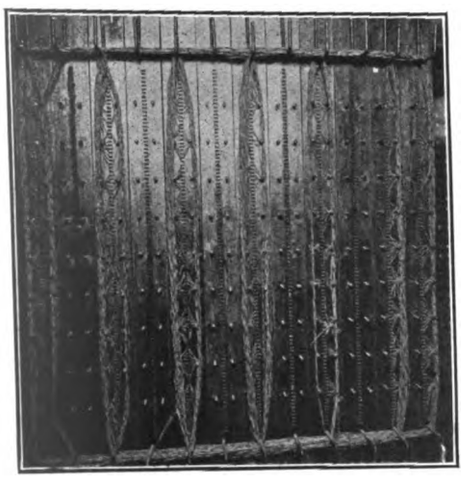
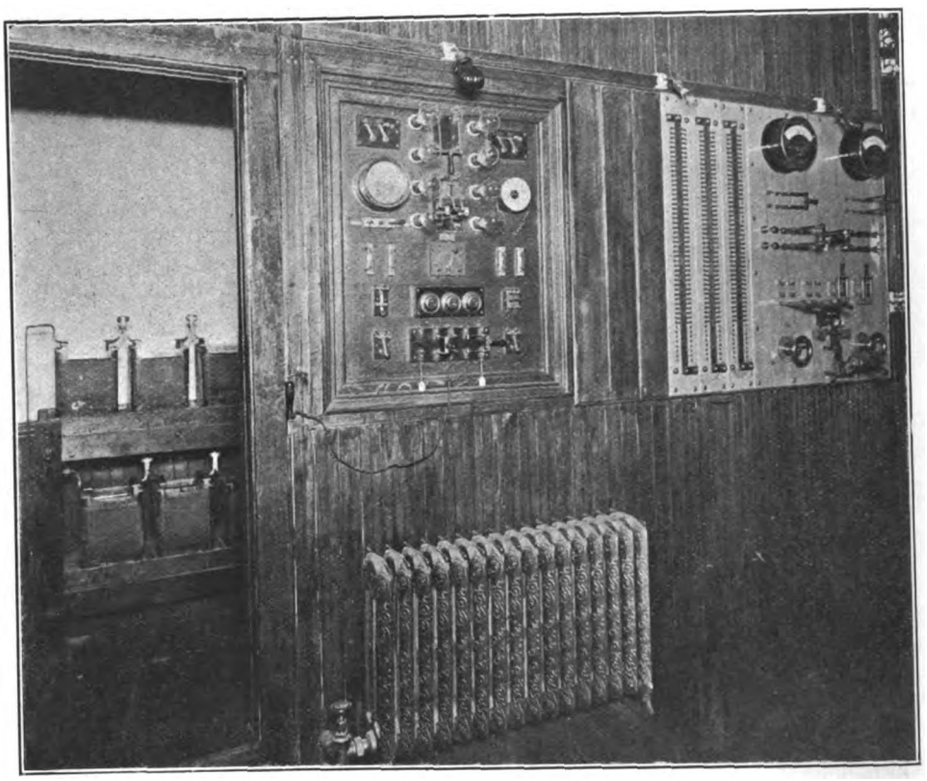
The Geneva Telephone Company, Geneva, N. Y.

ABOUT six years ago the Geneva Automatic Telephone Company was organized and for a number of years successfully operated this system. the loyal citizens spared no expense and trouble to beautify the city by liberally planting shade trees on all the streets and avenues. plant is now one in which the city takes great pride. The cable distribution is such as to readily handle the future growth of the plant.



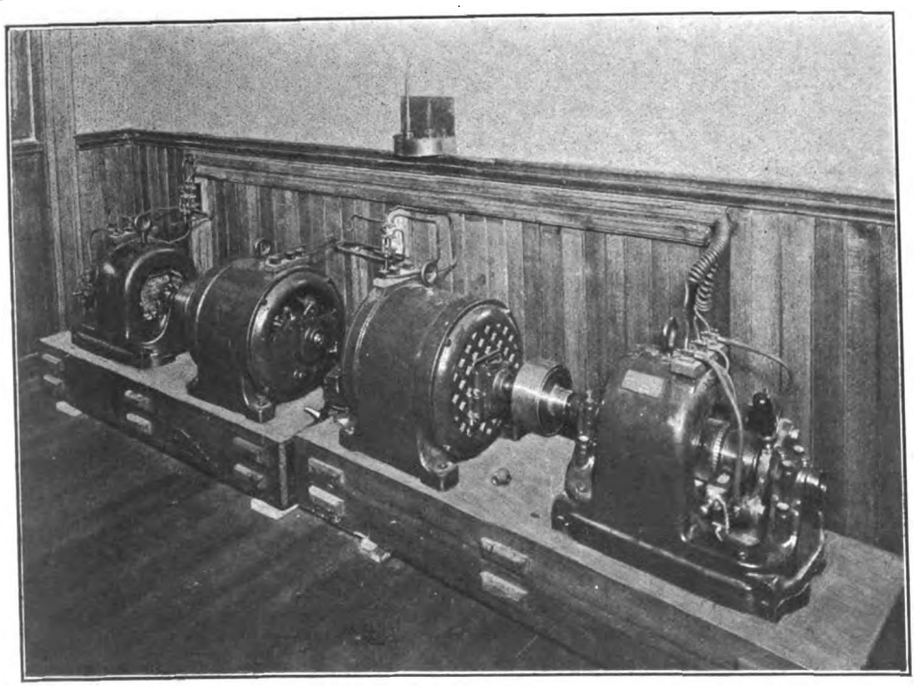
SECTION OF DISTRIBUTING RACK, GENEVA, N. Y., TELEPHONE COMPANY.



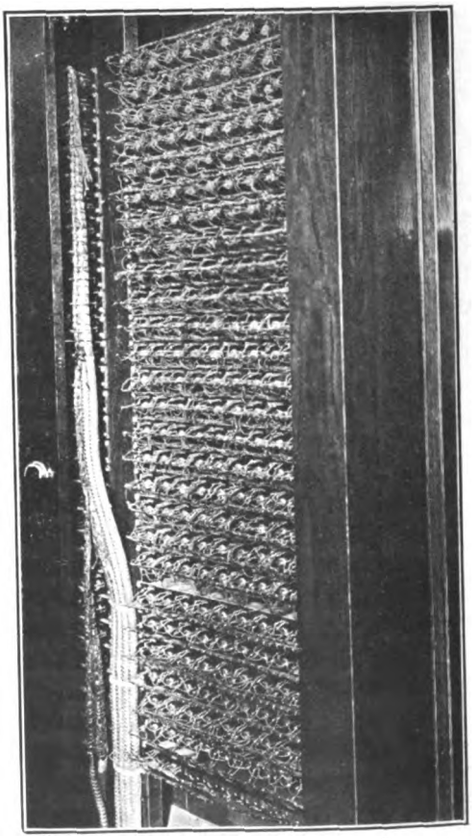
POWER BOARD AND PORTION OF BATTERY ROOM, GENEVA, N. Y., TELEPHONE COMPANY.

In 1902, however, the company was reorganized under the name of the Geneva Telephone Company and the new company decided to install a full common battery system and rebuild the plant.

Work was commenced on this about the middle of September, 1902, and was rapidly pushed to completion. On February 1, 1903, the exchange was opened, giving service to something over 300 patrons. Since February 1 the list of subscribers has more than doubled, being now over 600. By January 1, 1904, the list will reach the 1,000 mark.



CHARGING MACHINES, GENEVA, N. Y., TELEPHONE COMPANY.



SECTION REAR OF RELAY CABINET, GENEVA, N. Y., TELEPHONE COMPANY.

On account of Geneva being the home of the nursery business of the country, Their efforts have been amply rewarded from a picturesque point of view, for Geneva is a beautiful city, but from a telephone engineer's standpoint it presented many a hard problem in the way of "tree trouble." These problems were so successfully overcome by the liberal use of cable and "tree wire" that the outside

The central station or exchange is handsomely furnished and decorated. The switchboard is of the multiple type, with

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electric light line and double electric light supervisory signals arranged for party line system. The cabinet is of quartered oak finished in golden oak to match the woodwork of the room.

The arrangement of the multiple jacks is such as to allow a full set of multiple jacks to each two operators' positions.

The present equipment is 600 lines, with an ultimate capacity of 1,600. With the present installation, however, using the rapid party line system, the board can easily handle from 1,200 to 1,500 subscribers.

The outside cables terminate in 100-pair terminal heads, equipped with lightning and high-current protectors. From these heads the cable is conducted through "cable runs" to the cabinet which contains the main and intermediate racks, from which they run to the multiple and answering jacks.

The relay and distributing cabinets are finished to match the switchboard and are equipped with glass doors so arranged as to allow of easy access to both front and back of the relays and racks.

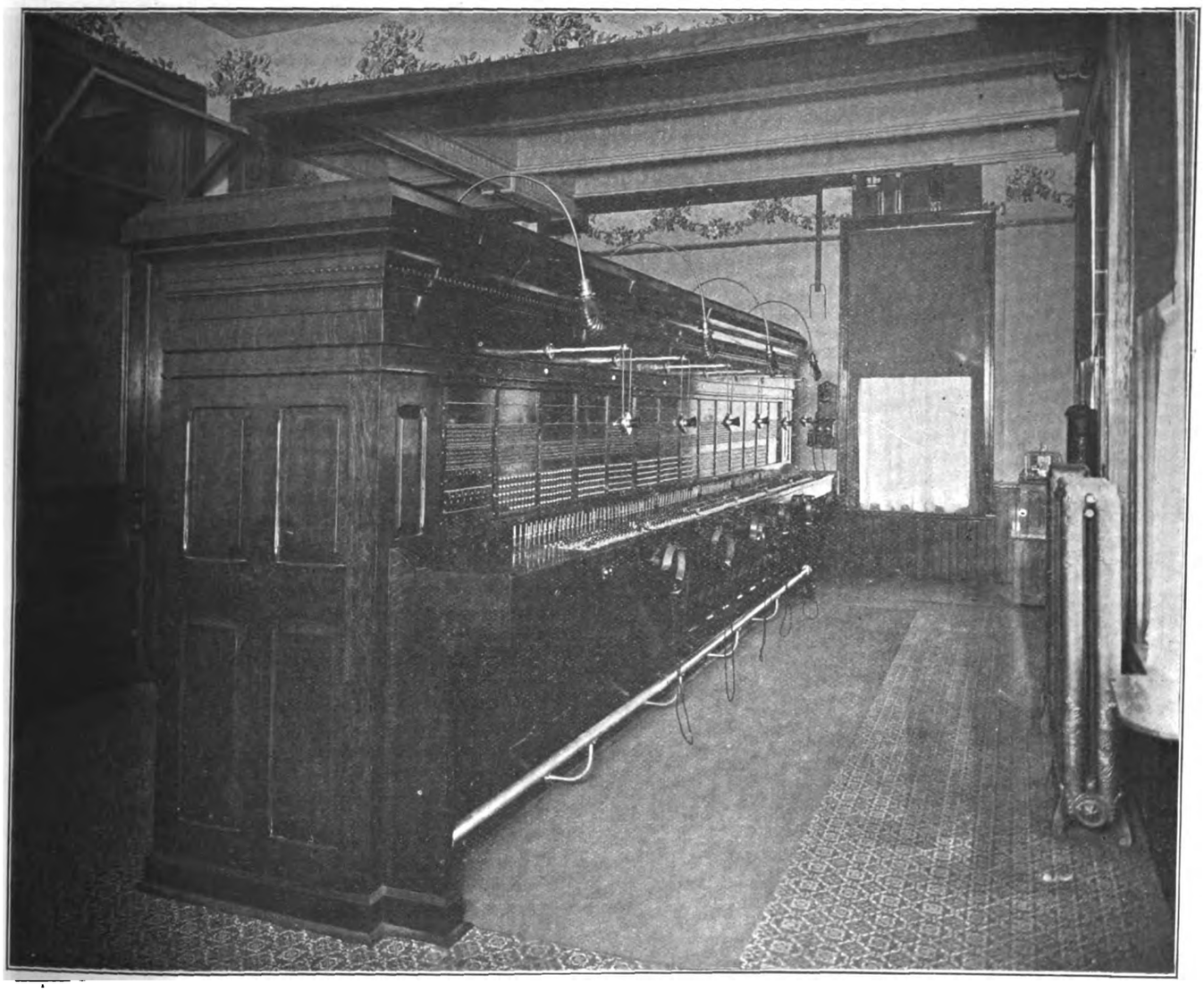
The power plant consists of two sets, twelve each, of chloride accumulator storage batteries of 520 ampere-hour capacity, furnished by the Electric Storage Battery Company, of Philadelphia, Pa.

The motor-dynamos for charging are the alternating-current motor and direct-current generators, manufactured by the Wagner Electric Manufacturing Company, of St. Louis, Mo. The power boards are pink Tennessee marble, on which are mounted the volt and ammeters, switches, etc. The measuring instruments are the round pattern, type F, made by the Weston Electrical Instrument Company, Waverly Park, N. J. The switches are the tubular knife switch type, made by the Crouse-Hinds Company, Syracuse, N. Y. The I-T-E circuit-breakers are furnished by the Cutter Company, Philadelphia, Pa.

The fuse board is also of pink Tennessee marble, on which are mounted the regulation fuses.

The Geneva Telephone Company is under the management of Mr. F. S. Bronson, who takes great pride in his exchange.

The contract for building and equipping the plant was awarded to the Century Telephone Construction Company, of Buffalo, N. Y. This company manufactured all the central station and substation apparatus in its Buffalo factory. This company has built and equipped many similar successful exchanges throughout the western and central part of New York state.



MAIN OPERATING SWITCHBOARD, EXCHANGE OF GENEVA, N. Y., TELEPHONE COMPANY.

Radium salts can be separated into two parts, one small but very active, and the other containing the greater part of the material, but inactive. Upon standing, the active part loses its radioactivity, while the other regains it, and this fact seems to indicate that the same set of molecules can not remain radioactive.

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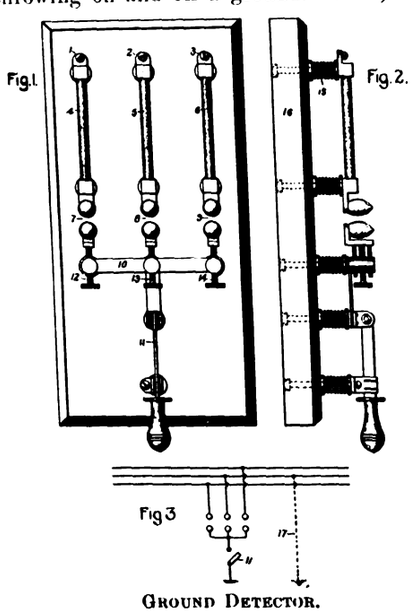
Electrical Patents.

A ground detector having several novel features has been invented by Mr. Charles C. Badeau, of Schenectady, N. Y., who has assigned his interest to the General Electric Company. The object of this invention is to provide an effective ground detector for electric circuits, and to distinguish between a static and dynamic discharge, by a device durable and simple in construction. The essential feature of the invention consists in providing a spark-gap between the lines and earth at the point at which the detector is located, and means for increasing the length of said gap with respect to a charge between the line wires. The best form thus far devised in carrying out the invention comprises a plurality of gaps with respect to the line wires, the aggregate sparking distance of which the potential of the line is unable to bridge, and a switch for throwing on and off a ground. Thus, if

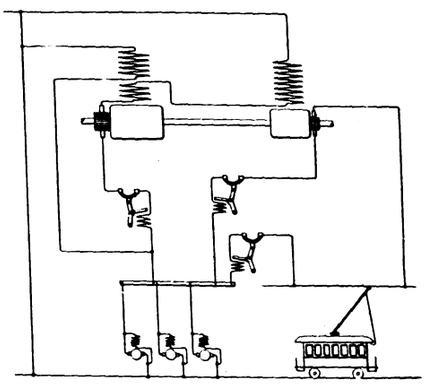


GROUND DETECTOR.

a discharge occurs across the gaps a removal of the ground will force the potential to traverse the aggregate arcing distance, and since the line potential is unable to do this, a dynamic discharge will be quieted, thereby indicating the character of the discharge. Included in series with the device is a resistance for cutting down the current, so as to prevent destruction of the contacts. The invention therefore consists in a ground detector provided with means for requiring a longer path of discharge from wire to wire than from any wire to ground in connection with a switch for throwing off and on the ground, and comprises also a plurality of discharge paths from different line wires in connection with a common ground switch.

In the accompanying illustrations of the invention, Fig. 1 is a front view of an apparatus embodying the improvements. Fig. 2 is a side elevation, and Fig. 3 is a diagram showing the relation of the instrument to a circuit. Referring first to Figs. 1 and 2, 1, 2, 3 represent terminals adapted to be connected with leads from a circuit. The device shown is adapted to three-wire circuits or triphase circuits, though the improvements are in no respect limited to such an application. In series with the terminals are resistance blocks 4, 5, 6, such as a baked mixture of graphite and clay, connected in series relation to spark-gaps 7, 8, 9, mounted in a common metal support 10, adapted for connection with ground through a switch 11. Each gap may be varied in length by means of adjusting screws 12, 13, 14. The parts are supported upon insulating pillars, as 15, mounted upon a base 16. In a three-wire circuit the terminals 1, 2, 3 are connected with the three line wires, respectively, or for a two-wire circuit two may be so connected. The gaps are adjusted with respect to the circuit so that the arcing distance of the several gaps interposed between the line wires will be longer than the potential of the system can jump. The switch is normally closed. Thus, if a ground occurs on the system the line potential is sufficient to spark across but one of the gaps, and by opening the switch the sparking will cease. If, however, the discharge is a static one the sparking will still continue, since the aggregate gap is within jumping distance of a static discharge. The dotted line 17, in Fig. 3, indicates a supposed ground on one of the line wires. The switch 11 being assumed closed, the gap will be abridged, but opening the switch will quiet the discharge if dynamic in character. If, however, the discharge is static, it will still continue. A gap is preferably provided for each wire, since an indication thus is afforded as to the wire on which the ground occurs. The parts being in multiple, the grounded wire will be the only one in whose spark-gap no sparking will occur. The interposition of the resistance blocks 4, 5, 6 cuts down the current, thus preventing damage to the instrument and waste of energy, and at the same time acts as a relief for the line from static charges.

In operating constant-potential systems of electrical distribution it is common to employ electromotive-force devices between the generator and the distributing network to raise the potential on particular wires or feeders in order to compensate for decrease of potential due to excessive load on such wires or feeders. These devices are commonly electrodynamic boosters, which are generally placed in the station to compensate for the drop over a long feeder or from increase of load. These devices are sometimes engine driven and sometimes operated by electric motors. When motor driven, any damage to the motor which destroys its driving power—as, for instance, an opening of the switch controlling the motor circuit, or a throwing of its circuit-breaker, or other accident tending to stop it—leaves the booster without a driving power, and under the current of the feeder circuit it reverses and becomes a motor, and being commonly a series-wound device rapidly accumulates speed until it is torn apart by centrifugal force. A new means for controlling these electric boosters has been patented by Mr. Merle J. Wightman, of New Brighton, N. Y., the patent thereon being assigned to the General Electric Company, of New York. It is the object of the invention to prevent such disastrous consequences, and means



CONTROLLING ELECTRIC BOOSTERS.

are provided for automatically protecting the booster from "running away," as it is called, in case the driving motor ceases to operate. In carrying out the invention, the series field commonly provided for boosters is dispensed with and instead a field winding connected in the circuit of the driving electric motor is employed. By this means if the motor circuit opens, or its armature burns out, or motor current is interrupted in any way, the field magnet becomes deenergized and the booster comes to a stop. In some cases, as where a considerable lead must be given to the brushes to ensure the best operation of the booster, a few opposing turns on the field magnet are provided and connected in the feeder circuit, so as to counteract the tendency to magnetize the field magnet from armature reaction, and even in cases where ordinary lead only is provided a few opposing turns of this kind may be employed in order to destroy effectually the residual magnetism of the field.

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TECHNICAL ASSOCIATIONS AT SARATOGA.

MEETINGS OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, THE AMERICAN RAILWAY MASTER MECHANICS AND THE MASTER CAR BUILDERS.

The American Society of Mechanical Engineers held a four-days' session at the United States Hotel, Saratoga Springs, N. Y., last week, beginning Tuesday, July 23. The meeting was very well attended. The society will hold its annual session in New York city, in December of this year.

On Friday the members of the society and their friends were the guests of the General Electric Company and the American Locomotive Company, at Schenectady, a special train taking them over and back. They were very pleasantly entained and shown through the very extensive works of both companies.

The ELECTRICAL REVIEW will publisn several of the papers which were read and discussed at this meeting of the society.

The American Railway Master Mechanics' Association concluded its thirty-sixth annual convention at the Grand Union Hotel, Saratoga, Friday, June 26. Many of its members remained over this week to attend the session of the Master Car Builders' Association, which began Monday and continued until Wednesday. Mr. George H. Daniels, general passenger agent of the New York Central & Hudson River Railroad, made a witty opening address, welcoming the car builders to Saratoga.

The Master Mechanics elected the following officers for the ensuing year:

President, W. H. Lewis, of Roanoke; first vice-president, P. H. Peck, of Chicago; second vice-president, H. F. Hall, of Cleveland; third vice-president, J. F. Deems, of New York; treasurer, Angus Sinclair, of New York city; secretary, Joseph W. Taylor, of Chicago.

It seemed to be a very fortunate arrangement that brought together these three technical associations at Saratoga Springs. It proved to be a great advantage in many ways, and there was a constant mingling of the practical and technical men that can not fail to be of much value in advancing the interests of all the associations and of the industries which their membership represent.

Among the attendants at the various meetings were A. A. Thresher, Dayton, Ohio; J. N. Derby, New York; A. L. Rohrer, Schenectady, N. Y.; A. L. Doremus, F. V. Henshaw and Charles W. Startsman, Ampere, N. J.; Colonel John T. Dickinson, New York; J. A. Werner, Philadelphia; Frank G. Bolles, Cincinnati, Ohio; J. C. Shainwald, New York; Edgar Peckham, Kingston, N. Y.; A. B. Prool, Jr., New York; Daniel M. Brady, New York; E. H. Mullin, New York; E. T. Lyle, Buffalo; A. N. Spencer, Cincinnati, Ohio; G. A. Hagar, St. Louis, Mo.; Charles A. Moore, New York; W. M. Probasco, Pittsburg; Ray D. Lillibridge, New York; T. F. Lyman, New York; J. E. Meek, New York; Frederick Swift, Boston, Mass., and A. J. Rosseau, Chicago, Ill.

At the meetings on Thursday, June 25, the report on "Electrically Driven Shops" was presented by C. A. Seley, and was discussed at some length by the author and by R. H. Soule, L. R. Pomeroy, W. R. McKeen, H. H. Vaughan and others.

Among the electrical and allied interests were the following exhibitors and exhibits, to be seen at the Grand Union Hotel:

The H. W. Johns-Manville Company, of New York city, had an exhibit of its products in the south side of the Grand Union court. This company was ably represented by Messrs. W. E. Robinson, T. F. Lyman, J. E. Meek and others.

Manning, Maxwell & Moore, of New York, were represented by Messrs. Charles A. Moore, J. N. Derby, C. E. Randall, D. F. Williston, George E. Terry, F. P. Smith, Percy Brotherhood and others.

The Westinghouse Air Brake Company had a very interesting exhibit, with a beautifully illuminated sign, and was represented by Messrs. Herman Westinghouse, W. M. Probasco, F. M. Nellis, E. M. Herr, E. L. Adrean, S. J. Kidder and others of its staff from Pittsburg and St. Louis.

The Stromberg-Carlson Telephone Manufacturing Company, Chicago, Ill., and Rochester, N. Y., had a very excellent exhibit of its various types of telephones and telephone apparatus, and distributed some very handsome new illustrated catalogues. Mr. A. J. Rosseau, of Chicago, was in charge of the exhibit.

The Peckham Manufacturing Company, of Kingston, N. Y., had a large exhibit. A four-ton Peckham electric truck, designed for high-speed electric railways, with a speed of from forty to seventy miles per hour, was shown. E. Peckham and others represented this company.

The Consolidated Railway, Electric Lighting and Equipment Company, of New York, was represented by Colonel John T. Dickinson, and had on exhibition the Pullman car Elysian, equipped throughout with the lighting system of this company. This car, which was used by President Roosevelt in his recent extensive tour, was shown on a side-track of the Delaware & Hudson Railroad, and was visited by a large number of practical railway men.

The General Electric Company was ably represented, among the gentlemen in attendance being A. L. Rohrer, J. R. McKee, E. H. Mullin, H. D. Hawkes and F. H. Gale.

The Robbins Conveying Belt Company, New York city, presented an interesting exhibit, and was represented by A. B. Prool, Jr., E. Williamson Miller, G. Murray and others.

Mr. Frank G. Bolles represented the Bullock Electric Manufacturing Company, of Cincinnati, and distributed some interesting literature respecting the well-known Bullock electrical apparatus.

The Crocker-Wheeler Company, of Ampere, N. J., was strongly represented, and an interesting poster in colors, relating to the product of this company, was to be seen conspicuously in the various hotels. Among the representatives present were A. L. Doremus, Putnam A. Bates, Charles W. Startsman, F. B. Degress and F. V. Henshaw.

The Link Belt Engineering Company, Nicetown, Philadelphia, Pa., was represented by J. A. Werner, R. R. Fauntleroy and J. M. Dodge.

The Standard Paint Company, of New York, was represented by J. C. Shainwald and J. N. Richards.

The Buffalo Forge Company had an interesting exhibit, and was represented by E. T. Lyle and W. F. Wendt.

Mr. A. N. Spencer represented the J. A. Fay & Egan Company, of Cincinnati, Ohio.

The B. F. Goodrich Company, Dayton, Ohio, was represented by Roger Johnson.

Mr. E. G. Fisher represented the National Electric Headlight Company.

Mr. Frederick Swift, president of the Boston Car Wheel Company, 501 Tremont Building, Boston, was in attendance. Mr. Swift is an old electric light man, and is now actively engaged in the car-wheel business. He is also the New England agent for the Baldwin Locomotive Works.

Copper Production in Hungary.

In Hungary, in 1901, there were mined 161,548 metric tons of copper, the value of which was about $47,313. The quantity produced in the preceding calendar year was some twenty tons greater. Formerly eighty per cent of the copper was mined by the government, but in the past year only fifty per cent was so mined. There are at present sixteen copper-mining concerns in Hungary, of which two state and three private undertakings supply the greater part of the metal.

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Reviews of Current Engineering and Scientific Literature.

The Pino Hydroscope.

The hydroscope is an instrument for enabling one to examine visually submerged bodies. This particular one is for use in examining the bottoms of vessels. It consists of a telescoping tube, with one or more right-angle bends, in which are placed mirrors. The lower part carries a number of incandescent lamps, which serve to illuminate the object to be examined. A system of wipers, operated by hand, serves to remove all moisture condensing on the glass cover or mirrors. The instrument can be arranged to examine surfaces in a vertical position, or, by the addition of a second bend, the bottom of vessels. The outer surface of the glass end-plate is kept clean by streams of water. Lenses are arranged within the interior to condense the beam of light and transmit it to the eye-piece at the upper end.—*Abstracted from the Electrical Engineer (London), May 29.*

The Vizzola Electric Power Plant, Italy.

This gives a brief description of the large hydraulic power plant at Vizzola, Italy. In developing this the Societa Lombarda has expended about $2,400,000. The plant supplies energy for factory driving and for lighting neighboring towns. From the central station ten three-phase circuits distribute energy to distances of about twenty-five miles. The total length of the primary lines is eighty-seven miles. On January 1 last, this system was supplying 15,000 incandescent lamps and 750 electric motors from ninety-eight substations. The capacity of the substations is 15,500 kilowatts. In the central station are ten generators of 2,000 horse-power each, each driven directly by a turbine. There are also three sets of exciters, each of 200 horse-power. The waterfall varies from seventy-five to eighty-seven feet, and it is conducted to the turbines by twelve steel tubes six feet in diameter. Three of the alternators generate current at 11,000 volts, fifty cycles. The river Ticino is the source of supply of the water, the total length of the canal that had to be constructed was about four and one-quarter miles with a drop of fifteen per 1,000 and with a capacity of about 1,000,000 gallons per minute. The water velocity was 4.5 feet per second. The average income from the sale of power is $40 per horse-power-year. The generating plant is at present fully loaded throughout the greater part of the day, so that the operating company is now erecting a new plant nine miles further down the river, where a fall of twenty-seven feet is available and 6,000 horse-power can be developed. A steam plant is also being erected at Castallanza, where 5,400 horse-power will be available. This plant will supply power for excessive demands and when the water is low.—*Abstracted from the Electrical Engineer (London), June 12.*

Measurement of the Efficiency of Asynchronous Motors.

In this article M. Larmoyer discusses two methods of testing induction motors. The first is that due to Heyland, in which the performance of the motor is deduced by the use of the general transformer diagram, and the methods of determining the constants used in this computation are described. The second method is that known as the separation of losses, and is due to Swinburne. In this the no-load losses are measured, the Foucault losses are calculated, and in this way the efficiency of the machine under the load is predetermined. The use of these two methods is illustrated by an example, and the results of the two methods agree satisfactorily. The motor tested was a three-phase induction motor, of thirty-two horse-power, 460 volts, fifty cycles, running at 750 revolutions. The Heyland method gave an efficiency under load of 82.2 per cent. The slip was 2.63 per cent. The Swinburne method gave an efficiency of eighty-eight per cent, and the slip was 2.66 per cent.—*Translated and abstracted from the Bulletin of the Association des Ingénieurs Electriciens (Liege), June 10.*

A Notable Observation with Radium.

When undertaking some work in the weighing of radium, Herr Ernest Dorn secured about thirty milligrammes of the strongest radium bromide on December 3, 1902. This was contained in a small tube of glass free from alkali. The tube was six millimetres long and 0.46 millimetre in diameter, the glass being 0.3 millimetre thick. The tube was sealed by fusing. On May 27 of this year, after nearly six months, it was decided to open the tube. In order to do this the tube was held in the left hand and a three-corner file was used to cut the glass. As soon as this file scratched the glass, an electric spark punctured the glass, with some noise. The spark was bright enough to be noticed, although the author was standing close to a window on a bright summer afternoon. The noise was heard by a second person, who was standing in the middle of the room. The explanation suggested for this phenomenon, is that the negative electrons had passed through the glass walls and escaped, while the positive electrons had been retained within the tube. This had caused an electric charge to appear on the outside of the tube, assisted possibly by the radium rays. It is noteworthy that the potential was sufficient to break through at least 0.2 millimetre of glass.—*Translated and abstracted from Physikalische Zeitschrift,* June 15.

Note on the Probable Occasional Instability of All Matter.

In this connection Sir Oliver J. Lodge considers the effect of acceleration of an actively charged electron. An equation is deduced giving the radiating power in terms of the mass of the particle, its acceleration and charge and the velocity of light. In this equation the eighth power of the velocity of the rapidly moving particle appears. Now, as radiation loss is equivalent to a resisting medium, and accordingly the revolving particle tends to move inward toward its centre and its speed to increase. A slight increase in speed brings about a great increase in the radiating power, wherefore the change, once begun, tends to increase until the speed approaches the velocity of light. On the electric theory of matter, radiation or loss of energy must occur from every atom, and therefore it is only a question of time how long an atom shall last before it reaches this stage. Directly this stage is reached another effect supervenes, the rapidly moving portion of the mass begins rapidly to rise in value. This effect is unimportant until the speed comes very near to the light velocity, but the mass becomes suddenly infinite or very great when the light velocity is attained. It would seem that the momentum must increase and must disturb the balance of forces holding the parts of the system together. In an extreme case it might happen that the lighter body would suddenly become the heavier and would jerk the rest of the atom off. In any case it appears likely that an atom

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at this stage would begin to break up. In other words, the fact of the electronic radiation seems to carry with it liability to change or decay of all matter possessing an electric constitution, the change from one form to another being accompanied by radioactivity. Attention is directed to a sort of astronomical analogy to this, in the contracting or gradual collapsing of a nebula, with the occasional shrinking off of peripheral material as an unstable stage is periodically reached. The author says further that this critical stage is reached only when the velocity of the moving particle approaches very nearly that of light. When it is within one per cent of the light speed the mass is trebled, and when it is within one part in a thousand of its limiting velocity, the mass is quintupled.—*Abstracted from Nature (London), June 11.*

Theory of a Singing Arc.

It is well known that an alternating-current arc, shunted by a capacity and an inductance, will give a musical note. In this article, M. P. Barry describes an experiment made to test a suggested explanation. The pitch of the note depends upon the capacity and the inductance of the shunt circuits. A rapid oscillation of the current is produced by this circuit, which sets the gas in the arc and the surrounding air into vibration. The author believed that this effect was similar to the breaking up of a stream of mercury or other liquid when highly charged, and in order to test this, a circuit was set up, in which an arc lamp was supplied by means of storage batteries. In shunt with this arc was connected a capacity and an inductance, a system of lenses threw the image of the arc on a screen, passing the beam of light first through a perforated disc. This circuit gave the usual singing note. By revolving the disc in time with this note and by shifting its phase, an image could be secured of any particular phase of the action. By means of this, the variations in the light of the arc could be followed, and it was seen that in one instant the arc was out. The current variations were traced by means of the Blondel oscillograph, which showed that the current varied with a frequency equal to the pitch of the note. If the note was pure, the curve obtained was sinusoidal, but if harmonics were present, it was irregular. In all cases it fell to zero at one instant. The author thinks that the explanation usually given for the breaking up of a stream of conducting liquid when charged, is sufficient to explain this phenomenon, and that the arc starts again after going out because the carbons and the column of gas between them are still hot.—*Translated and abstracted from L'Industrie Electrique, June 10.*

The Prevention of Electrically Deposited Dust.

It has frequently been noticed that where electrical circuits are supplied from the continuous-current system with a voltage above 200, dust gathers in the vicinity of all flexible conductors and on the lamps. Mr. D. S. Munro here considers the probable cause of this phenomenon and suggested a method of preventing it. It seems evident that a number of small particles of suspended matter, in a normal room, are floating in the air approximately at earth potential. These are drawn toward the outer wire, either being positive or negative, and those particles which are not too firmly caught and held in the small hairs of the braiding, are in time charged and projected with force against the wall or whatever happens to be near. The author made an experiment with the object of comparing the effect of differently surrounded conductors. The board was covered with smooth white paper and vertically across this were fixed a number of conductors all of the same resistance. The distance from the wire to the paper was one-half an inch. Part of these wires were connected to the positive side of the circuit and the others to the negative side. These wires were so connected that they remained charged at all times. They included bare copper and vulcanized rubber, silk-covered, flexible wire and Glover wire taped and braided, and a conductor concentrically covered with lead. After eight days the positive bare wire and the external positive concentric were distinctly covered with dust, and the paper behind them held a streak of dust. The silk-covered flexible wire next showed signs and in about fourteen days was thickly covered. At the end of one month, the Glover wire and the paper behind it showed slight signs of dust. In the case of the wires connected to the earth side, there was no indication of dust. In ordinary circuit wires, the comparatively thick dielectric minimizes the collecting property, and there seems to be no way of preventing the collection of dust on high-voltage lamps. It is suggested that if flexible conductors were made concentric with the earth, connected outside, there would be no such trouble.—*Abstracted from the Electrical Review (London), June 5.*

Energy Losses on Electric Cars.

In designing an electric traction system the greatest care is taken to obtain a plant that will generate and distribute the necessary power at the least expense, but after this has been delivered to the car very little attention is paid to its economical use. Mr. W. Park here discusses this phase of electric car operation, and shows how the expense of running the car might be materially reduced. A good deal may be accomplished by a proper training of the motorman and an insistance upon a correct handling of the car. In cases where recording wattmeters have been installed the records of power consumed vary as much as twenty or thirty per cent on similar cars operating under similar conditions. But aside from this phase of the problem a considerable saving may be effected by increasing the running time of the cars somewhat. As an illustration two cases are cited: The car is assumed to weigh twenty-eight tons. The length of the run is one-half a mile in each case. In the first case this distance is covered in 108 seconds, and in the second case in 136 seconds, the schedule speed, allowing twenty seconds for stops, being fourteen miles per hour in the first case, and eleven and one-half miles in the second case. The entire distance is covered without a stop. In the first case the energy consumption is sixty-one watt-hours per ton-mile, and in the second case forty-five watt-hours per ton-mile. The overall efficiency in the first case is forty-nine per cent, and in the second case, sixty-two per cent. The difference in the running is brought about by accelerating the car for fifty-five seconds in the first case, and then allowing it to drift for thirty-five seconds, and bringing it to a stop with the brakes in eighteen seconds. In the second case the car is accelerated for thirty-five seconds only, so that the maximum speed is but twenty-one miles per hour, as against twenty-three with the other. It then drifts for ninety-five seconds, and is brought to a standstill in six seconds. The energy saved in the second case is lost in braking where the highest speed is obtained, but is made with a sacrifice of twenty-eight seconds' time. Another point urged by the author is the saving effected by decreasing the number of stops. It would be possible not only to decrease the power consumed, but also to reduce considerably the running time, by appointing fixed stopping-places and adhering strictly to these.—*Abstracted from the Tramway and Railway World (London), June 11.*

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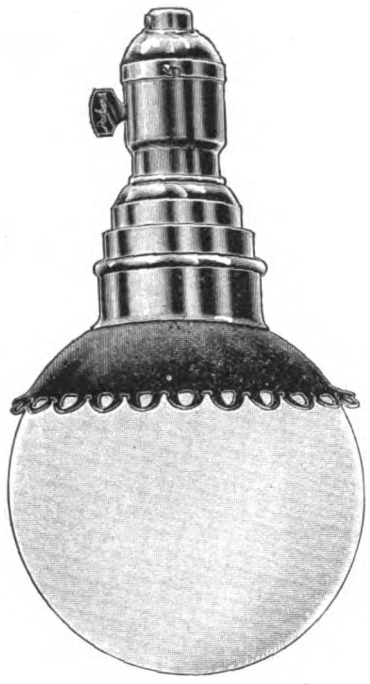
INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

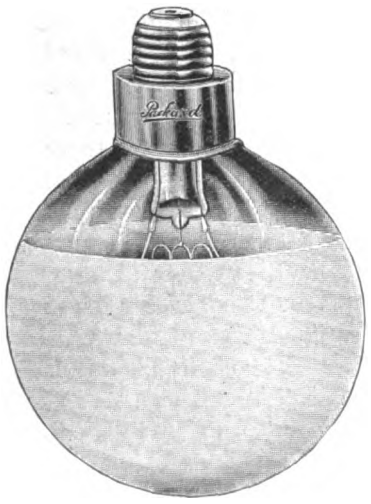
New Type Incandescent Lamp.

The Electric Appliance Company, Chicago, Ill., is placing on the market the "Zenith" incandescent lamp, manufactured by Packard. The "Zenith" lamp is



NEW TYPE INCANDESCENT LAMP.

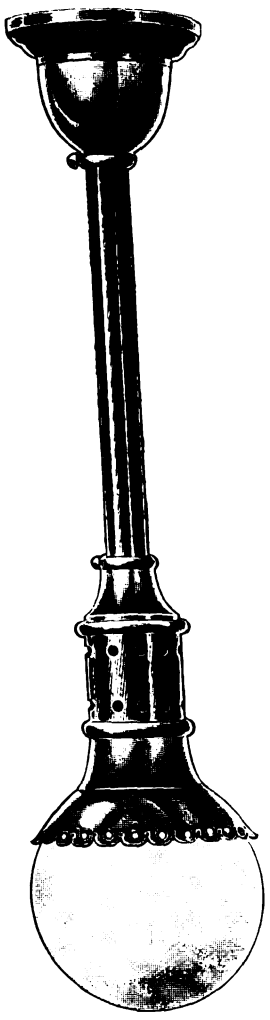
claimed to be an intermediate between the arc lamp and the incandescent lamp, retaining the simplicity of the latter. It is made in two sizes, twenty-five and fifty-five candle-power, at two efficiencies, 1.9 and 2.18. This new type of incandescent lamp gives a brilliant yet soft white light,



NEW TYPE INCANDESCENT LAMP.

which is evenly distributed beneath the lamp. The range of voltage is from 90 to 150, and the lamp is furnished regular with Edison base, but can be furnished also with T.-H. base. The manufacturer claims that the lamp possesses simplicity, reliability, high efficiency and low first cost, and that it can be used on either alternating or direct-current circuits, and requires no attention during life.

The simple collar (style A) adapts this lamp for use on any style of fixture, or



NEW TYPE INCANDESCENT LAMP.

it is furnished complete with ceiling stem. The accompanying illustrations give a good idea of several forms of this lamp.

The new marine barracks at the Naval Academy, Annapolis, are to be lighted by electricity, generated by a motor-generator set consisting of a 100-horse-power direct-current motor mounted on the same bed-plate with and direct-connected to a sixty-kilowatt, two-phase alternator. The current will be generated at 1,100 volts and transmitted across the river and there transformed to 440 volts. These machines have recently been ordered from the Westinghouse Electric and Manufacturing Company, together with the usual switchboard and auxiliary apparatus.

Gold Car Heating and Lighting Company.

The amount of heating apparatus sold by the Gold Car Heating and Lighting Company during the past year was nearly double that of any former year since the origin of this business. Not only has the tremendous increase taken place in its steam railway car heating department, but the electric heating branch has developed and improved very materially as well. During the past three months, the number of cars and locomotives for which orders for heating equipment has been received has been very gratifying. A few of the orders recently taken by the Gold company for car, locomotive and electric car heating equipment are as follows:

	Equipments.
Canadian Pacific	290
Brooklyn Heights Railroad	240
Missouri Pacific	125
Wabash	105
Erie	102
New York, New Haven & Hartford	101
Massachusetts Electric Companies	100
Metropolitan Street Railway	100
Southern	79
Louisville Railway	75
Central Railroad Company of New Jersey	58
New York Central & Hudson River Railroad	45
New Orleans & North Eastern	40
Boston & Albany	37
C. C. C. & St. L.	36
Denver & Rio Grande	35
Chicago & Eastern Illinois	32
Western Maryland	21
South Side Elevated	20
Scranton Railway	15
Nashville, Chattanooga & St. Louis	21
M. St. P. & S. S. M.	22
Cincinnati, Hamilton & Dayton	12
Texas & Pacific	24
Georgia Railroad	4
Lake Shore & Michigan Southern	15
Boston & Maine	28
New York, Ontario & Western	14
Delaware, Lackawanna & Western	25
Chesapeake & Ohio	5
Atlanta & West Point	6
Central of Georgia	14
Alabama Great Southern	4
Cincinnati, New Orleans & Texas Pacific	14
Vicksburg, Shreveport & Pacific	8
Alabama & Vicksburg	6
Mobile & Ohio	15
Louisville & Nashville	3

Within the last few months the company has sold nearly 4,000 sets of its heating equipment in the United States alone. During the past month an order has also been received for the shipment of several thousand sets of its specialties abroad.

The very general adoption of its car, locomotive and electric heating apparatus all over the world, where modern appliances of this kind are used, speaks volumes for the merit of the improved Gold system of car heating.

The main office of Gold Car Heating and Lighting Company is at Frankfort and Cliff streets, New York city. The other offices of the company are at Chicago and London.

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Alternating-Current Series Arc Lamps.

In developing the series alternating-current enclosed system, types of which apparatus are shown in the accompanying illustrations, the Adams-Bagnall Electric Company, of Cleveland, Ohio, has aimed to produce a line of great simplicity and reliability in operation, low in cost of maintenance, and possessing at the same time the highest economy and sensitiveness of action.

Fig. 3 shows the regulator used with this system. The essential parts of this regulator consist of an M-shaped iron element and a movable coil, partly counterbalanced by a weight working over a knife-edge bearing. The coil is wound in sections to avoid excessive voltage between adjacent parts, and is constructed so as to run at a low temperature. This is important to the life of the coil, as well as economy in operation.

Oil dashpots are provided, which ensure steadiness in operation and enable the circuit to be started by simply closing the line switch. In operation, the weight is placed so as to balance that part of the weight of the coil not lifted by magnetism. It will be readily seen that this arrangement gives a minimum inertia of moving parts. When operating a full circuit of lamps, the movement of the regulator coil is very slight, requiring only weak dashpot adjustment, and rendering the regulation very sensitive.

FIG. 1.—ALTERNATING-CURRENT SERIES ARC LAMP.

Figs. 1 and 2 show the type of lamp, and, in outward appearance, the shunt and differential lamps are identical. The cases are of pure Lake copper, stamped to shape. The outer globe is spherical, with a single opening, giving a neat appearance and maximum strength. Stamped steel enameled reflectors are used in connection with inner and outer globes for all outside work. The inner globe is pear-shaped, open at one end only, giving a maximum life of carbon.

The controlling apparatus is of simple construction, and is especially designed for easy trimming in any kind of weather. A door opening in the side of the case renders the mechanism instantly available for inspection. The lamp parts are largely interchangeable. Special attention is given to securing insulation of a non-combustible nature.

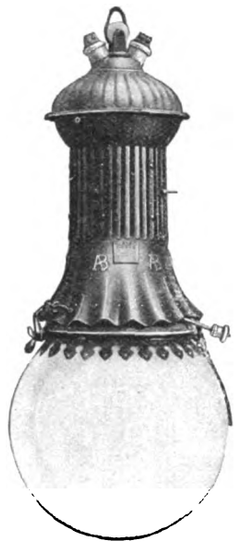

FIG. 2.—ALTERNATING-CURRENT SERIES ARC LAMP.

An electromagnetic mechanism, instead of solenoid control, is used for the mechanical operation of the lamp. The electromagnets being very sensitive, the manufacturer states that this gives an absolute uniformity of range, the anti-friction construction making it possible to maintain a constant voltage at all times.

The alternating-current differential lamp consists essentially of a flexible lever rocking over a knife edge, carrying at its opposite ends a shunt and series electromagnet, to the former of which is attached the clutch mechanism. By the peculiar shaping of the pole tips of these electromagnets a uniform range in voltage is obtained, from the point of pick-up to that of feeding. The electromagnetic control enables the operation of the lamp with a low energy consumption. Coin silver contacts are used for the cutouts, and a small Krupp resistance is used for starting the lamp after it is properly trimmed.

In the shunt lamp of this type a safety circuit, closed by a small balance lever, is employed, which automatically operates to throw the coarse wire spool into action to bring the carbons together. In a lamp tested for seventy volts this circuit closes at eighty volts, so that the shunt winding never has to meet an electromotive force greater than eighty volts. As the small lever has no winding, it in no way complicates the lamp. Either set of the main cutout contacts is ample to carry the full current continuously, but a second set is only for additional safety, and closes by the same movement that controls the first set.

The operation of the shunt lamp of this type is as follows: Nominally, the shunt circuit is the only path across the lamp. As soon as the current is turned on, however, and the pressure across the lamp rises to eighty volts, a small auxiliary cutout is brought into play, and closes a safety circuit through the main cutout winding. The cutout spool now attracts its armature, and moves upward until the carbons drop together. The carbon path, having the lowest resistance of any, takes practically all of the current when the cutout spool overbalances the shunt spool, and the auxiliary contacts fall apart. The cutout spool continues to fall, separating the carbons until the pull of the shunt balances the weight of the cutout spool. If, for any reason, the carbons do not come together, the cutout spool continues in an upward motion until the main cutout contacts make up, after which the lamp stands cutout until the circuit is shut off.

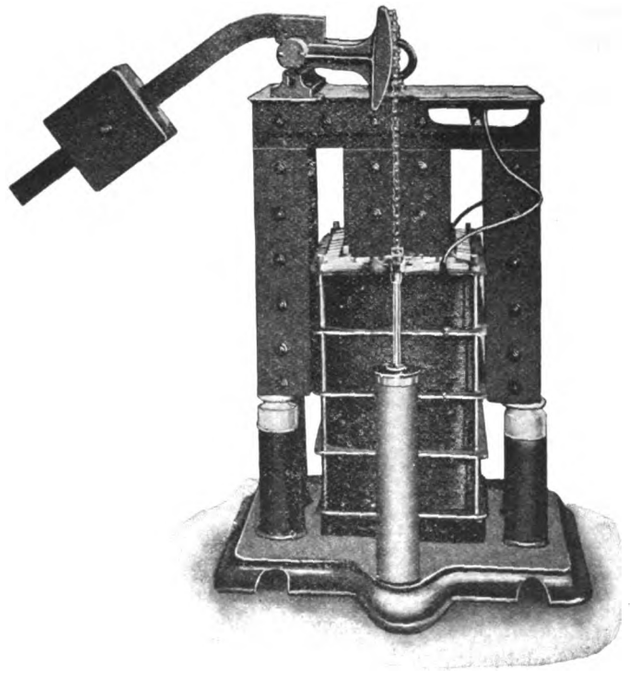

FIG. 3.—REGULATOR.

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Engine-Type Railway Generators.

The accompanying illustrations show several stages of the assembly of the engine-type railway generators which the Stanley Electric Manufacturing Company, of Pittsfield, Mass., has designed to fulfill the extraordinary conditions which a continuous-current generator must meet in railway service. Fig. 1 shows the armature of a ten-pole railway generator; Fig. 2, the armature ventilating device, and Fig. 3, the field of a ten-pole railway generator. Fig. 4 shows a "S. K. C." railway generator direct-connected to a cross-compound Corliss engine.

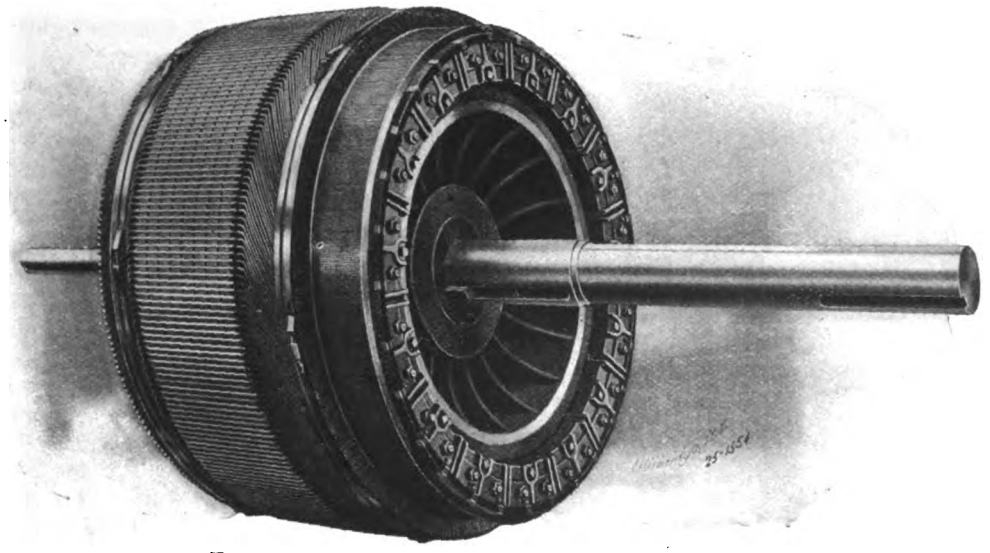

FIG. 1.—ARMATURE OF TEN-POLE RAILWAY GENERATOR.

The armature laminations are dovetailed into the arms of a cast-iron spider, and are clamped between two end-rings drawn together by bolts passing inside of the laminations, cast in one piece with the end-rings on the supports for the armature winding. The laminations are subdivided by ventilating ducts of novel construction. The steel fingers are held between supports bent up from punchings in the manner shown in Fig. 2, and the space thus left entirely open for the free circulation of air. Ventilating ducts are also placed at each end of the core, between the laminations and the end-plates.

The armature is all in the same cylindrical surface, and, with but few exceptions, is of the multiple or parallel type. Equalizing rings are placed on the ends of the core, and are connected to the winding at proper intervals. These rings equalize any difference or potential under the different poles, due to any slight mechanical or electrical lack of symmetry. The coils are formed and insulated before being placed in the slots, and are held in place by wedges in the slots and by bands over the ends.

The commutator is built upon a separate spider which is mounted upon a projection of that of the armature. The clamping rings are held together by bolts which pass completely through the spider. The end-ring is in sections, so that one part may be removed without dismantling the whole commutator.

The field yoke is made of cast iron, and is parted horizontally. The inside of the ring is turned out smooth, and where the steel poles fit against the yoke the pole is extended. The pole is made of cast steel; and the pole-shoes of cast iron. The pole is bolted through the yoke with two bolts, and the shoe is held against the pole core by screws through its face.

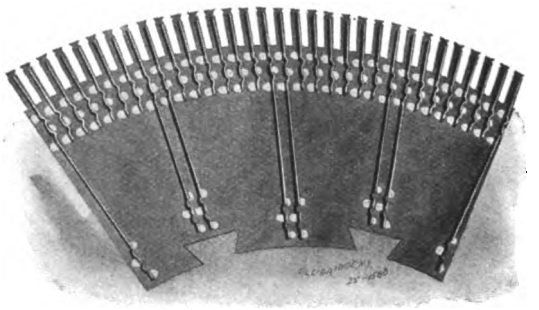

FIG. 2.—ARMATURE VENTILATING DEVICE.

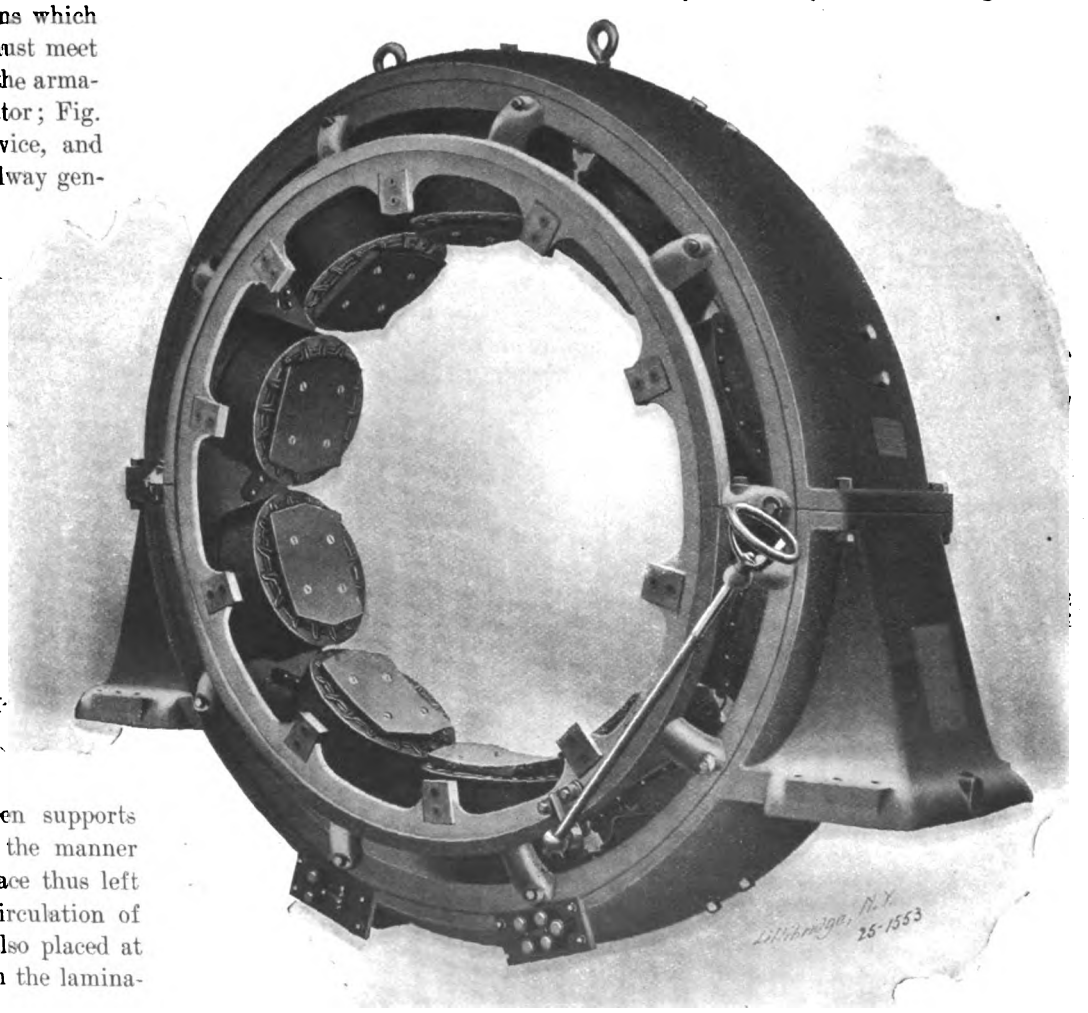

FIG. 3.—FIELD OF TEN-POLE RAILWAY GENERATOR

The poles are of rectangular section, with rounded ends. The field coil is round, allowing a ventilating space on each side of the pole core. The shunt and

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series windings are wound separately, and are kept apart and from the poles by fibre strips.

The manufacturer states that the greatest advance made in these machines is in their electrical design. The idea of subdivision of all reactions has been carried out in every part. The temperature rise of any part, after a continuous run at full load for twenty-four hours, will not exceed thirty-five per cent. The machine will carry twenty-five per cent overload continuously with a rise not exceeding fifty degrees centigrade, and will carry fifty per cent overload for two hours with a rise not exceeding fifty-five degrees centigrade. The length of iron between two ventilating ducts has been made unusually short, and the cross-connections of the armature coils are well exposed to the air.

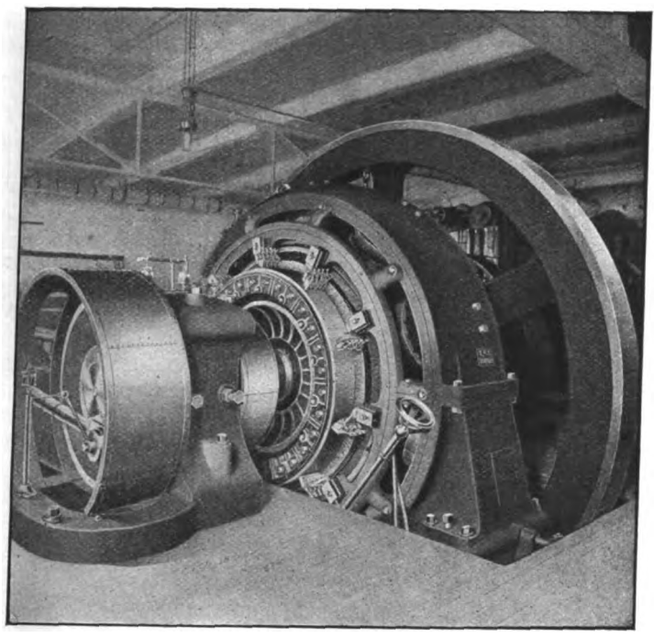


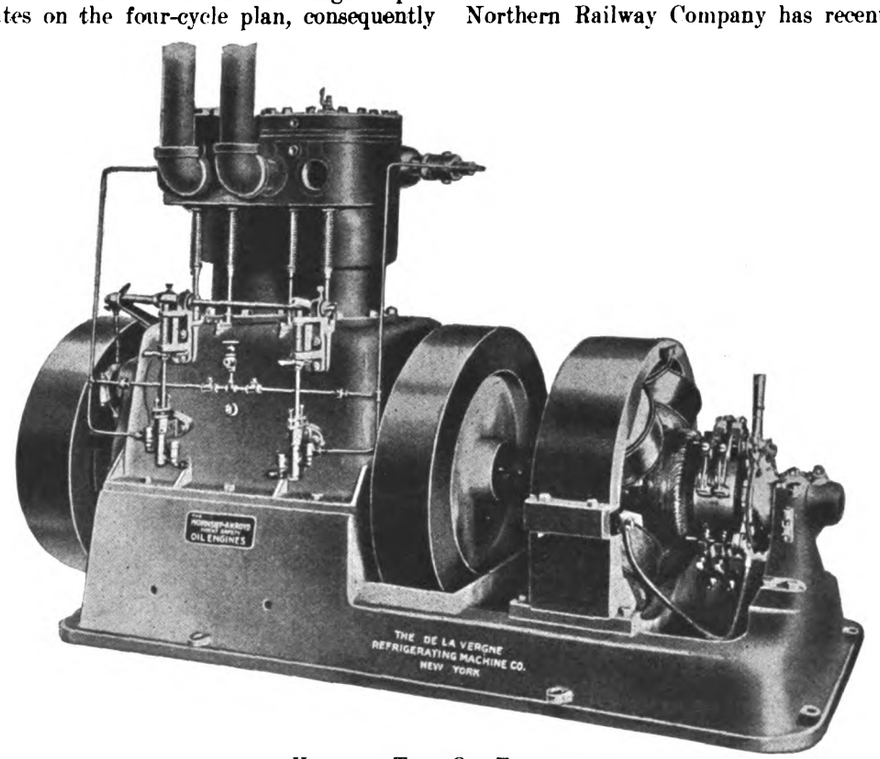
FIG. 4.—RAILWAY GENERATOR DIRECT-CONNECTED TO CROSS-COMPOUND CORLISS ENGINE.

The "Hornsby-Akroyd" Oil Engine, Vertical Type.

The "Hornsby-Akroyd" oil engine of the horizontal type is being very largely used for operating dynamos for electric lighting and power work. This engine has hitherto been chiefly made of the horizontal type, and, operating at a comparatively slow speed, is suitable only for operating the dynamo by belting.

In order to satisfy the demand which has arisen for direct-connected outfits the maker of this engine, the De La Vergne Refrigerating Machine Company, New York city, has recently put on the market a vertical type two-cylinder oil or kerosene engine which is shown in the accompanying illustration. The engine here shown is of fifteen horse-power and runs at a speed of about 450 revolutions per minute. Other sizes are in preparation. The crank-shaft of the engine is rigidly connected to the dynamo by shaft coupling. The crank-pins are set in line and an explosion each revolution of the crank-shaft is obtained. The engine operates on the four-cycle plan, consequently proper combustion is obtained in the cylinder. The fuel is supplied to the vaporizers by two separate oil supply pumps, accordingly the engine can be operated as a single-cylinder engine should it be desired to do so. The regulating speed governor, the most important feature of direct-connected outfit, is the Rites patent governor placed in the flywheel of the engine. The regulation of speed is effected by automatically varying the length of the oil pump stroke. Thus if the load on the engine is decreased the governor, by means of an eccentric, suitably decreases the stroke of the oil pump, varying exactly the pressure in the cylinder to suit the load which the engine has to overcome. Perfect regulation of speed is guaranteed by the maker and it claims variation in speed of less than two per cent. The incandescent lights obtained being absolutely steady, no matter how rapidly the load is changed within the limits of the power of the engine.

The consumption of oil, it is stated, is less than one pound per actual horse-power-hour, the fuel used being ordinary kerosene, crude or fuel oil. When using kerosene the cost of operation is approximately one cent per horse-power-hour. When crude oil is used this cost is usually less than one-half cent per horse-power-hour. The operation of this engine is entirely automatic and it requires no adjustment whatever, the only attention necessary being the heating up of the vaporizers for five or ten minutes before starting and occasional lubrication afterward.



VERTICAL TYPE OIL ENGINE.

For the purpose of furnishing current to the arc lamps at the Allouez ore docks on Lake Superior, which are the largest iron ore docks in the world, the Great Northern Railway Company has recently purchased from the Westinghouse Electric and Manufacturing Company two seventy-five-kilowatt, 2,200-volt, two-phase generators, complete with two 5.62-kilowatt exciters, and a four-panel switchboard. The order also calls for seven seven and one-half and one two and one-half kilowatt transformers.

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The Convention Group.

The accompanying illustration is a group of the delegates and attendants at the seventh annual convention of the Independent Telephone Association of the United States of America. The two-days' session at the Auditorium Hotel, Chicago, June 24 and 25, was not as well attended as in some former years, but those who were there found a pleasant reception and thoroughly enjoyed meeting with old friends and making new acquaintances. The committees worked arduously to properly entertain those who had made the trip and were present at Chicago. Many faces of old-time telephone men, pioneers in the industry, will be recognized in this group, and as the retiring of Judge Thomas from the presidency was the signal for a thorough getting together of kindred spirits, this group will be preserved with more than ordinary interest.

A Group of Delegates and Attendants at the Convention of the Independent Telephone Association of the United States, Chicago, June 24 and 25.

Steam Turbine and Electrical Power Machinery for Philadelphia Subway.

One of the largest contracts for steam turbines and electric power machinery recorded in American territory has been closed by Westinghouse, Church, Kerr & Company with the Philadelphia Rapid Transit Company, covering 15,000 kilowatts of steam turbine and approximately 50,000 kilowatts of electrical generating and converting machinery, for equipping the new rapid transit subway and elevated system now under construction in Philadelphia. The most interesting feature of the equipment to be installed, is that steam turbines are to be used exclusively for power generation in the new central station, now under construction. There will be three turbines installed, each of 5,000 kilowatts normal capacity, which will be of the type now being built by the Westinghouse Machine Company for large powers. The turbines will be directconnected to Westinghouse three-phase, twenty-five-cycle generators, and the units will run at 750 revolutions per minute with 175 pounds of steam, twenty-seven and one-half inches vacuum and possibly 100 to 150 degrees of superheat. The three units will operate in multiple upon a common bus-bar, and power will be distributed directly at a nominal potential of 13,000 volts from the station without the use of any intermediate transformers; for this purpose the generators are wound for high potential.

The new power station will be located upon the Delaware River, near the foot of Green street, and is laid out for an ultimate capacity of 50,000 kilowatts, it being the idea of its designers to concentrate at this point the entire power generating equipment at present distributed among a number of smaller stations. The location of the new station upon the river bank secures excellent coaling facilities and an inexhaustible supply of water for condensing purposes.

The present equipment will furnish power for the subway and some reserve power for the surface traction system pending the execution of proposed plans for centralizing the entire power system.

The contract also comprises a large amount of transforming and converting machinery to be installed in the several substations, which will be built at various locations in the district covered by the transit system. This machinery will be used for converting the high-tension alternating-current power received from the power station into low-potential direct current for use directly upon the third rail of the traction system. The first installation will comprise fourteen 1,000-kilowatt and two 500-kilowatt rotary converters. Each of the 100-kilowatt rotaries will be furnished with three 375-kilowatt step-down transformers and each of the 500-kilowatt rotaries with three 175-kilowatt transformers of similar design. The electrical equipment will be built by the Westinghouse Electric and Manufacturing Company.

The new rapid transit system, now under construction, will cover the entire business district of Philadelphia, and includes a two and four-track subway about one and one-quarter miles in length, extending from the Delaware River along Market street, to a point near Twenty-third street, a short distance from the Schuylkill River. At Broad street an appropriate central terminal station will be erected. The enterprise is one of the most important in the history of American railway development, and the introduction of the steam turbine in such large sizes is particularly gratifying by reason of the confidence shown in this comparatively new type of prime mover.

The Manchester Section of the British Institution of Electrical Engineers.

The third annual report of the Manchester section of the British Institution of Electrical Engineers has been received. Owing to the absence of the chairman, Mr. H. A. Earle, in South Africa, it was impossible for him to deliver his opening address until the opening of the second half of the session, Mr. Edward W. Cowan occupying the chair.

Nine ordinary general meetings were held, at which papers were read. These meetings were all well attended, there being an average of 118 members and visitors present. The membership of the association stands as follows: 75 members, 127 associate members, 188 associates and 82 students, making a total of 472, or forty-seven more than last year. The meetings of the section were held in the new physical laboratory of Owens College, and the committee expresses its appreciation of the kindness of the council and Dr. Schuster.

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CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

LONG-DISTANCE OHIO RAILROAD—A contract for grading and covering the route between Napoleon and Defiance, Ohio, has been awarded by the People's Rapid Transit Railway Company to Morrison, Fowler & Scott. It is stated that cars will be running between Toledo and Defiance by next fall. The plan is to build north from Cincinnati, and south from Toledo. Originally, the southern terminus was at Greenville, Darke County, 150 miles distant. Then the project was enlarged and the route extended to Cincinnati. The section now building from Toledo to Defiance is fifty miles in length. The project, complete, contemplates a road 220 miles long, and will pass through fifty-four cities and towns. The company will carry express goods, freight and passengers. The franchise privileges include freight cartage. The directory of the company was reorganized after the route was extended from Greenville south, and now includes the following gentlemen: J. Morgan, president and general manager; W. P. Heston, Adam Burger, L. J. Weadock, T. M. Franey and M. A. Merkley, of Toledo; G. Bloodhart, Gibsonburg; Charles F. Clay, Napoleon; J. C. Diehl, Defiance; O. K. Dickinson, Paulding; J. H. Pulskamp, Selina; T. J. Hostetter, Ansonia; W. H. Pennell, Van Wirt, and H. H. Farr, Eaton.

NEW YORK CENTRAL TO BEGIN WORK SHORTLY—The preliminary work for the building of the new terminal of the New York Central Railroad Company will be started within the month, according to the latest announcement. The first task will be to tear down the buildings on the area between Forty-fifth and Forty-seventh streets and Lexington and Park avenues. The old sewer, gas and water mains will have to be taken up, and the building of new ones to take their places will be accomplished. Bids will be called for at once, and the contract will include rock and earth moving, masonry, laying tracks and erecting the steel work. An entirely new temporary terminal will be built at Forty-fifth street and Lexington avenue. At this temporary terminal all the local traffic will be handled, only the through trains running down to the present terminal. There can not be much work done under the existing tracks, as the locomotives and cars used in daily service are too heavy to warrant methods similar to that which is successful in ordinary subway work. Two large power stations will be built, one north of the Harlem River, and the other still further away. The exact locations of these are not yet talked about. In the switching service it may be necessary to use an overhead trolley service, but it will be different from that ordinarily installed. Generally speaking, the electric power will be transmitted by the third rail. This rail will be covered and protected so that rain, snow or sleet can not, by any possibility, interfere with the moving of traffic. It is stated that the work will be in full swing by September 1. The Board of Estimate and Apportionment has considered the revised plans for the terminal improvements, and after being presented, one by one, these were all formally approved.

PERSONAL MENTION.

MR. JOHN RICE, sales manager of the Standard Electrical Manufacturing Company, Niles, Ohio, was a New York visitor for several days of last week.

MR. CHARLES E. BROWN, secretary of the Central Electric Company, and Mr. W. W. Low, president of the Electric Appliance Company, were among the Chicago visitors to New York last week.

MR. JOSEPH HYDE PRATT, of the Engineering Company of America, is making an extended trip through the West, looking over properties for which the Engineering Company acts in the capacity of consulting engineer.

MR. A. R. BLISS, of Lowell, Mass., is making an extended visit to a number of western and southern states, in the interests of his company, the New England Motor Company, of which he is the treasurer and general manager.

MR. CYRUS O. BAKER, JR., president of the firm of Baker & Company, platinum refiners, of Newark, N. J., sailed on Wednesday of last week on the Philadelphia for Europe, where he will make a stay of two months visiting European capitals, including London, Berlin, Paris and St. Petersburg.

MR. AND MRS. T. F. MANVILLE and family sailed on the Kaiser Wilhelm II., on June 23, for London and the Continent, where they will spend the next two months. Mr. Manville goes to London on business in connection with the London branch of the H. W. Johns-Manville Company.

MR. C. H. MORTIMER, secretary-treasurer of the Canadian Electrical Association, is a prominent figure in Dominion electrical circles. Mr. Mortimer is proprietor and editor of the Canadian *Electrical News*. At the recent convention at Toronto, miniature daily editions were distributed to all in attendance.

MR. FRANK G. BOLLES, manager of sales of the Bullock Electric Manufacturing Company, Cincinnati, Ohio, passed through New York city last week on his way to the Saratoga convention of the Master Mechanics, the Mechanical Engineers and the Master Car Builders, and proceeded to Niagara Falls, where he was a prominent figure at the convention of the American Institute of Electrical Engineers.

MR. H. M. LITTELL has accepted the general managership of the Rapid Transit Company, of Chattanooga, Tenn., and left for his new field of work this week. Mr. Littell is an experienced and able railway manager, an ex-president of the American Street Railway Association, and will be sure to win additional honors now that, after a rest of a few years, he has decided to actively enter again upon street railway management.

MR. CHARLES DAY, Philadelphia, Pa., at the meeting of the American Society of Mechanical Engineers, held at Saratoga, presented a paper entitled "The Machine Shop Problem." Mr. Day has been more than singularly successful in handling this problem, delineating in a graphical manner the essence of the best modern practice in machine shop development. The discussion which followed Mr. Day's paper was interesting and conclusive, and of a highly complimentary nature to the author.

MR. L. W. STANTON, consulting and constructing telephone engineer, of Cleveland, Ohio, is working on a number of new installations. Mr. Stanton is making a specialty of multiple cable distribution and construction. Mr. F. A. Focke has resigned his position as engineer for the Federal Telephone Company, and accepted an appointment with Mr. Stanton, and Mr. C. E. Kent, also well-known and for some time prominently connected with large telephone interests, is also now identified with Mr. Stanton in his work.

MR. A. E. MEIXELL, formerly the superintendent of the Fairmount Park Transportation Company, Philadelphia, has accepted a connection with H. F. Sanville, 710 Girard Trust Building, Philadelphia, and in future will represent Mr. Sanville throughout the state of Pennsylvania. Mr. Sanville is a dealer in street railway supplies and his office acts as a Philadelphia sales department for the following companies: Albert & J. M. Anderson Manufacturing Company, Waclark Wire Company, Electric Railway Equipment Company, Simonds' Manufacturing Company, and Johnson Wrecking Frog Company.

MR. M. H. GERRY, JR., chief engineer and general manager of the Missouri River Power Company, was unavoidably absent from the meeting of the Montana Society of Engineers, before which body he was to read a paper on the 50,000-volt transmission plant and system of this company. The paper was read by the secretary, after which details of the plant were fully explained by Mr. W. L. Miller, the resident representative of the company in Butte. The various phases of this and other electric power transmission systems were discussed by Messrs. Hebgen, Sickles, Magnus, Traphagen and others.

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ELECTRIC LIGHTING.

FONDA, IOWA—An electric light plant will be installed in this village.

MADISON, MINN.—This city will double the capacity of its electric plant, at a cost of $8,000.

MANKATO, MINN.—At a mass meeting of the citizens it was decided to install an electric light plant.

MIDDLETOWN, N. Y.—The Haverstraw electric light plant has been sold to S. R. Bradley, of Nyack, for $21,000.

WARRENSBURG, N. Y.—Thomas J. Smith, of this village, will establish an electric light plant at North Creek.

SCHALENBURG, TEX.—C. L. Melcher has purchased the electric light plant from L. E. Mueller, of Houston.

STOCKTON, CAL.—The electors of Stockton have voted to bond the municipality for $160,000 and build a lighting plant.

GRAND RAPIDS, N. D.—Ralph Maxwell has been granted an exclusive electric light franchise for the city of Lidgerwood.

KINGSTON, N. Y.—The board of directors of Saugerties has granted a franchise to the Ulster Heat, Light and Power Company.

WINONA, MINN.—The Winona Railway and Light Company has been granted a ten-year contract by the city to light its streets.

BEAUMONT, TEX.—A deal has been completed whereby the electric light plant has changed hands. The consideration was $275,000.

BURLINGTON, VT.—At a special meeting of the city council it was voted to establish a municipal electric lighting plant, to cost $150,000.

HARRODSBURG, KY.—The city has commenced work on the new electric light plant here, and it will probably be ready for operation by September 1.

GUTHRIE CENTER, IOWA—The $15,000 required to build the new electric lighting plant has all been subscribed, and a site has been purchased. Work will begin at once.

MUNCIE, IND.—The central power-house of the Union Traction Company, at Anderson, is being enlarged, so that the power for 275 miles of electric lines will be generated there.

HUNTSVILLE, ALA.—The city council has ratified the contract with the Huntsville Railway, Light and Power Company. The company will light the city for five years, at the rate of $75 per light per annum.

AUGUSTA, ME.—The name of the Clinton Electrical Company has been changed to the Primary Power Company. The company has voted to decrease its capital from $2,000,000 to $1,000,000, and the par value from $100 to $50.

ALBANY, N. Y.—The residents of Menands and Brookside have formed a company for the purpose of lighting their houses with electricity. The company is capitalized at $10,000, and the plant will be in operation before the winter sets in.

WATERLOO, ILL.—The Secretary of State has granted a license to incorporate to the Taylorsville Gas and Electric Company, with a capital stock of $85,000. The company is organized for the purpose of consolidating the business of the Citizens' Gas Company and the Taylorsville Electric Company.

DENVER, COL.—A mortgage for $1,000,000 was issued recently in the county clerk's office on the property of the Denver Gas and Electric Company. The instrument is made out to the Bankers' Trust Company, of New York city. The mortgage secures an issue of one thousand $1,000 bonds, to run for fifteen years with interest at six per cent.

BOYNE CITY, MICH.—E. A. Stowe and C. C. Follmer, of Grand Rapids, are at the head of an enterprise which will utilize the power of Boyne River for the purpose of supplying electric light and power to this city. The plant, it is said, will cost about $20,000, and it is expected that it will be completed and in operation by October 1. About 200 horse-power will be developed.

SAN FRANCISCO, CAL.—The Kaweah River Power Company has been incorporated for the purpose of generating electric power on the Kaweah River, and distributing it to mines, etc., in the vicinity. Its capital stock is $2,500,000, and its directors are Edward Records, of San Francisco; Leon M. Hall, Edward W. McGrath and Albert W. Havens, of Oakland, and William G. Morrow, of Sausalito.

BALTIC, CT.—The Scotland Electric Company, with a capital of $100,000, has been chartered. The incorporators are John Eccles, Frederick Sayles and Harold Lawton. The company has plans for the development of large water privileges on the Shetucket River in the towns of Canterbury and Scotland. It is authorized to distribute electricity in Windham County and also in the towns of Franklin, Sprague and Lisbon.

NORTH ADAMS, MASS.—It is said that plans are being perfected for the development of a great electrical power plant to utilize the water power from Howe's Pond in Readsboro, Vt., and from the Deerfield River, most of the power from which will be brought to this city. Boston and Providence capitalists are behind the scheme, and a company will probably be formed shortly with a capital of at least $300,000.

SAN FRANCISCO, CAL.—It is stated that an eastern company of influential men, with G. M. Broyles, of French Corral, as their representative and also one of their number, has taken up a water right on the Middle Yuba River, in Sierra County, near Smartsville. The company will incorporate and ere long begin the construction of a large power plant on the site. It is expected that not less than 25,000 horse-power can be developed.

ELECTRIC RAILWAYS.

PHILADELPHIA, PA.—A charter has been issued to the Central Pennsylvania Traction Company, which will take over the Harrisburg Traction Company and subsidiary lines. The capital stock is $2,100,000.

OKLAHOMA CITY, OKLA.—The Oklahoma Traction Company has let the contract for the construction of an electric railway from this city to Guthrie, a distance of thirty-five miles. The road will cost $300,000. Work has begun.

COATESVILLE, PA.—A charter has been granted to the Brandywine Electric Street Railway Company, with a capital of $600,000, to build a trolley line from Coatesville to Parkesburg and Downington. The company is composed of Coatesville capitalists.

DANBURY, CT.—The Danbury & Harlem Traction Company, which has partially built an interstate railroad from this place to Goldens Bridge, N. Y., has been authorized by the New York State Railroad Commissioners to issue a mortgage for $500,000 to pay for construction work.

DAYTON, OHIO—The Greenville, Union City and Traction lines have been consolidated, and will be known as the Dayton & Muncie Traction Line. The articles of incorporation, with a capital of $800,000, have been filed. The projectors of the enterprise hope to have the line in running order by November 1.

PHILADELPHIA, PA.—All street railways in and about the towns of West Chester, Coatesville and Downington, in Chester County, have been combined. The combined roads will cover all the northern part of Chester County with nearly fifty miles of track, and will have a capital of more than $500,000.

PLATTSBURG, N. Y.—A deal has been closed between the owners of the Keeseville, Ausable Chasm & Lake Champlain Railroad and a syndicate represented by John P. Powers of Lansingburg, N. Y., for the purchase of the road at a price said to be $60,000. The plan is to convert it into a third-rail electric road. It is said that an electric road will be running to Lake Placid inside of a year.

MONROE, MICH.—A company composed of Ohio and Michigan capitalists has been incorporated for the construction of an electric line between Toledo and Ann Arbor. The company is known as the Ohio & Michigan Traction Company, with a capital of $1,650,000. The power-house is to be located at Petersburg, Mich., and the general offices at Toledo. It is hoped to have the road in operation as far as Dundee, Mich., before the winter. The line will be about forty-five miles in length, *via* Petersburg, Dundee and Milan.

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ELECTRICAL SECURITIES.

A daily study of stock market conditions for the past week could only result in the summing up of a conclusion that, for dulness and general apathy, the conditions are almost record-making. A peculiar undertone prevailed, however, in that the sluggishness was very generally regarded with complacence and, in fact, welcomed by a large portion of the institutions doing business in this manner. Compared with the closing quotations of a week ago, while there have been changes of several points in some instances, the average shows a really better tone. The general conditions, as reported from industrial centres throughout the country, render it impossible for even the most pessimistic to foresee any industrial collapse; and the very gradual decline and easy falling off in prices have made it impossible to figure out any speculative collapse. Within the next two weeks a great many financial institutions and manufacturing concerns will have balanced their semi-annual accounts, and with the breaking in of a new financial period, there seems to be reason to believe that a generally stronger tone will prevail in all quarters.

ELECTRICAL SECURITIES FOR THE WEEK ENDING JUNE 27.

New York:	*Closing.*
Brooklyn Rapid Transit	56
Consolidated Gas	191¾
General Electric	179
Kings County Electric	200
Manhattan Elevated	136¼
Metropolitan Street Railway	124
New York & New Jersey Telephone	161
Westinghouse Manufacturing Company	198

The board of directors of the New York & New Jersey Telephone Company has been increased by the election of the following: Frederick P. Fish, John W. Griggs, Theodore F. Miller, General James Jourdan, William C. Courtney and Waldron Hopkins. The increase in the board was recently authorized by the stockholders. The directors have declared the usual quarterly dividend of 1½ per cent.

Boston:	*Closing.*
American Telephone and Telegraph	140½
Edison Electric Illuminating	236
Massachusetts Electric	82
New England Telephone	128½
Western Telephone & Telegraph preferred	89

The directors of the American Telephone and Telegraph Company have voted to issue $21,943,200 new stock. Holders of record on June 30 will be entitled to subscribe to the new issue on the basis of one share of new stock for every five shares now held. Payments for the new securities are to be made in five installments—$20 per share on September 22 and November 21, 1903; January 22 and March 22, 1904, and the final payment on May 6, 1904, when the new shares will be issued. The company has declared the regular quarterly dividend of 1½ per cent and ¾ per cent extra, payable July 15. Transfer books close July 1 to July 15, inclusive.

Philadelphia:	*Closing.*
Electric Company of America	8½
Electric Storage Battery common	60
Electric Storage Battery preferred	60
Philadelphia Electric	6¼
Union Traction	44½
United Gas Improvement	88

Chicago:	*Closing.*
Chicago Telephone	125
Chicago Edison Light	148
Metropolitan Elevated preferred	66
National Carbon common	22
National Carbon preferred	91
Union Traction common	3½
Union Traction preferred	30

LEGAL NOTE.

INTERFERENCE PROCEEDINGS DECISION AND APPEAL—The interference proceedings of Spaulding *vs.* Norden were decided by Judge Fitts, of Washington, D. C., in favor of Norden. This refers to the "Norbitt" temporary decorative socket, as made under Mortimer Norden's patents by the Crouse-Hinds Electric Company, of Syracuse, N. Y. Mr. Russell Spaulding, president of the Elblight Company of America, is appealing from this decision.

TELEPHONE AND TELEGRAPH.

MANHEIM, PA.—The United Telephone Company will establish an exchange in this village.

FLUSHING, OHIO—Work has been commenced on a new telephone line between New Athens and Uniontown.

ST. LOUIS, MO.—The Kinloch Telephone Company has increased its capital stock from $2,000,000 to $3,000,000.

HUNTINGTON, IND.—The Home Telephone Company has been incorporated, and will build lines in Huntington County.

IRVINGTON, N. J.—The New York & New Jersey Telephone Company has been granted a franchise by the town council.

ROME, N. Y.—The common council of this city has voted to grant a telephone franchise to J. Alexander Vanliew, of Albany.

UTICA, N. Y.—The Rensselaer Telephone Company has extended its lines to Albany, Schenectady, Cohoes and Waterford.

CHARLESTON, W. VA.—The Newark Telephone Company, of Newark, Ohio, has been authorized to increase its capital stock from $60,000 to $100,000.

FARMER, N. Y.—The Home Telephone Company will extend its line from Seneca Falls to Ovid, having secured the right of way for its poles and wires.

WALTON, N. Y.—The stockholders of the Riverside Telephone Company, whose line runs from Bainbridge to Sidney, have voted to extend the line to Otsego.

FULTON, N. Y.—The Postal Telegraph Company has set new poles from Ogdensburg to this city, for a new trunk line of six wires between Ogdensburg and Syracuse.

HARRISBURG, PA.—The South Penn Telephone and Telegraph Company, with a capital of $200,000, has been incorporated, the main office of the company being at Waynesburg.

BANGOR, ME.—The State Belt Telephone Company will establish an exchange at Bath, and also extend its line from Bath to Chapman Quarries, Cross Roads and Klecknersville.

TROY, N. Y.—The Clifton Park Telephone Company, of Jonesville, was incorporated recently with a capital of $5,000. The directors include Erastus R. Forte, John R. McElroy and Robert Jump.

DALLAS, TEX.—The independent local and long-distance telephone companies, of Chickasha, I. Ter., have been purchased by the Topeka & El Reno Telephone Company, the consideration being $15,000.

COHOES, N. Y.—It is stated that the independent telephone companies of central New York are to be joined together by a large trunk line system of telephone wires stretching from Erie, Pa., to Rutland, Vt.

EDWARDSVILLE, ILL.—The Kinloch Telephone Company has completed arrangements with the Macoupin County Telephone Company, of Carlinsville, for the construction of a telephone line from Alton to Springfield.

CLEVELAND, OHIO—The United States Telephone Company will increase its capital stock from $2,000,000 to $2,500,000, the additional amount being six per cent preferred stock. The proceeds will pay off the floating debt.

OTTUMWA, IOWA—A new building, to cost between $20,000 and $25,000, will be erected in this city by the Iowa Telephone Company, the work to be commenced at an early date. The entire system will be reorganized and between $80,000 and $100,000 expended.

CANAJOHARIE, N. Y.—The Cooperstown, Cherry Valley & Sharon Springs Telephone Company has been incorporated to operate from Cooperstown to Sharon Springs. The capital is $5,000, and the directors are: A. B. Cox, of Cherry Valley, and D. M. Tickler and Howard Clark, of Cooperstown.

BAKERSFIELD, CAL.—The Southern Pacific is making a number of improvements to its telegraph lines. A new wire has been strung between Los Angeles and Vincente, a distance of sixty miles; another through the mountains, between Bealville and Tehachapi, all of which will be continued to Bakersfield. Lines are also being strung to the north, between Bakersfield, Fresno, Lathrop, Stockton and Sacramento, as well as to Alcalde, Hanford, Portersville and Santa Barbara.

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INDUSTRIAL ITEMS.

THE ROBERTS MANUFACTURERS' AGENCY, Memphis, Tenn., a recently organized company, will act as manufacturers' agent for mechanical and electrical equipments.

THE THOMAS E. CLARK WIRELESS TELEGRAPH-TELEPHONE COMPANY, Detroit, Mich., will be pleased to send its wireless bulletins, comprising Nos. 6 and 7, describing "Junior" type and "Standard No. 1" type instruments, to any one making a request for them.

THE MANHATTAN ELECTRICAL SUPPLY COMPANY, New York city, has issued a series of pamphlets descriptive of numerous electrical specialties. This company carries a large stock of all forms of electrical appliances, and a large clerical force ensures prompt deliveries and good service.

THE SWEDISH-AMERICAN TELEPHONE COMPANY, 88-92 West Jackson Boulevard, Chicago, Ill., has just issued an attractive pamphlet entitled, "For They Themselves Have Said It." This company's reputation for high-class advertising is well borne out by this recent publication, and the company will be pleased to send it to interested parties upon request.

THE B-R ELECTRIC AND TELEPHONE MANUFACTURING COMPANY, Kansas City, Mo., is the new company which has been formed as the successor to the B-R Electric Company and the Kansas City Telephone Manufacturing Company. The company has constructed a new building at the corner of Fifth and Delaware streets, and is now established in new quarters.

THE ROPE FIBRE PULLEY COVERING COMPANY, Springfield, Ohio, manufactures a unique covering adapted for pulleys used in transmission service, which covering is claimed to greatly increase the efficiency and lessen the friction for transmission work. The product is inexpensive, and large users of power are finding it a permanent method of reducing power expense.

THE WILLARD STORAGE BATTERY COMPANY, Cleveland, Ohio, has secured an order from the Wilmington City Electric Company for elements to enlarge its battery from 2,000 ampere-hours to 3,400 ampere-hours. The original battery has been in use for five years without renewals. During this time it has carried a load every day. It was on account of this excellent performance that the order for the enlargement of the cells was given.

THE THRESHER ELECTRIC COMPANY, of Dayton, Ohio, has taken possession of its new factories in that city, and will now have about 60,000 square feet of floor space. The new establishment is thoroughly equipped with overhead cranes and the latest tools. These improvements will enable the Thresher company to increase its line of manufacture to units of 1,000 kilowatts. The number of employés will be increased, and the growing business of this well managed company will be promptly taken care of. Mr. A. A. Thresher, who is at the head of the company, is to be congratulated over the success he has won.

THE COMMERCIAL ELECTRIC COMPANY, Indianapolis, Ind., has had occasion to enlarge its quarters for the manufacture of its standard apparatus. The company is now completely installed in a new plant at Twenty-first street and Northwestern avenue. A full equipment of modern shop tools, which will enable it better than ever to maintain its excellent deliveries and keep the standard of its product at a high point, has been installed. The present plant has a capacity of fully four times that of the previous one, but the rapid increase in orders has made it necessary to make further extensions as soon as possible.

THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, Chicago, Ill., and Rochester, N. Y., has recently sold to the Kearney Telephone Company, of Kearney, Mo., a 100-drop switchboard and 200 telephones. The telephone and telegraph department of the Southern Pacific Railroad will equip its division from El Paso to New Orleans with this company's apparatus. Mr. A. S. Foote, general foreman of this department, is stringing copper circuits between cities, and from stations to sections underground circuits are used. It is intended to make very general use of the telephone in the railroad service.

THE BRISTOL COMPANY, Waterbury, Ct., has just issued catalogues No. 9 and No. 10, descriptive, respectively, of Bristol's recording pressure and vacuum gauges and Bristol's recording volt, ampere and wattmeters. These catalogues are handsomely illustrated, and each illustration is supplemented by an accurate description of the apparatus. These catalogues contain complete lists of the recorders recently added to an already large list of this class of instruments which the Bristol Company has manufactured so satisfactorily for a long time. Interested parties may secure these catalogues by corresponding with the company.

THE PITTSBURGH TRANSFORMER COMPANY, Pittsburg, Pa., is in receipt of a letter from the Atlantic Coast Electric Light Company, regarding the operation of Pittsburgh transformers on this company's system. Mr. John F. Kellers, the superintendent, states that during one severe lightning storm in the early part of last August, twenty-three transformers of other makes were destroyed, while the Pittsburgh transformers remained uninjured. During the past five years this company has not burned out a single Pittsburgh transformer, nor has any of them caused the slightest trouble. Mr. A. H. Mustard is the sales agent for the Pittsburgh Transformer Company, with offices at 120 Liberty street, New York city.

MESSRS. BAKER & COMPANY, Newark, N. J., platinum refiners, have just issued several highly attractive pamphlets which bear directly upon the platinum refining industry. These are entitled, respectively, "The Alchemistic Symbols," being a brief account of their origin and meaning, by James Lewis Howe, Washington and Lee University; "Platinum," describing the sources of supply, indentification and separation of the ore; "Tucker's Combustion Apparatus for Determining with Accuracy the Volatile Ingredients and Total Ash of Any Organic Matter;" "Shimer's Combustion Apparatus for the Determination of Carbon in Iron, Steel, Etc." Baker & Company are the sole manufacturers of and licensees for these apparatus.

THE TOWER-BINFORD ELECTRIC AND MANUFACTURING COMPANY, Richmond, Va., describes and illustrates a very complete line of electrical apparatus in its catalogue No. 3. This company makes a specialty of knife switches, radial switches, switchboards, panel-boards, fuse blocks, etc. The company has just put a special article on the market which is designated as the "Regina" knife switch. These are single-break, single-throw, fuseless switches, and are made for fifteen and twenty-five amperes capacity, 125 and 250 volts. The fifteen-ampere size is adapted for panel-board work, and is mounted with either turned wood or spade handles. The blades, jaws and current-carrying parts are made of high-grade drawn copper, and the company claims that the switches are perfect in both electrical and mechanical design.

THE GOULD STORAGE BATTERY COMPANY, 25 West Thirty-third street, New York city, has issued a new bulletin descriptive of line batteries. This company has recently closed a number of contracts, among which may be noted those for the following installations: Berlin Street Railway Company, Berlin, N. H., a floating battery of 220 cells; San Jose Street Railway Company, San Jose, Cal., 255 cells, with a twenty-two-kilowatt regulating booster, this contract being obtained through the Western Electrical Supply Company; Newton & Boston Lines, Boston, Mass., removing a battery which formerly floated at the station out to Lexington, Mass., adding to the present plant cells in 617 tanks, and also adding an automatic regulating booster of its constant electromotive-force type with a capacity of fifty kilowatts; St. Louis Smelting and Refining Company, St. Louis, Mo., duplicating a plant which this company had at its factory at Desloge, Mo., by installing 250 cells, changing the plates so that there will be two batteries of eleven plates in nineteen plate tanks. Each of these batteries will be equipped with a double fifteen-kilowatt booster.

OBITUARY NOTICE.

MAJOR JAMES B. POND, the well-known lecture bureau manager and former newspaper man and author, died at his residence in Jersey City on Sunday, June 21. Major Pond was the most prominent man in his profession of lecture manager, and at the time of his death possessed a very wide acquaintance in all parts of the world. He was the author of "Eccentricities of Genius" and other works, and was an able and interesting writer. At one time or another he was the manager of nearly every distinguished person who lectured for the public, and with scarcely an exception, all of them became his devoted friends. His death will be greatly felt by a multitude of friends. A widow and one son survive him.

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CHARLES W. PRICE . . . . PRESIDENT and EDITOR
STEPHEN H. GODDARD . SECRETARY and MANAGER
RUSSELL HOWLAND . GENERAL REPRESENTATIVE
WM. HAND BROWNE, JR. . . . TECHNICAL EDITOR
AINSLIE A. GRAY . . . . . ASSISTANT EDITOR

WESTERN OFFICE — 40 Dearborn Street, Chicago, Ill. CHARLES FRENCH, Manager.

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ENGINEERING AND PHYSICAL PROBLEMS.

On two occasions at the recent Institute convention, President C. F. Scott emphasized the difference between what he called "engineering" and "commercial" problems. His views in this matter drew protests from several members present, but it seems to us that he is entirely right.

The Two Questions.

We should, however, term the two sides of the whole problem somewhat differently. There is a commercial problem which has to do with the greatest return on capital invested or the expenditure of the least amount of money to accomplish the work in hand. There is, on the other hand, a purely physical question, which is concerned only with the possibilities of the apparatus or installation under consideration. Before one can say how much money should be expended for a certain piece of apparatus, one must know what that apparatus will do, and in answering the latter question, the element of cost does not enter. After the possibilities of the apparatus or installation are known, the commercial problem can be solved and not before.

THE PACIFIC CABLE.

Ever since the first cable was successfully operated under the Atlantic, it has been a pet theme for Presidents, in their messages to Congress from time to time, to emphasize the advantages which would accrue to the United States if a similar cable were stretched under the Pacific Ocean connecting San Francisco or some other point on the western coast of the United States with the Orient. Long before possessions of any magnitude in the far East country were dreamed of, the subject of an American-owned Trans-Pacific cable was talked about, and if the plans laid down by legislators and fostered by executives had been followed, much good would have been accomplished. But like many another good institution, the matter of a government-owned Trans-Pacific cable was thrashed in and out of many sessions before the late John W. Mackay made his offer to the United States Government to construct and maintain a cable as a private business enterprise.

Outside of Political Influence.

This businesslike statement from a man who had become world-renowned and famous through his connection with trans-oceanic cable enterprises, was the beginning of the end of the separateness of the United States and the far East. The lifting of this subject out of the realms of political interference, made way for the speedy consummation of the project.

An All-American Route.

The condition under which the charter was awarded to the Pacific Commercial Cable Company is a matter of history, and needs to be touched upon but briefly here. The Pacific Commercial Cable Company was incorporated under the laws of New York on September 23, 1901. Its charter called for a route, such that it would have a station on no other but American soil. This necessitated the equipping of a colony on Midway Island, a place hitherto uninhabited except on occasions of infrequent visits by the savage races of that locality.

The Commercial Value.

From a commercial point of view, one of the immediate effects of the determination to lay this cable was a reduction in the rates imposed by European companies, the cost for a word from San Francisco to the Philippines being reduced from $2.35 to $1.60. Before entering into this contract, the new company bound itself to charge only $1.00 a word from San Francisco to Manila and China, and fifty cents a word to Honolulu, and within two years further to reduce the charge to the latter point to thirty-five cents.

The Strategic Importance.

The war with Spain and the acquirement of the Philippine Islands made the cable a necessity from a strategical point of view. The late President McKinley was enthusiastic over the possibilities of this cable, and his advocacy has been heartily seconded by the present chief executive, Theodore Roosevelt.

The Cable Opened on Time.

The great experience which the cable laying companies have had, and the propositions which have been overcome since the original trans-oceanic cable was laid, have made the physical effort of cable laying easier than the ordinary citizen imagines. There was a great deal of doubt as to the possibility of the cable being in such a state of completion as to make it possible to transmit a message on Independence Day, 1903. By those well informed, however, and acquainted with the wonderful foresight of which the late John W. Mackay was possessed, and of the enterprise and perseverance of his son, Mr. Clarence H. Mackay, who has taken the reins of control into his hands, and of the expertness of his associates, the claims of the company were never for a moment doubted. The first message was transmitted by means of this cable on July 4, 1903.

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THE TWENTIETH ANNUAL CONVENTION OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

The twentieth annual convention of the American Institute of Electrical Engineers, which was held at Niagara Falls the week beginning June 29, was in point of interest and attendance of members, one of the most successful that has been held. The register of members and guests reached nearly the 500 mark, though not an inconsiderable number of these should be credited to the Society for the Promotion of Engineering Education, which convened at the same place on July 1.

The First and Second Days.

The interest of the first day centered in President Scott's address, which gave a review of the work of the past year and called attention to the noteworthy happenings and the substantial growth of the Institute. The second session was devoted to the consideration of railroad papers, and here some valuable contributions to the railway problem were made. In some quarters the value of so-called theoretical discussion is questioned, but when theoretical deductions are based upon sound experimental results, the value of such discussions should be apparent. The Institute paper by Mr. Frank L. Sessions drew attention to a successful application of storage battery locomotives. The statement made by Mr. E. A. Sperry that storage battery locomotives are not only more efficient but have a greater capacity per pound than compressed air locomotives will, undoubtedly, draw vigorous protest from our compressed air friends.

Transmission Papers.

The discussion on the introductions presented by the Committee on High-Tension Transmission was satisfactory, and drew statements from a number of engineers who have been working in this particular field. One drawback to these discussions was the number of subjects to be considered. It was found necessary to hold two sessions on a warm day, yet the interest was sufficient to hold a goodly number of members until nearly six o'clock.

Thursday's Session.

At Thursday's session a number of papers of miscellaneous character were read. The chief points of interest of this day's work were the steps taken toward the adoption of the cadmium cell as the standard of electromotive force, and the description by Professor H. J. Ryan of his cathode ray alternating-current wave indicator.

Engineering Education.

On Friday, the joint session held with the Society for the Promotion of Engineering Education brought out a number of valuable papers on the education of the engineer. These were nearly all from practising engineers, this fact giving them particular interest. Throughout all there was a plea for a broader education. It is not only natural but right that those men who have had experience should state what seems to them to be lacking in the training of the engineering student, though it is possible that some of the authors do not realize how crowded the courses offered at our technical colleges are, and to what extent the addition of these broadening studies will cut down instruction in specialized work.

Social Side.

The social side of the convention was most enjoyable, as the Local Committee spared no pains to provide for the comfort and pleasure of the visiting members. Niagara Falls has many advantages as a place of meeting, and there is no doubt that the twentieth convention of the Institute will long be remembered with much pleasure by those members who were able to attend.

THE NATIONAL ASSOCIATION OF ELECTRICAL CONTRACTORS.

The third annual convention of the National Association of Electrical Contractors will be held at Detroit, Mich., July 15, 16 and 17. An exhibit will also be made in conjunction with the convention by the manufacturers of electrical supplies.

The Representative Electrical Contractors.

This association is made up of the representative electrical contractors of the United States. The national body had its origin in a state association, which under organization was so much benefited that it at once realized the value of an inclusive and broad affiliation.

The Growth of the Organization.

Under the leadership of its charter members the national body then assumed influential proportions. Its governing body includes representatives from a number of states as directors, many of whom are executive officers in similar local orders. During the past year there has been a large increase in membership, and the continued success and growth of the association are evidently assured.

VELOCITY OF OBJECTS FLOATING IN WATER.

On another page of this issue will be found a communication from Mr. George H. Gibson, of Boston, Mass., commenting upon a recent criticism of a statement appearing in a technical paper, that objects floating in running water move more swiftly than the water.

Mr. Gibson, while not agreeing either with General Bentham or the editor of the paper in which the communication first appeared, does not fully agree with our comment, although the conclusions reached do not differ from ours. He discusses the problem clearly and logically, and his objection to our method seems to be that we do not show that the object would float more slowly than the surrounding water.

In our comment, we purposely attack the problem in a different way. The original letter of General Bentham conveys to the general reader the impression that objects floating on running water are acted upon by a greater force than the water, and must, therefore, float faster than the surrounding water. It was this particular idea that we wished to dispel.

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Twentieth Annual Convention of the American Institute of Electrical Engineers, Held at Niagara Falls, June 29 to July 3, 1903.

Proceedings of the Last Three Days.

TUESDAY evening, June 30, Mr. Leonard Wilson delivered an interesting lecture on "Reverse-Current Circuit-Breakers and the Protection of Transmission Lines." Mr. Wilson described a recent type of apparatus which has been developed, and which consists of a three-legged transformer wound so that a fault on one line would be indicated at the station, so that the line could be cut out. A further development had produced an apparatus which does this automatically. The apparatus was shown in operation, and was examined with considerable interest.

NIAGARA DAY, WEDNESDAY, JULY 1.

The sessions held on Wednesday were given up to the consideration of introductions to discussion submitted by the members of the Committee on High-Tension Transmission. These introductions were printed in the issues of the ELECTRICAL REVIEW of May 30 and June 27.

The morning session was called to order at 9.30, President Scott occupying the chair. The first introduction taken up was that by Mr. C. E. Skinner, of Pittsburg, Pa., entitled "Methods of Bringing High-Tension Conductors Into Buildings." This paper provoked a lively discussion, during which a number of engineers connected with high-tension transmission systems pointed out the advantages and disadvantages of the methods suggested by Mr. Skinner, and described the methods in use in their respective installations.

Communications were read from Messrs. Henry Floy, of New York; M. H. Gerry, Jr., of Helena, Mont.; O. H. Ensign, of Los Angeles, Cal.; A. L. Mudge, of Pittsfield, Mass., and others. These communications pointed out an objection to the use of tile, as suggested by Mr. Skinner, since the arrangement shown in the paper would not prevent birds and insects from finding their way into the tile and causing trouble. The arrangement for preventing snow and ice from falling upon the wire was criticised, and it was suggested by several that the wire should either enter the building at the gable end, or a gable should be built in the roof over the point where the wires enter.

Mr. Floy said that a simple hole in the wall was the best thing. When a traveling crane is used the wire may enter the building at the side, but an extension should be provided, allowing the wires to drop down below the crane and come up inside. This arrangement would also keep out the cold.

Mr. Ensign stated that his company was using a twelve-inch sewer pipe for entering the buildings. The wires are not over No. 1 B. & S. gauge, and are carrying 30,000 volts. The tile is set in the building at an angle of thirty degrees. There was no need to close the opening, although the temperature outside at times falls nearly to zero.

Mr. F. C. Pierce did not think that the walls should bear the strain of the line, as it was sure to cause bulging eventually.

The discussion was then taken up by the members present. Mr. R. D. Mershon, of New York, had used various methods, and thought that both the tile and the glass tubing were good. He had, however, found some difficulty in getting glass which would stand the excessive change in temperature. When frost collects in the tube there is a discharge in the line, which continues until the frost is dissipated.

Mr. R. F. Hayward, of Salt Lake City, said that the climatic conditions were very important in considering the method of entering a building. He was surprised at the closeness with which wires were strung in the East. On his system, operating at 40,000 volts, the line wires are kept six feet apart. They entered the building through an opening two feet square, and more than once he had seen arcs jump twelve inches to the iron casing of the opening. He did not think that eighteen inches or two feet is enough spacing between wires. At the Mercur Mills the 20,000-volt lines entered the gable end of the brick wall, the outlets being placed four feet apart. The holes are eighteen inches square, and are closed by two plates of glass, one flush with the inside and the other with the outside surface of the wall. These glass plates are pierced by a two-inch hole, through which a tube is carried, covering the wire. There was some trouble at first in obtaining satisfactory glass. Porcelain was much stronger, and will probably be used in the future.

Mr. V. G. Converse, of Pittsburg, held that the insulation should be protected from the weather—that a drain shed should be built out over the entrance, or a gable run down. The wire should be dropped down from the last pole, and come up to a bracket in the drain shed.

Mr. Percy H. Thomas, of Pittsburg, said that the rain shed is good, as it makes indoor construction possible. This shed may be constructed within the building. Much would be gained by mounting the insulators on an insulating panel.

Mr. P. M. Lincoln, of Pittsburg, said that trouble would be caused by taking up the end strain of the line outside, as Mr. Converse had suggested. The strain should be taken up within the building, as proposed by Mr. Skinner, allowing indoor construction to be used.

The second introduction to be taken up was that of Mr. R. D. Mershon, of New York, entitled "The Grounded Wire as a Protection Against Lightning." A communication was read from Mr. R. S. Kelsch, of Montreal, giving some experiences with the Lachine Rapids Hydraulic and Land Company's system. In this system one carbon lightning arrester is installed at each end of each line. No choke coil is used. This was all right for 500-volt lines, but for 2,200-volt lines it gave trouble. They also had experienced some trouble where their lines passed under the lines of other companies.

Dr. F. A. C. Perrine, of Pittsfield, Mass., thought that the grounded line was some protection if it was properly grounded. He did not approve of the use of barbed wire, because, due to the method of manufacturing, this wire can not be relied upon. If a barbed conductor were manufactured in the same way as cables are made, and flat points were used, there might be some advantage in using this. The barbs would assist in discharging the atmosphere if it were still, but would not aid when the atmosphere is in motion. He had conducted some tests to determine the amount of energy lost, due to induction, with a grounded wire, but had not been able to detect any. He thought that the immunity of power lines from atmospheric disturbances might be due to the use of iron poles, which bring the earth potential nearer to the wire.

Mr. C. J. Wurts, of Pittsburg, Pa., noticed that Mr. Mershon had not

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abandoned the spark-gap lightning arrester. He further disagreed with Mr. Mershon as to the effect of the motion of the cloud. The earth and the cloud formed a huge static machine, and when a discharge took place did not start from one point of the cloud, but from many points in converging streams. He thought Mr. Mershon was bold to give figures of the value of the grounded wire.

Mr. Percy H. Thomas spoke of the complexity of the problem of protecting against lightning in commercial service. He called attention to the experiments made by Sir Oliver Lodge some years ago, which had shown that cages surrounding the wire did not offer perfect protection. He thought it would be well to go slowly in putting dependence on the grounded wire.

Dr. A. E. Kennelly, of Cambridge, Mass., said that nothing would protect against a discharge of lightning to the line, but that a neighboring wire should afford some protection against atmospheric surges if the line wire were surrounded. The change in electrostatic capacity, due to the grounded wire, is trivial. Electromagnetic effects would be more serious.

Mr. Lincoln thought there would be some protection to the line, as the grounded wire would act as a short-circuited secondary, and protect the line against electromagnetic effects. In the West the transmission lines become charged due to the wind, an effect which was not apparent in the East.

Mr. D. B. Rushmore, of Pittsfield, Mass., called attention to the effect of altitude in mountainous countries, where the grounded wire should afford some protection against the change of potential.

Mr. J. F. Kelly, of Pittsfield, Mass., spoke of some of the early troubles on telegraph lines, due to atmospheric discharges. While the grounded wire should afford some protection, he did not think it would pay for the increased complication.

Mr. R. F. Hayward thought that engineers were working somewhat in the dark, as there are but little reliable data on the effects of atmospheric discharges. He suggested that all central stations and transmission plants should cooperate to collect systematically all information obtainable during electrical storms. He thought that if the engineer in charge would hasten to the point where trouble occurred as soon as possible, and make a careful record of what had happened, within a year we would be in a far better position to discuss the matter than at present. He spoke of the experience of the Telluride system in Utah, where transmission was first begun at 2,000 volts, where no great precaution was taken to guard against atmospheric disturbances. They had had no trouble on this system until the increase in voltage had called for an increase in insulation. Now, every storm finds a weak point in the system. All dry transformers have been sifted out in this way. They had no trouble where their lines passed under other wires, nor from atmospheric discharges. All protective devices should be carefully insulated.

Mr. W. L. Waters, of Milwaukee, Wis., explained his method of calculating the shielding effect of grounded wires. His figures give results differing somewhat from Mr. Mershon's. He stated that European engineers believe the grounded wire is more trouble than it is worth.

Mr. J. P. Jackson, of State College, Pennsylvania, said that the problem was to keep the ground potential near the line, which was accomplished by the grounded wire. He thought that Mr. Mershon should have included the constants of the grounded wire in his calculation, and that the effects of the wire had been somewhat exaggerated.

Mr. Mershon stated that his figures were based upon an actual case—that the atmospheric effects were not due so much to the charged particles which come into contact with the wire as to the effects induced by charged particles near the wire. In his discussion he had used the term "cloud" to designate any mass of air in motion, but not necessarily visible.

Mr. W. J. Hammer described the system used in certain Italian transmission plants. The arresters are placed in the building and jets of water are sprayed upon the wire without the building. They had no trouble whatever from lightning or atmospheric discharges.

Mr. Percy H. Thomas read his paper entitled "The Testing of Electrical Apparatus for Dielectric Strength." A communication from Mr L. A. Hawkins, of Pittsfield, Mass., called attention to the danger of using the spark-gap when testing apparatus insulated by oil, as the insulation will be punctured; but, due to the presence of the oil, the breakdown may not be perceived at the spark. He further called attention to the danger caused by the change of wave-form when a regulating resistance is used in the transformer circuit.

Mr. Gerry thought that the apparatus should be tested under actual conditions, but there is a temperature lag which may cause a condensation of moisture on the apparatus. The same view was taken by Mr. J. S. Peck, who stated that apparatus just installed was under the worst condition to be tested.

Mr. H. G. Stott, of New York, thought that the paper discouraged insulation tests, but unless these were made the purchaser had no way of knowing what factor of safety his apparatus possessed.

The discussion by Messrs. Lincoln, Waters, Skinner and Mershon brought out the difference between insulation tests and testing other materials. Insulation tests have two purposes—to show that sufficient insulating material has been used, and that the work has been carried out without injury to this. For this reason the test must be made on the completed apparatus.

The effect of regulating resistance in altering wave-form was emphasized by President Scott and others. Where the resistance is large it becomes the controlling factor, and causes a peaked electromotive-force wave.

In reply, Mr. Thomas spoke of the troubles of testing insulation. When making extremely high disruptive tests apparatus may be ruined which would otherwise have been entirely satisfactory in service. Every precaution must be taken to carry out the work. When static voltmeters are used in place of the spark-gap for determining the potential, great care must be taken. Fatigue tests are of little value, as the material weakens, due to continued strain. The distortion of the electromotive-force wave, due to the regulating resistance, is not great if the transformer is loaded. He did not think a relative study of dielectric strength and elastic limits of insulating materials would be of value.

At the conclusion of these remarks Dr. F. A. C. Perrine described briefly some recent work of his own in calculating a 350-mile transmission system. Such systems are usually laid out with duplicate or triplicate lines. If each line is continuous and a breakdown occurs, it will throw out the entire line, with disastrous effects upon the regulation, unless large amounts of copper are used. To avoid this contingency he had adopted the plan of cutting the lines up into sections. These sections might be ten or fifty miles in length, and were run between suitable switching substations. A breakdown at any point, then, threw out only that one section, leaving all the other sections of that line in operation. The switching could be done either by an attendant or automatically.

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The full discussion brought out by these papers made it necessary to call an afternoon session in order to complete the consideration of the reports made by the Transmission Committee. This was called to order at 2.30 P. M. by President Scott, and a paper by Mr. P. M. Lincoln, entitled "The Choice of Frequency for Very Long Lines," was taken up.

A communication from Mr. F. G. Baum, of Palo Alto, Cal., stated that so far as the line is concerned, a low frequency is better. Other considerations often make a higher frequency desirable. This is the case with the California transmission systems, where a large part of the energy is distributed for lighting systems in small towns.

In a letter from Mr. B. A. Behrend, of Cincinnati, the author stated that he did not think resonance effects need be anticipated, and in designing a line all the apparatus should be considered, not merely the line alone.

Mr. C. O. Mailloux, of New York, thought that it would be well to determine the lowest frequency which could be used satisfactorily in lighting and adopt that.

Mr. Stott stated that his company had carried out some tests at twenty-five cycles, with four-watt incandescent lamps. These were thrown on alternately on 110-volt direct-current and alternating-current circuits, and they had had no complaints whatever, and are now operating 30,000 incandescent lights at twenty-five cycles.

Mr. Mershon said that in many cases the installing engineer was forced to use that frequency for which apparatus was obtainable. He suggested the use of synchronous apparatus for improving the regulation of the line, a suggestion with which Mr. Lincoln did not agree.

Dr. Perrine called attention to the Bay Counties' Oakland transmission system, described recently by Mr. Baum, in which regulation was effected automatically.

Mr. Blackwell's paper, entitled "Star and Delta-Connection of Transformers," in the absence of the author, was read by Mr. Mershon.

Mr. J. S. Peck read a contribution to the discussion, entitled "Grounded and Ungrounded Transmission Circuits." In this the effects of grounding one or more legs of a transformer were considered, and it was shown that under certain conditions an excessive voltage could exist between the secondaries or the secondary and the ground. An abstract of this contribution will be printed in an early issue of the ELECTRICAL REVIEW.

Mr. Hayward called attention to the advantage of using the delta-connection, which enables the system to operate under a short-circuit. When high voltages are reached it is well to ground the neutral.

Mr. Gerry has obtained equal results with either delta or star-connection. The conditions indicated by Mr. Peck are not merely theoretical, but are very real. The advantage of the delta arrangement is that transformers can be cut in and cut out without interfering with the operation of the system.

Mr. P. N. Nunn, of Telluride, Col., also spoke of the real dangers pointed out by Mr. Peck, and stated that in one case he had seen an arc jump eight feet. There is less trouble if all the lines break at once. He is using the star-connection with a grounded neutral.

Mr. Thomas thought that the theoretical rise in voltage pointed out by Mr. Peck would not be reached, due to the change of inductance of the transformer.

Mr. Peter Junkersfeld, of Chicago, spoke of the Edison system in that city, and suggested that much trouble might be avoided if the single-pole switch were abandoned for a three-pole switch. The advantages of being able to cut out one transformer from a line were not great when there were many transformers in service. For this reason his company had recently installed three-phase transformers.

Mr. Henry W. Fisher read his paper, entitled "Electric Cables for High-Voltage Service." Mr. Philip Torchio, of New York, contributed a paper, entitled "The Operation and Maintenance of High-Tension Underground Systems," which was read by Mr. W. F. Wells. Mr. H. G. Stott read his paper, entitled "The Use of Automatic Means for Disconnecting Disabled Apparatus." These papers have all been published in the ELECTRICAL REVIEW.

A communication from Mr. W. G. Carlton, of Chicago, was read by Mr. Wells. Mr. Carlton described the Chicago system and called attention to the small damage done to high-tension cables when short-circuited. Mr. Wells himself did not think that automatic devices were necessary, as the use of a sufficient number of instruments at the generating station would enable the operator to cut out a disabled line before serious trouble was caused at the station.

Mr. W. C. H. Eglin, of Philadelphia, said that his system was using a high frequency, and that the company found a reverse-current circuit-breaker necessary to prevent flashing over of the direct-current side of the rotaries. They were also using a speed-limit device, and found it necessary to limit the energy put into a short-circuit. The cables were kept separate at the receiving end, and they had no trouble in operation.

Mr. Stott stated that his company was operating 120 miles of underground paper cable at 11,000 volts, and had found in all only one weak cable. Certain of the cables which became hot were found to be carrying heavy currents in the lead sheathing. This trouble had been overcome by sectioning the lead in the sheathing. He did not think that a reverse-current circuit-breaker was of any value, and had found that in case of accident all the alternating-current breakers went out simultaneously. He then described a device used abroad which prevents this.

Replying to questions, Mr. Fisher stated that his company was conducting tests on the temperature rise of underground cables, but that data was not yet in shape for publication. If paper cables are maintained at 100 degrees centigrade, the paper becomes brittle. They have cables now operating and guaranteed for 22,000 volts commercial service.

Wednesday afternoon special trolley cars were provided for those members who did not attend the afternoon session, which carried them on a visit of inspection to the Canadian power developments. A trip was then made down the Niagara River on the Canadian side, returning by the Great Gorge route. In the evening an enjoyable musical entertainment was given at the International Hotel. The ground was lighted with Cooper Hewitt lamps.

EXCURSION DAY, THURSDAY, JULY 2.

The morning session was called to order at 9.30 by President Scott. Professor J. W. Esterline read a paper prepared by himself and Mr. C. E. Reid, entitled "The Factors Which Affect the Energy Losses in Armature Cores." This paper is a study of the effect of the core losses in armatures, as affected by the shape of the armature stamping and the number of field-poles. The results of these tests are shown graphically. An abstract of this paper will be published in a later issue of the ELECTRICAL REVIEW.

This paper was discussed by Dr. W. E. Goldsborough, Professors S. F. Franklin and A. E. Kennelly and Mr. Leonard Wilson.

Dr. Goldsborough read a paper, prepared by himself and Mr. P. E. Fansler, on "Central Station Economies," which describes a test made of the generating station of the Union Traction Company of Indiana in the spring of 1902. The

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boiler room contains Babcock & Wilcox boilers, chain grate stokers, and the engine room, three cross-compound condensing Corliss engines, each rated at 2,000 horse-power, and each driving a 1,000-kilowatt three-phase generator with rotating fields. Tests show that the efficiency of the boilers, expressed in terms of the total calorific power of the whole, is 79.6 per cent. Some interesting curves were given, showing the distribution of load between two pairs of engines when operating in parallel. The average efficiency of the generating units—that is, the ratio of the generator output and indicated horse-power—is nearly ninety per cent. The average coal consumption per cent indicated horse-power was 2.85 pounds. The weight of water required to develop an indicated horse-power varied from 2.26 to 2.29 pounds. In approximating the actual and water consumption of engine and generators, the assumption was made that the auxiliaries required fifteen per cent of the steam generated. Replying to a question, Dr. Goldsborough stated that the efficiency of the high-tension transmission line was about seventy-four per cent, and that of the distributing line about seventy-five per cent. This provoked a good deal of discussion, as many present could not understand why such refinements in station design had been adopted, while a line having such poor efficiency was installed. Dr. Goldsborough stated in reply that the plans of the station contemplated an extension, and, when desirable, more copper could be added to the line. It was suggested that Kelvin's law might be applied to this line, but Mr. J. F. Kelly said that Kelvin's law was only applicable when other things were equal—that in many cases other considerations determined the amount of copper to be used.

A paper by Mr. Ralph L. Montague, entitled "The Electrical Equipment of a Gold Dredge," was read by Mr. M. H. Gerry, Jr. This described the types of installation which had been found satisfactory for the work of dredging, and the author stated that he did not suppose that even one per cent of the dredging ground in existence is at present being mined. The apparatus and process are both in an experimental stage, and there is much chance for improvement, both electrically and mechanically.

Mr. Skinner commented on this use of motors, stating that the service was very severe, as frequently the motors are stalled.

President Scott stated that it had been intended to have Professor Elihu Thomson outline a proposed electrical conference in 1904. As Professor Thomson was absent, due to sickness in his family, he called upon Professor Kennelly, who explained that a preliminary meeting of the Committee on Organization had been held, at which it was decided to hold a congress next year at the Louisiana Purchase Exposition, and that the government will be requested to extend invitations to other governments to send delegates. The scope and purpose of this congress had not been entered upon.

Professor Henry S. Carhart, of Ann Arbor, Mich., read a paper entitled "The Legalized Standard of Electromotive Force." In this he called attention to the doubt which exists concerning the correct value of the electromotive force of the Clark cell. The legal value in this country is 1.434 volts at fifteen degrees centigrade. A number of observers since this time have obtained values which point toward 1.433 as being the correct value. An absolute determination made by Professor Carhart and Dr. Guthe had given a value of 1.4333, the last figure being in doubt. He is now having a more improved apparatus built, and will, within a few months, take up the work again, and also redetermine the electrochemical equivalent of silver. He has, however, made some comparative measurements of the Clark cell at fifteen degrees centigrade and the cadmium cell, using the saturated cadmium sulphate solution at twenty degrees centigrade. Their results gave a ratio of 1.4067. Professor Carhart then called attention to the case with which the cadmium cell can be constructed and the advantages of this as a standard of electromotive force, and he recommended that the Institute appoint a committee to draw up specifications for the cadmium cell, and that steps be taken with a view to securing action by the government to adopt the cadmium cell as a standard, provided Mr. Weston would dedicate it to the public. It was explained that this cell differs from the "Weston" cell, as in the latter the solution is saturated only at four degrees centigrade.

The discussion of this paper turned on the importance of the matter, and the resolutions were amended, providing that Professor Carhart's paper be printed and distributed to scientific bodies both in this country and abroad, inviting comment. The resolutions were adopted, with the understanding that the committee report to the Institute prior to the convening of the congress. It was suggested that credit should be given to Mr. Weston by designating the standard as the "Weston" cell.

Professor Kennelly made a statement in connection with the proposed congress, relating particularly to the desirability of adopting units of magnetomotive force and reluctance. He touched upon the unfortunate existence of the two sets of units, the absolute and so-called "practical." It had been thought desirable to abandon the practical units, but it was now too late. It had also been suggested to use the same names for the absolute units, prefixing the syllables "ab" or "abs" before them (for instance, "abvolt," "abs-ampere"). He pointed out that there are two sets of standards for engineering and for commercial work. The former should be international, and the latter may be local. It was thought also that it would be desirable to take up the question of a standard of light.

Dr. Goldsborough moved that Dr. Kennelly's paper be distributed with Professor Carhart's. This was agreed to.

Professor H. J. Ryan read a paper entitled "The Cathode Ray Alternating-Current Wave Indicator," which describes the use of the cathode ray for tracing current and electromotive-force waves. This paper will be printed in an early issue of the ELECTRICAL REVIEW.

The discussion of this paper pointed out the value of this apparatus in practical work. On motion of Dr. Goldsborough, a vote of thanks was tendered to Professor Ryan for his painstaking work in developing an apparatus of such great value.

A paper by Mr. A. W. K. Peirce, entitled "Some Notes on Certain Underground Hoisting Problems on the Witwatersrand," was read by title.

President Scott made a reference to the proposed engineering building. Four of the five associations mentioned by Mr. Carnegie in his gift have accepted the gift, and have each appointed three members of a general committee to consider plans and means. This committee has appointed a subcommittee, one from each organization, and the American Society of Civil Engineers, which has not yet taken definite action, has been invited to appoint a member who will take part in the conferences, pending action by that society.

Mr. J. G. White, on behalf of the Committee on Resolutions, offered resolutions thanking Mayor Hancock for his kind welcome to the city of Niagara Falls; the Local Committee, for the delightful entertainments and excursions which the

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members had enjoyed; the Convention Committee, for the excellent programme, and the companies who had so generously contributed to their entertainment.

The meeting then adjourned, to meet the following morning in joint session with the Society for the Promotion of Engineering Education.

Thursday afternoon special trolley cars left the terminal station of the International Railway Company at three o'clock, making a trip to the Tonawanda substation of the Niagara Falls Power Company.

In the evening it had been planned to run special cars over the Great Gorge route, where the rapids would be illuminated by searchlights, but an unfortunate fire at a station on the road made the trip impossible.

BUFFALO DAY, JULY 3, 1903.

A joint meeting of the American Institute of Electrical Engineers and the Society for the Promotion of Engineering Education was held at 9.30 A. M. This meeting was called to order by President Scott, who introduced Professor Calvin M. Woodward, president of the society.

A paper was read by Professor W. S. Franklin, of Bethlehem, Pa., entitled "The Teaching of Physics to Engineering Students." The ultimate object of the teaching of physics to technical students is to lead the young man by a shortened route to that familiarity with physical things which is possessed by such a man as John Fritz. The shortening of the route which leads to this result depends upon the fact that the teacher of physics has to do largely with an epitome of real knowledge, and the primary object of physics is to develop in the young men's minds a logical structure consisting of an aggregate of conceptions and theories. Professor Franklin criticised those methods of teaching which apostrophize the wonders of Nature or which have the slightest speculative tendency.

The discussion of this paper showed a general agreement with Professor Franklin's ideas. It was pointed out by Professor Langsdorf, of St. Louis, that two methods should be recognized in laboratory work. In the first an equation is given to the student, which he must verify by experiment. In the latter the experimental work must be carried out first, and from the results obtained the equation for the curve must be deduced. In his opinion the latter method is the better.

Mr. J. G. White, of New York, read a paper entitled "The Problems that Are Facing the Electrical Engineer of To-day, and the Qualities of Mind and Character Which Are Needed to Meet Them." The qualities necessary in an engineer are originality, accuracy, quickness, thoroughness, lucidity, tactfulness and honesty. Emphasis was laid upon the necessity for correct speech and good manners, and it was urged that English be taught throughout the entire engineering course. The engineer should also have the use of at least one other modern language, and a thorough training in mathematics. The education of an engineer really begins after graduation, and this should be recognized as it is in other professions. It is more important to be able to master thoroughly one subject than to know much about many things. The best training for an engineer would be a thorough, broad college course, followed by three years in a technical school. Subjects for special attention would be English, arithmetic, particularly mental drill, algebra, physics, chemistry, electricity and magnetism, dynamo construction and ethics. Secondary subjects would be Latin, French, surveying and electrochemistry. Third should come Spanish or German and geology, and fourth, botany, zoology, logic, and mental and moral philosophy. He thought it necessary that the engineer should have some knowlege of business methods.

Professor Jackson read the paper contributed by Mr. B. Gherardi, Jr., upon "The Proper Qualifications of Electrical Engineering School Graduates, from the Telephone Engineer's Standpoint." While telephone engineering is a specialty, there is no need for special training, though it is desirable, if time allows, that telephone problems be taken up. The telephone engineer's general training should be such as to enable him to solve any problem, and no attempts should be made to teach data, to the neglect of other matters.

A paper by Mr. L. A. Osborne, upon "The Proper Qualifications of Electrical Engineering School Graduates, from the Manufacturer's Standpoint," was read by Mr. J. S. Peck. Mr. Osborne's experience had been that, while all the young men go through training for engineering, but few of them follow strictly engineering work, and not more than one in ten is fitted to take up this work successfully. On the other hand, there is a tendency of modern industries to demand technical training of men in its commercial departments.

In the discussion of these papers Dr. Goldsborough was not prepared to admit all that the practical men had said, and questioned whether they knew the conditions under which these courses were laid out.

Professors A. F. Ganz, F. C. Caldwell and others spoke of the great difficulty in laying out a satisfactory technical course, and the limited time, and said that suggestions as to what could be left out without loss in efficiency would be of much assistance.

Professor C. F. Allen made the point that the colleges were not turning out trained engineers, and that the young man must be given a chance to get some experience.

Professor Henry S. Carhart thought that differentiation should come in practice, and not in the schools, and that the principles should be taught in connection with the laboratory to give them points. The object should be to make an engineer, not a specialist.

Professor D. C. Jackson read a paper entitled "Typical Electrical Engineering Courses." Students have little power of thinking accurately, but the fault can not be laid on the secondary schools. The old method of training was better than the new, as it was thorough. An engineering course should include English, mathematics, drawing, chemistry, physics and mechanics, and then other things might be added to these. He criticised sharply superficial descriptive courses. The principles should be taught throughout, and it is necessary for the director of the technical course to be thoroughly familiar with proper pedagogical methods.

Mr. E. H. Mullin, of New York city, read a paper entitled "Training an Artist in the Forces of Nature." This pointed out some of the defects of technical education in the present day, and in answer to the question "How may the average man be trained for his profession?" Mr. Mullin said that we should teach methods, instill principles, and lay deep and sure the foundation of elementary knowledge, trusting the future to take care of itself. We have therefore two correlated branches of education to consider—education as an art, and education as a science. Education as an art involves perfect familiarity with a larger or smaller number of facts. We have to exercise the faculty of memory, and this memory must be clear and accurate. Having obtained the outlines through education as an art, the property of education is not to use them as we have been taught, but to apply them to new problems. Not only, therefore, is memory needed, but imagination.

Mr. T. J. Johnston read a paper entitled "Engineering English." In this Mr. Johnston criticised sharply the poor and often bad English found in technical writings, and made a strong plea for more

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attention to the teaching of English in technical schools.

President Woodward expressed the pleasure that the Society for the Promotion of Engineering Education had had in holding a joint session with the American Institute of Electrical Engineers, to which President Scott replied that the pleasure was mutual.

On Friday afternoon, July 3, special trolley cars were provided for a trip to Buffalo, where visits of inspection were made at the terminal house of the Niagara-Buffalo Transmission Company, the substation of the Buffalo General Electric Company and the substation of the Buffalo Railway Company, all operated by Niagara power. Visits were also made to the central exchange of the Bell Telephone Company. For this run some of the new high-speed electric cars were provided, which can run at a speed of sixty miles an hour.

The convention was then declared adjourned.

Among those present at the convention were the following: C. F. Scott, Pittsburg, Pa.; R. W. Pope, New York; George F. Sever, New York; E. H. Mullin, New York; W. S. Barstow, New York; H. W. Buck, Niagara Falls, N. Y.; deL. Rankine, Niagara Falls; E. G. Acheson, Niagara Falls; B. J. Arnold, Chicago, Ill.; R. B. Owens, Montreal; C. J. Field, Brooklyn, N. Y.; Dr. W. E. Goldsborough, St. Louis, Mo.; G. A. Hamilton, Elizabeth, N. J.; Carl Hering, Philadelphia, Pa.; William R. C. Corson, Hartford, Ct.; William Hand Browne, Jr., New York; D. B. Rushmore, Pittsfield, Mass.; W. L. Waters, Milwaukee, Wis.; W. J. Jenks, New York; Elmer A. Sperry, Cleveland, Ohio; John F. Kelly. Pittsfield, Mass.; William J. Hammer, New York; William H. Wiley, New York; M. H. Gerry, Jr., Helena, Mont.; Charles S. Bradley, New York; George W. Davenport, Winchester, Mass.; Charles R. Huntley, Buffalo, N. Y.; J. G. White, New York; A. J. Wurts, Pittsburg, Pa.; G. E. Cox, Niagara Falls; George Urban, Jr., Buffalo, N. Y.; R. F. Hayward, Salt Lake City, Utah; William C. Woodward, Providence, R. I.; B. Abry, Pittsburg; A. H. Armstrong, Schenectady, N. Y.; Gano S. Dunn, Ampere, N. J.; W. L. R. Emmet, Schenectady, N. Y.; Cary T. Hutchinson, New York; P. M. Lincoln, Pittsburg, Pa.; Francis B. Crocker, New York; A. E. Kennelly, Cambridge, Mass.; C. E. Skinner, Pittsburg, Pa.; Calvert Townley, New York; Calvin M. Woodward, St. Louis, Mo.; H. A. Storrs, Denver, Col.; Joseph W. Richards, Bethlehem, Pa.; F. A. C. Perrine, Pittsfield, Mass.; C. A. Waldo, La Fayette, Ind.; Arthur N. Talbot, Urbana, Ill.; W. D. Weaver, New York; Frank G. Bolles, Cleveland, Ohio; D. B. Dean, Cleveland, Ohio; Henry S. Carhart, Ann Arbor, Mich.; Edwin R. Weeks, Kansas City, Mo.; Louis A. Ferguson, Chicago, Ill.; Ira O. Baker, Champaign, Ill.; A. A. Knudson, New York; F. L. Hutchinson, Milwaukee, Wis.

THE PACIFIC CABLE.

PRESIDENT ROOSEVELT SENDS FIRST MESSAGE TO GOVERNOR TAFT, MANILA, P. I., JULY 4.

Due to the energy and enterprise of Mr. Clarence H. Mackay, president of the Commercial Pacific Cable Company, and his associates, the cable joining San Francisco with Manila was completed and a message sent on July 4, the anniversary of the Declaration of Independence. Mr. Mackay's father, the late John W. Mackay, was the originator of the idea of the Pacific cable, and to him and his son the credit of this great enterprise is due.

The Commercial Pacific Cable Company was incorporated under the laws of New York on September 23, 1901, its charter authorizing it to lay and operate a submarine cable from California to the Philippine Islands by way of the Hawaiian Islands.

A series of soundings that had been made under the direction of the Navy Department, when it was thought that there was a possibility of the government constructing the cable, was placed at the disposal of Mr. Mackay's company. These recommended the route from San Francisco to the Hawaiian Islands, thence to Midway Island, Island of Guam and the Philippines. This route had four great sound stretches of 2,276, 1,254, 2,539 and 1,490 miles.

During the latter part of 1901, the late John W. Mackay made an offer to the government to lay a cable across the Pacific, without subsidy or guarantee of any kind and solely as a private enterprise. The Commercial Pacific Cable Company had meanwhile been incorporated and the contract for the first section of the cable, from San Francisco to Honolulu, awarded. This was to the India Rubber and Gutta Percha Works Company, of London, England. The cableship Silvertown with the first section of the cable, consisting of 2,413 nautical miles, on board, left the English coast on September 23, 1902, arriving at San Francisco on December 4. The shore ends of the cable were manufactured at the New Jersey works of the Okonite Company, Limited, of New York, and laid by the experts of that company at San Francisco, Honolulu, Manila and other points.

On December 15 the Silvertown left for Honolulu, arriving there on December 26. Meanwhile, on November 27, the steamship Ventura, with two cable hands and two splicers, under the direction of Mr. L. G. Martin, had left with the shore end, which was to be laid at Honolulu. By December 19, the cables were in from the offices to the cable-house and the splicing completed on December 22. The arrival of the cableship at Honolulu on December 26 was the occasion of great excitement and enthusiasm. On Sunday, December 27, the heavy shore end was laid, and on the morning of December 29 the ship buoyed this end up and went down to the deep-sea buoy. Owing to heavy weather, the shore end was not picked up and spliced on to the deep-sea end until January 1, and at 4 P. M. the cableship told Honolulu that the final splice was about to be commenced and to call San Francisco at nine o'clock.

A separate contract had been awarded to the Telegraph Construction and Maintenance Company for the remaining sections of the cable from Honolulu to Midway, Guam and the Philippines. On April 9 last, the cableships Colonia and Anglia left London with more than 6,000 miles of cable in their tanks. The Anglia arrived at Manila on May 22, and having landed the shore end on May 24, paid out cable through St. Bernardino Strait and on toward Guam. She arrived at Guam on June 4. The Colonia had proceeded direct to Guam, where she arrived on May 27, arriving at Midway on June 19, when communication between Midway and Guam was established. This left only the small section between Midway and Honolulu to be laid to complete the system. On the arrival of the Colonia at Midway, the Anglia proceeded from Midway to Honolulu.

As President Roosevelt is spending the summer at Oyster Bay, L. I., temporary headquarters had been established in one of the local village business houses. Mr. G. H. Usher, superintendent of the Postal Telegraph-Cable Company, was in charge of preparations for receiving the first message.

At twelve minutes past eleven o'clock President Roosevelt sent the following message to Governor Taft:

To Governor Taft,
Manila.

I open the American Pacific Cable with greetings to you and the people of the Philippines. THEODORE ROOSEVELT.

This message was immediately followed by a congratulatory note to Mr. Mackay as follows:

To Mr. Clarence H. Mackay,
President Pacific Cable Company.

Congratulations and success to the Pacific cable which the genius of your lamented father and your own enterprise made possible.

THEODORE ROOSEVELT.

These messages were followed by a number of congratulatory, official and ordinary despatches.

A section from Manila to Hong Kong is a part of the company's contract. This will be completed in the same manner and with the same rapidity as the section already finished.

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A British Light Railway System.

By Our Special Correspondent.

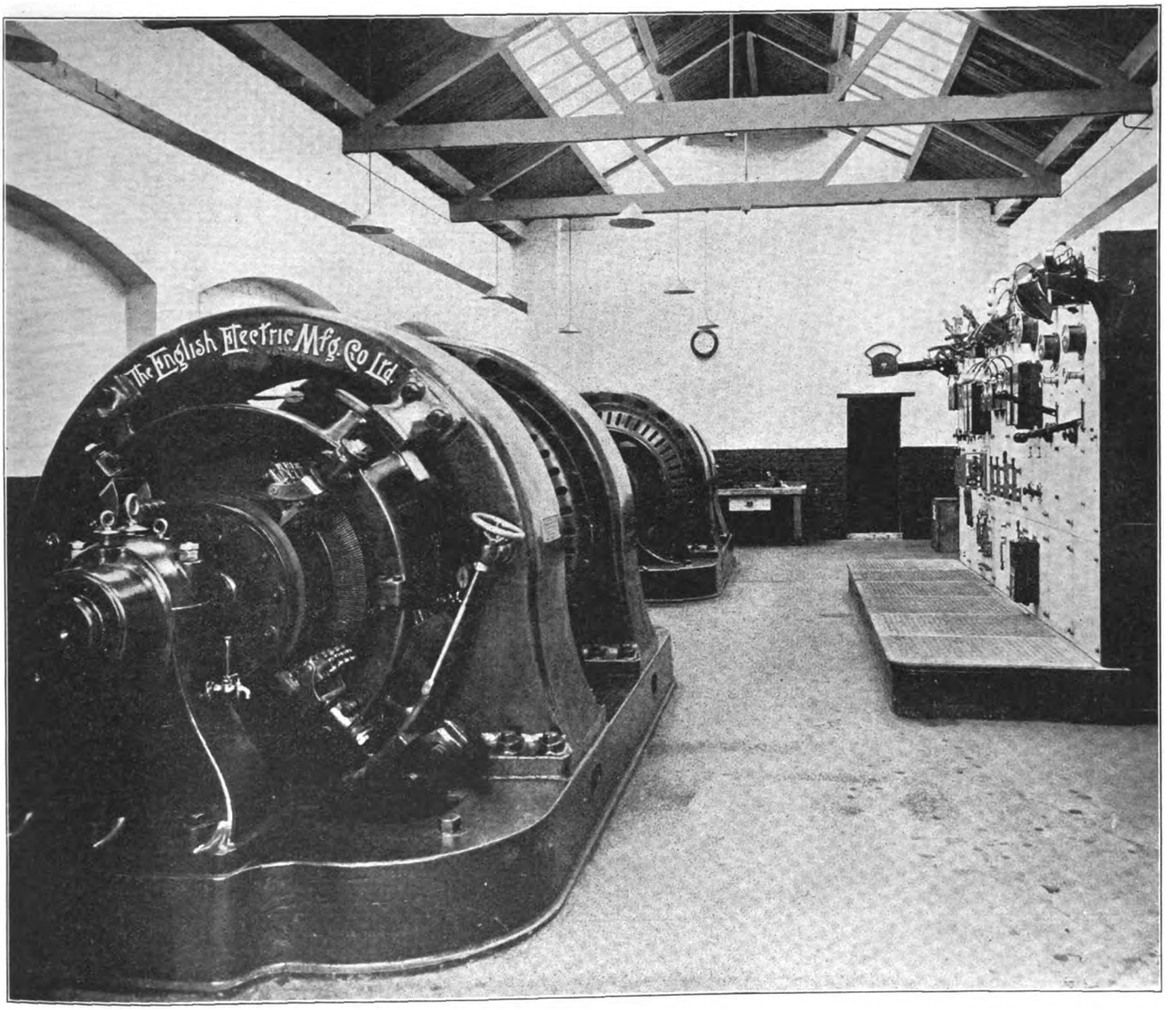
AN interesting system of tramways or light railways has recently been completed in the south of England, serving a purely country district. It is an addition to the very few examples we have here of electric trolley lines running on private as well as public roads and its electrical equipment is of more than ordinary interest. In a sense the line may be stated to be an actual extension of the Portsmouth municipal tramway system which was completed some months ago. It is owned by the Hampshire Light Railways Company, and an agreement has been entered into by which the Portsmouth corporation has undertaken to run a certain number of cars over the lines owned by the company.

The necessary electrical energy for the operation of the line is purchased from the Portsmouth Corporation, and the manner in which the joint arrangement has been carried out suggests that other country districts might be effectively linked up with town tramways, even when the two systems are operated by different authorities.

The commercial prospects of the line are excellent, and though in a sense it will be mainly patronized by pleasure-seekers, there is little doubt that it will be ultimately largely used by residents who, however, largely opposed the scheme, together with the railway companies.

The length of line is six miles from the terminus at Cosham to the terminus at Horndean, and is of single line construction with passing places. The track is practically divided into three sections, owing to the different forms of construction rendered necessary by the nature of the country.

Section No. 1 from the junction with the Portsmouth Corporation Tramways to the top of Portsdown hill, is about one mile in length. This section presents all the features of ordinary railway construction, the line being taken across country some distance back from the county road, but parallel to it. There are three bridges in this section, one over the London & South Western Railway Company's line at Cosham, and two others over roads crossing the line of the track. About three-quarters of a mile of the track is carried on embankments, and the remaining one-quarter is carried through cuttings. The rails are laid



VIEW OF SUBSTATION, HAMPSHIRE LIGHT RAILWAYS SYSTEM.

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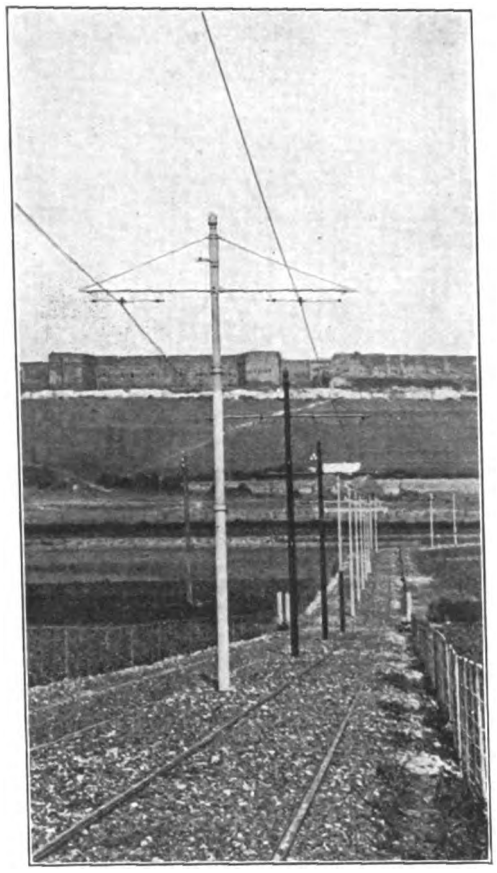
on longitudinal concrete sleepers eighteen inches wide by twelve inches deep, and are kept to gauge by tie-bars spaced about every seven feet, the whole being ballasted up to the level of the rail-table. This construction is general for this section, except in places where the depth of the filling is considerable. In these instances the rails are supported on timber framing, the uprights of which extend right through the filling to a substantial concrete foundation. This form of construction being adopted to ensure the stability of the track should the filling material settle at any time.



A Portion of the Road, Hampshire Light Railways.

Section No. 2 from the junction with section No. 1 at the top of Portsdown hill, through the village of Purbrook to Waterlooville, is a distance of about two and one-half miles. This portion of the line is laid on the county road, and the form of construction is that of ordinary street tramway, that is, a foundation of six inches of concrete extending over the whole width of the track; the rails being laid on this foundation, and the whole tramway area paved with six-inch granite sets.

Section No. 3 from the junction with section No. 2 at Waterlooville to the terminus at Horndean is about two and one-half miles in length. This portion of the line is laid on the waste ground at the side of the county road, the construction of the track being exactly similar to that of section No. 2, that is, the rails are laid on the longitudinal concrete sleepers, and the whole being ballasted up to rail-table level.

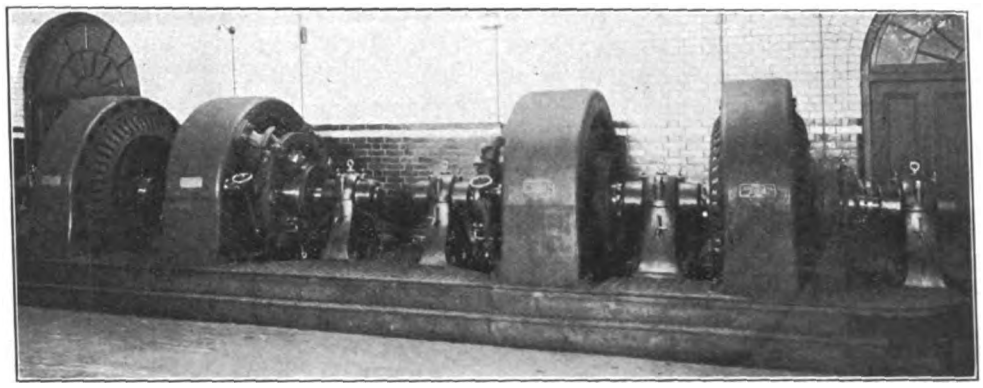
The rails used are of the ordinary grooved tramrail type, weighing ninety-six pounds to the yard, and are laid in lengths of forty-five feet with a percentage of shorter lengths to avoid cutting rails in the construction of the loops.

The overhead construction is somewhat unique, combining a special form of construction for light railway work with the ordinary form of bases, brackets, etc., for those parts of the line going through towns and villages. The system adopted is centre-running, the trolley wire which is No. 00 B. & S. gauge being in duplicate and carried over the centre of the track. Where double track exists centre-pole construction is adopted, and where the track is single, side poles with brackets are used, and on some parts of the line where the roadway is particularly wide the span wire system is in vogue.

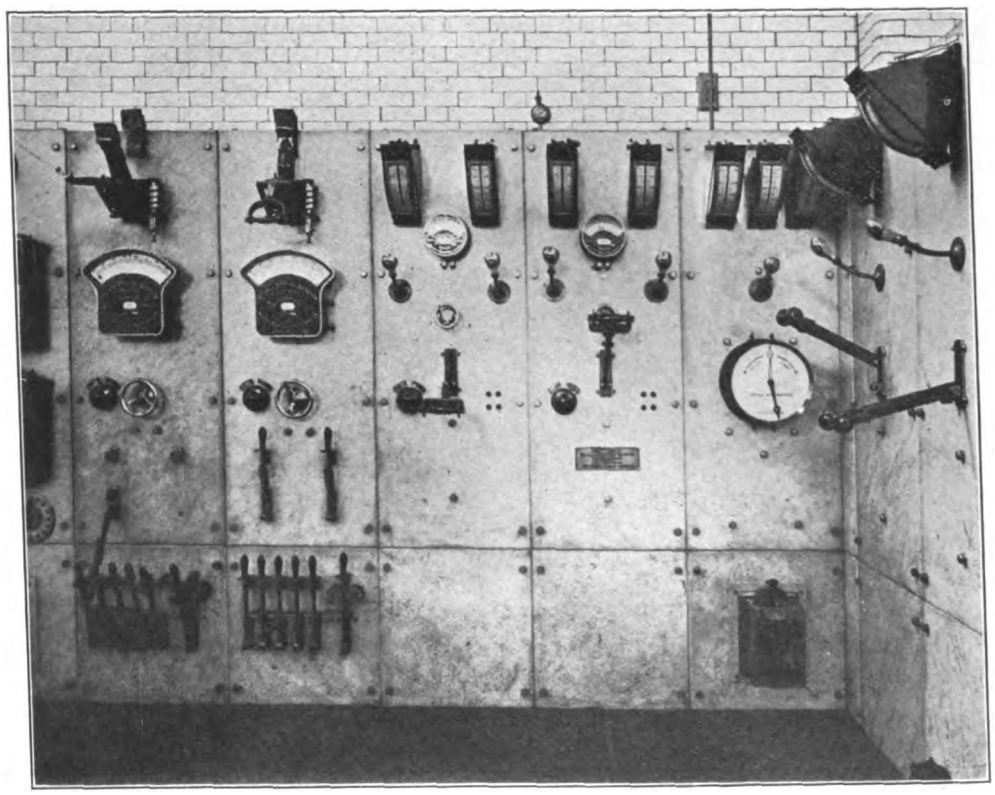
The type of brackets for light railway work, although plain in construction, is quite sightly, and particularly strong. The tie-rod supporting the bracket is held by a substantial malleable iron clamp on the top of the pole, the other end being attached to a combination flexible suspension bracket, and securely turned over the outside of the pipe, thus ensuring absolute rigidity for the bracket.

The trolley line is as usual divided into one-half-mile sections, a feeder pillar being erected at each place, having in addition to the usual four line switches a sufficient number of main switches to allow the main cables to be disconnected for making a loop test in case of breakdown.

The switches are mounted on marble panels, the holes being substantially bushed with ebonite and fitted in cast-iron pillars with water-tight doors. The trolley wire is supported by gun-metal hangers throughout. The insulation of



Motor-Generator Sets, Portsmouth Power-House, Hampshire Light Railways.



Extension of Switchboard at Main Power-House, Hampshire Light Railways.

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the bolts supporting the wire being of specially moulded mica and capable of standing particularly high mechanical and electrical stresses. The ears are also made of a specially tough quality of gun-metal, varying in lengths from fifteen inches to twenty-four inches to suit the conditions of the work.

As the end of the line is a considerable distance from the Portsmouth power-house, the system necessarily called for transmission of energy at a high pressure.

The system of transmission is a three-phase one, three-phase motor-generators being at the tramway power-house in Portsmouth, whence current is transmitted at 6,000 volts to a substation about midway along the line.

There are two motor-generator sets which have been erected in the tramway works, each consisting of a four-pole direct-current shunt-wound motor, direct-coupled to an eight-pole three-phase alternator, carried on the same bed-plate. The motor derives its supply from the tramway bus-bars, and in consequence runs at 550 volts, and the output of each machine at 375 revolutions per minute is, on the alternating-current side, 250 kilowatts. The motor closely follows the standard practice adopted by Messrs. Dick, Kerr & Company, which have carried out the complete contract in their direct-current machinery. The armature is of the tramway slotted type; the windings being carried in slots. The armature core, which is built up of laminated discs, is carried on a cast-iron spider which is firmly keyed to the shaft, and the special construction of the spider permits of ample ventilation to the armature coils. The field yoke is of cast iron, the field magnets being built up of laminations and cast into the frame. The coils are wound on removable spools which are kept in position by a pole-shoe which also serves the purpose of properly distributing the magnetic flux.

The alternating-current generator having, as already stated, a capacity of 250 kilowatts when supplying current at 5,500 volts, is of the revolving field type, with external stationary armature. The stator consists of laminated segments, built up into a cast-iron frame, and special provision is made to give ample ventilation. The windings are carried in slots and connected up in star fashion. The field magnets, consisting of laminated steel, are carried on the revolving hub, which is itself keyed to the shaft.

Exciting current is led into the field magnet coils by means of two brass slip-rings, each slip-ring being provided with copper gauze brushes. The excitation of the fields of the alternator is obtained from a direct-current shunt-wound generator, which is coupled direct to the main shaft and carried inside one of the outer bearings. The details of the substation machinery are exactly in accord with the machinery at the main power-house.

The switchboard at the main power-house is connected to the already existing tramway switchboard, and is made up of five panels, carried on wrought-iron frames. On the motor panels are automatic circuit-breaker and illuminated dial ammeter, the necessary switches, motor starter and field rheostat. The generator panels, of which there are two, are provided with the necessary fuses and switches, field rheostat, field breaking switches and resistances, and synchronizing apparatus. The fifth panel is for the feeders, and controls the entire output of the motor-generator sets, and is provided with three high-tension fuses, one high-tension switch and Kelvin ammeter.

The switchboard at the substation consists of eight panels, the details of construction being similar to the board at the power-house. The input panel and two motor panels deal with current at 5,000 volts, and are arranged so that no live connections are accessible from the front of the board. They are provided with the usual ammeters and the necessary fuses and switches. The generator panels, which deal with the current for the overhead line, are provided with the usual equipment. There are, in addition, two feeder panels, and the ordinary board of trade panel.

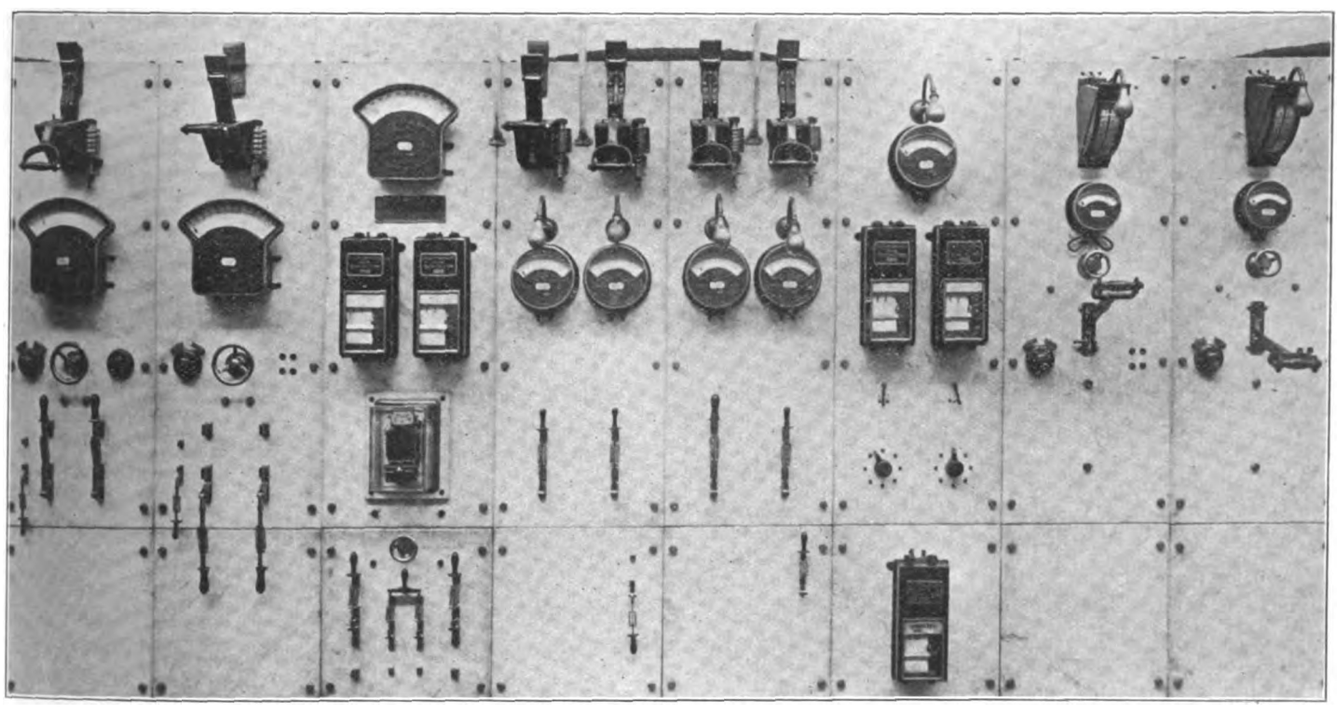
The current is carried by a specially constructed three-core cable to the substation: the sectional area of each conductor in this cable is 0.05 square inch, and has a conductivity of over ninety-eight per cent according to Matthieson's standard. The cable is lead sheathed and under this lead sheathing is bound a copper earthing strip. The thickness of the dielectric between the cores is 0.1875 inch and between the core and the cable and the cable earthing strip 1.875 inches.

The insulation material used on the cables is specially impregnated paper, and so high is the insulation qualities of this that these cables which are in duplicate have stood an alternating electromotive force of 20,000 volts for fifteen minutes without the slightest defect becoming apparent.

From the substation a continuous current is taken to different parts of the line to cables of 0.5 and 0.25 square inch capacity, the whole of the cables being laid on the solid system. Thanks are due to Messrs. Dick, Kerr & Company for the material and illustrations contained in the above description.

A. W.

London, June 27.



SWITCHBOARD AT SUBSTATION, HAMPSHIRE LIGHT RAILWAYS.

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ENERGY TRANSFORMATIONS IN THE SYNCHRONOUS CONVERTER.[1]

BY WM. S. FRANKLIN.

CONTENTS.

1. Introduction.
2. The synchronous converter compared with the autotransformer. Statement of object of this paper.
3. The many-ring converter. Derivation of armature current. Discussion of energy transformations.
4. The two-ring converter. Discussion of energy transformations.
5. The three-ring converter. Discussion of energy transformations.
6. The four-ring converter. Discussion of energy transformations.
7. Summary of results as to energy transformations.
8. Armature reaction of many-ring converter. Influence of load upon electromotive-force curve. Cutting away of pole-faces to annul distortion of electromotive-force curve at full load.
9. The criterion of reality of component parts into which a physical aggregate is resolved by mathematical analysis.

I—INTRODUCTION.

The engineer ordinarily approaches the study of the synchronous converter with ready-made knowledge of the direct-current dynamo and of the alternating-current dynamo. The result is that the action of the synchronous converter is usually described in terms of the activities of the synchronous alternating-current motor and the direct-current generator, and the theory of the synchronous converter is usually developed in terms of those notions which apply primarily to the synchronous alternating-current motor on the one hand and to the direct-current generator on the other. As a matter of fact, the external electrical relations of the synchronous converter may be completely represented by this method of attack. When, however, the synchronous converter itself—its internal activities, as it were—is the object of study, the notions of the synchronous alternating-current motor and of the direct-current generator do not suffice. There are certain elements of behavior of the synchronous converter which are foreign both to the synchronous alternating-current motor and to the direct-current generator; to examine into these elements we must attend to the actual physical activities of the synchronous converter without regard to the mathematical analysis of these activities into their more or less fictitious and unreal component parts, namely, synchronous motor activities and direct-current generator activities. I give in a subsequent section of this paper a statement of the criterion which enables one to judge of the physical reality or unreality of the component parts into which a physical aggregate is resolved by mathematical analysis, and it suffices here to state that this criterion shows the physical unreality of synchronous motor activity and direct-current generator activity as component parts of the activity of the synchronous converter.

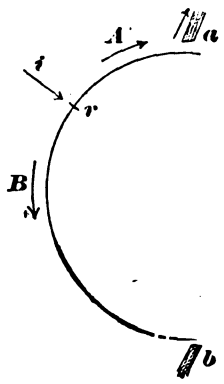

FIG. 1.

II—THE SYNCHRONOUS CONVERTER COMPARED WITH THE AUTOTRANSFORMER. STATEMENT OF OBJECT OF THIS PAPER.

Let *b* Fig. 1 represent one of the direct-current brushes of a two-ring converter. Let this brush be chosen as the zero or reference point of potential, and let *a* represent the other direct-current brush. Let *r* be the position of the alternating-current tap at a given instant. This tap *r* is at a potential which is between the potentials of *b* and *a*. Let *i* be the instantaneous value of the alternating current entering at *r*. A portion, A, of this current *i* flows up hill, as it were, from *r* to *a*, receiving energy because of assistance due to the induced electromotive forces in the windings between *r* and *a*. Another portion, B, of the current *i* flows down hill from *r* to *b*, giving up energy because it is opposed by induced electromotive forces in the windings between *r* and *b*.

The energy received by the current A as it is boosted up from *r* to *a* is in general equal to the energy which is delivered by the current B which flows down from *r* to *b*.

Let *b*, Fig. 2, represent one of the service mains to which alternating current is supplied by an autotransformer. Let this main be chosen as the zero or reference point of potential, and let *a* represent the other service main. Let *r* and *r'* be the two supply mains. The main *r* is at a given instant at a potential which is between the potentials of *b* and *a*, and the current *i*, which enters at *r* at the given instant divides into two parts, A and B. The portion A flows up hill, as it were, to *a*, receiving energy because of assistance due to the induced electromotive forces in the windings between *r* and *a*. The other portion, B, flows down hill, from *r* to *b*, giving up energy because it is opposed by induced electromotive forces in the windings between *r* and *b*.

The energy received by the current A as it is boosted up from *r* to *a* is equal to the energy which is delivered by the current B which flows down from *r* to *b*.

In the autotransformer a definite portion of the energy which is transferred from the supply mains to the service mains is transferred by virtue of the conductive connections between supply mains and service mains through the windings

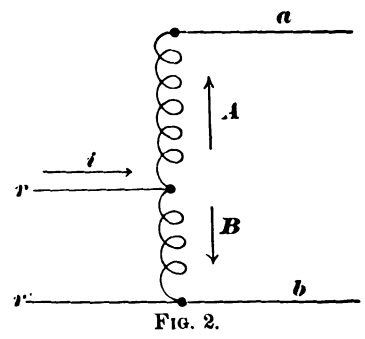

FIG. 2.

of the transformer. In the synchronous converter, also, a definite portion of the energy which is transferred from the supply mains to the service mains is transferred by virtue of the conductive connections through the armature windings of the converter.

In the autotransformer a definite portion of the energy which is transferred from the supply mains to the service mains is transferred by being inductively transformed from winding B, Fig. 2, which acts as a primary coil, to winding A, which acts as a secondary coil. In the synchronous converter a definite portion of the energy which is transferred from the supply mains to the service mains, is transferred by being inductively transformed from the portion B, Fig. 1, of the armature winding, which at the given instant acts as a motor, to the portion A of the armature winding, which at the given instant acts as a generator.

The object of this paper is to determine, of the total energy which flows through a synchronous converter, the fractional part which is conductively

[1] A paper presented at the twentieth annual convention of the American Institute of Electrical Engineers, Niagara Falls, N. Y., June 29 to July 3, 1903.

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transferred from supply mains to service mains, and the fractional part which is inductively transformed. In case of the two-ring converter, the inductively transformed energy consists of two distinct parts, namely, (*a*) the energy which is transformed by simultaneous and balanced generator-motor action, and (*b*) the energy which is transformed by successive and unbalanced generator-motor action. These parts will be more fully discussed when we consider the problem of the two-ring converter.

III—THE MANY-RING CONVERTER.

Fig. 3 represents one side of a two-pole, many-ring converter. E is the electromotive force between the direct-current brushes *a* and *b*, I is the direct current entering at *a* and leaving at *b*, *i* is the current in the armature wires, at a point on the armature which is at angular distance β from brush *a*, and $d\,i$ is the value of the alternating current flowing out of all the collecting rings connected to commutator bars in the angular element $d\,\beta$ at the instant that these bars are at angular distance β from brush *a*. The arrows represent the directions in which the various electromotive forces and currents are considered as positive.

We shall assume here, as also in the discussion of the two-ring, the three-ring and the four-ring converters, that the converter receives alternating currents at unity power-factor, that alternating electromotive forces and currents are harmonic, and that the losses of energy in the converter are negligible.

Before proceeding to the consideration of energy transformations, it is necessary to determine the distribution of current in the armature for given direct-current output. From the above assumptions, we have:

$$d\,i = -\,\mathrm{A}\cos\beta\,.\,d\,\beta \qquad (1)$$

in which A is an undetermined constant. Integrating this equation we have

$$i = -\,\mathrm{A}\sin\beta + \mathrm{K} \qquad (2)$$

in which K is another undetermined constant. These constants A and K are determined by the following two conditions: 1. The generator and motor activities are at each instant balanced in the many-ring converter. 2. The alternating-current input of power is equal to the direct-current output of power. In order to formulate these two conditions it is necessary to find an expression for the generator (or motor) action in the element $d\,\beta$. Let $d\,e$ be the induced electromotive force in the element $d\,\beta$. Then it is easily shown on the basis of the above assumptions that

$$d\,e = \tfrac{1}{2}\,\mathrm{E}\sin\beta\,.\,d\,\beta \qquad (3)$$

Let d G be the generator action in watts (motor action if negative) in the element $d\,\beta$. Then $d\,\mathrm{G} = i\,.\,d\,e$, or

$$d\,\mathrm{G} = -\,\frac{\mathrm{E\,A.}}{2}\sin^2\beta\,.\,d\,\beta + \frac{\mathrm{E\,K.}}{2}\,.\,\sin\beta\,.\,d\,\beta \qquad (4)$$

The first condition above mentioned requires that the integral of d G from $\beta = 0$ to $\beta = \pi$ shall be equal to zero. That is:

$$\int_0^{\pi} -\,\mathrm{A}\sin^2\beta\,.\,d\,\beta + \mathrm{K}\sin\beta\,.\,d\,\beta = 0 \qquad (5)$$

which gives

$$\frac{\pi\,\mathrm{A}}{2} - 2\,\mathrm{K} = 0 \qquad (6)$$

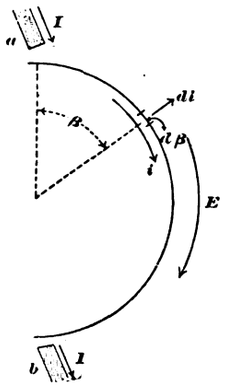

FIG. 3.

The alternating current intake of power in the half armature is

$$\tfrac{1}{2}\,\mathrm{E}\int_0^{\pi}(1 - \cos\beta)\,d\,i$$

and the direct-current output of power in the half armature is

$$\tfrac{1}{2}\,\mathrm{EI}$$

and these are equal, so that, using the value of $d\,i$ from equation (1), we have

$$\mathrm{I} - \int_0^{\pi}\mathrm{A}\cos^2\beta\,.\,d\,\beta - \mathrm{A}\cos\beta\,.\,d\,\beta = 0 \qquad (7)$$

which gives

$$\frac{\mathrm{I} - \pi\mathrm{A}}{2} = 0 \qquad (8)$$

Equations (6) and (8) determine the values of A and K, giving

$$\mathrm{A} = \frac{2\,\mathrm{I}}{\pi} \qquad (9)$$

$$\mathrm{K} = \frac{\mathrm{I}}{2} \qquad (10)$$

Using these values of A and K in equation (2) we have

$$i = \frac{\mathrm{I}}{2} - \frac{2\,\mathrm{I}}{\pi}\sin\beta \qquad (11)$$

It is worthy of note that the problem of the determination of armature currents in a synchronous converter is one which is properly based in every case on energy considerations, as in the above discussion.

We are now prepared to discuss the problem of energy transformations in the many-ring converter. Since the total generator action which is taking place at each instant in the many-ring converter is equal to the total motor action, therefore the inductively transformed power is equal to the total generator action (or to the total motor action). That is: the inductively transformed power, P, is equal to the integral of (4) over those portions of the armature where d G is positive. Now d G is positive where i is positive, since $d\,e$ is everywhere positive, and from equation (11) we find that i is negative from $\beta = 0$ to $\beta = 51°.75$, positive from $\beta = 51°.75$ to $\beta = 128°.25$, and negative from $\beta = 128°.25$ to $\beta = 180°$. Therefore, attending to one-half of the armature and multiplying the result by two, we have:

$$\mathrm{P} = \mathrm{EI}\int_{\beta\,=\,51°.75}^{\beta\,=\,128°.25} -\,\frac{2}{\pi}\sin^2\beta\,.\,d\,\beta + \tfrac{1}{2}\sin\beta\,.\,d\,\beta \qquad (12)$$

which gives

$$\mathrm{P} = 0.1153\ \mathrm{EI} \qquad (13)$$

That is, 11½ per cent of the energy which flows through a many-ring converter is inductively transformed and 88½ per cent is conductively transferred from the alternating-current supply mains to the direct-current service mains.

Remarks—The activities of the two-ring, three-ring and four-ring converters are much more complicated than those of the many-ring converter. The wide separation of the alternating-current taps in the few-ring converter introduces pulsations in value of current and power in the various windings, as they pass a given point, so that in considering the internal actions of the few-ring converter, everything must be expressed as a function of time; and in the summation of generator and motor actions time integrations are involved.

IV—THE TWO-RING CONVERTER.

Fig. 4 represents one side of the armature of a two-pole two-ring converter; *r* is one of the alternating-current taps, *a* and *b* are the direct-current brushes, E is the electromotive force between direct-current brushes, I is the direct current flowing in at *a* and out at *b*, and i_a and i_b are the values of the currents in the armature parts as shown at instant *t*.

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The arrows show the directions in which the various electromotive forces and currents are considered as positive.

The algebraic expressions for i_a and i_b are determined fundamentally by the same consideration of energy relations as in case of the many-ring converter. The expressions are:

$$\left.\begin{aligned} i &= \tfrac{1}{2}\,\mathrm{I} + \mathrm{I}\cos\omega t \\ i_b &= \tfrac{1}{2}\,\mathrm{I} - \mathrm{I}\cos\omega t \end{aligned}\right\} \quad (14)$$

Furthermore,

$$\left.\begin{aligned} &\text{Electromotive force between } a \text{ and } r \\ &\quad = \tfrac{1}{2}\,\mathrm{E}\,(1-\cos\omega t) \\ &\text{Electromotive force between } r \text{ and } b \\ &\quad = \tfrac{1}{2}\,\mathrm{E}\,(1+\cos\omega t) \end{aligned}\right\} \quad (15)$$

Let A be the generator action (motor action when negative), in watts between a and r; and let B be the generator action (motor action when negative), between r and b. Then

$$\mathrm{A} = \tfrac{1}{2}\,\mathrm{EI}\,(\tfrac{1}{2} + \tfrac{1}{2}\cos\omega t - \cos^2\omega t) \quad (16)$$

$$\mathrm{B} = \tfrac{1}{2}\,\mathrm{EI}\,(\tfrac{1}{2} - \tfrac{1}{2}\cos\omega t - \cos^2\omega t) \quad (17)$$

In case of the two-ring converter, the total generator action does not balance the total motor action at each instant and we must distinguish two parts in the inductively transformed power, namely, the power P which is transformed by simultaneous and balanced generator and motor action, and the power Q, which is first converted into kinetic energy as the armature is accelerated and afterward converted back into electrical energy as the armature is retarded.

The power P/2 (the division by two is on account of our considering one-half only of the armature) is equal to the integral of A during the time that A is positive, B negative, and A numerically less than B; plus the integral of B during the time that B is positive, A negative and B numerically less than A; minus the integral of A during the time that A is negative, B positive, and A numerically less than B; minus the integral of B during the time that B is negative, A positive, and B numerically less than A—these integrals being extended over half a cycle, and the final result divided by the duration of half a cycle. The value of P so found when divided by EI gives, of the total power which flows through the machine, the fractional part which is inductively transformed without passing through the intermediate stage of kinetic energy.

From equations (16) and (17) we find:

1. Generator action in $a\ r$ is less than motor action in $r\ b$ from $\omega t = 0$ to $\omega t = 45°$.

2. Generator action $a\ r$ is greater than motor action $r\ b$ from $\omega t = 45°$ to $\omega t = 60°$.

3. Generator action takes place in both $a\ r$ and $r\ b$ from $\omega t = 60°$ to $\omega t = 120°$.

4. Motor action in $a\ r$ is less than generator action in $r\ b$ from $\omega t = 120°$ to $\omega t = 135°$.

5. Motor action in $a\ r$ is greater than generator action in $r\ b$ from $\omega t = 135°$ to $\omega t = 180°$.

Therefore,

$$\mathrm{P} = \frac{2}{\pi}\int_0^{45°} \mathrm{A}\,.\,dx + \frac{2}{\pi}\int_{135°}^{180°} \mathrm{B}\,.\,dx - \frac{2}{\pi}\int_{120°}^{135°} \mathrm{A}\,.\,dx - \frac{2}{\pi}\int_{45°}^{60°} \mathrm{B}\,.\,dx \quad (18)$$

in which x is written for ωt.

The numerical evaluation of the integrals in equation (18) gives:

$$\frac{\mathrm{P}}{\mathrm{EI}} = 0.09517 \quad (19)$$

That is, nine and one half per cent of the total energy which flows through a two-ring converter is inductively transformed by simultaneous and balanced generator and motor action.

The power Q/2 (division by two is on account of considering one-half only of the armature) is found by taking the integral of A + B during the time that this sum is positive, namely, from $\omega t = 45°$ to $\omega t = 135°$, and dividing the result by the duration of half a cycle. This gives

$$\frac{\mathrm{Q}}{\mathrm{EI}} = \frac{1}{\pi}\int_{45°}^{135°} (1 - 2\cos_2 x)\,dx = 0.3183 \quad (20)$$

That is, 31.8 per cent of the energy which flows through a two-ring converter is inductively transformed by successive and unbalanced generator and motor action.

From the above results, it follows that 58.65 per cent of the energy which flows through a two-ring converter is transferred from the alternating-current supply mains to the direct-current service mains by virtue of the conductive connections through the converter armature.

V—THE THREE-RING CONVERTER.

Fig. 5 shows one side of the armature of a two-pole three-ring converter, r' and r'' are two of the three alternating-current taps, a and b are the direct-current brushes, i_a, i_b and i_c are the values of the currents in the armature parts, as shown at instant t, E is the electromotive force between the direct-current brushes, and I is the steady current flowing in at a and out at b. The arrows show the direction in which the various quantities are considered positive.

The algebraic expressions for i_a, i_b and i_c are

$$\left.\begin{aligned} i_a &= \frac{\mathrm{I}}{2} - \frac{4\,\mathrm{I}}{3\sqrt{3}}\cos(\omega t - 150°) \\ i_b &= \frac{\mathrm{I}}{2} - \frac{4\,\mathrm{I}}{3\sqrt{3}}\cos(\omega t - 30°) \\ i_c &= \frac{\mathrm{I}}{2} - \frac{4\,\mathrm{I}}{3\sqrt{3}}\cos(\omega t + 90°) \end{aligned}\right\} \quad (21)$$

For present purposes, we need consider only the generator and motor actions which occur in the three armature parts, $a\ r'$, $r'r''$ and $r''b$, during one-third of a cycle, namely, from $\omega t = 0$ to $\omega t = 120°$. The integral of all the generator actions in these armature parts during this third of a cycle divided by the duration of the third of a cycle, gives one-half of the inductively transformed power P.

The electromotive forces involved are as follows:

Electromotive force between a and r'

$$= \tfrac{1}{2}\,\mathrm{E}\,(1 - \cos\omega t) \quad (22)$$

Electromotive force between r' and r''

$$= \frac{\sqrt{3}\,\mathrm{E}}{2}\,.\,\cos(\omega t - 30°) \quad (23)$$

This equation is available only from $\omega t = 0$ to $\omega t = 60°$, since at the instant $\omega t = 60°$, r'' coincides with b and after this instant a portion of the section $r'\ r''$ is in the half armature which is out of consideration.

Electromotive force between r' and b

$$= \tfrac{1}{2}\,\mathrm{E}\,(1 + \cos\omega t) \quad (24)$$

This equation is used only during the interval from $\omega t = 60°$ to $\omega t = 120°$.

Electromotive force between r'' and b

$$= \tfrac{1}{2}\,\mathrm{E}\left[1 - \cos(\omega t - 60°)\right] \quad (25)$$

Let A, B′, B″ and C be the generator actions (motor actions when negative) in the armature parts $a\ r'$, $r'\ r''$, $r'\ b$ and $r''\ b$ respectively at instant t. Then we have:

$$\mathrm{A} = \tfrac{1}{2}\,\mathrm{E}\,(1 - \cos\omega t)\,.\,i_a \quad (26)$$

$$\mathrm{B}' = \frac{\sqrt{3}\,\mathrm{E}}{2}\,.\,\cos(\omega t - 30°)\,.\,i_b \quad (27)$$

$$\mathrm{B}'' = \tfrac{1}{2}\,\mathrm{E}\,(1 + \cos\omega t)\,.\,i_b \quad (28)$$

$$\mathrm{C} = \tfrac{1}{2}\,\mathrm{E}\left[1 - \cos(\omega t - 60°)\right].\,i_c \quad (29)$$

Equation (27) applies from $\omega t = 0$ to $\omega t = 60°$, and equation (28) applies from $\omega t = 60°$ to $\omega t = 120°$.

From equations (26) to (29) we find:

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A is *positive* from $\omega t = 0$ to $\omega t = 100°.5$
A is *negative* from $\omega t = 100°.5$ to $\omega t = 120°$
B′ is *negative* all the time during which it applies
B″ is *negative* from $\omega t = 60°$ to $\omega t = 79°.5$
B″ is *positive* from $\omega t = 79°.5$ to $\omega t = 120°$
C is *positive* from $\omega t = 0$ to $\omega t = 60°$
Therefore

$$P = \frac{3}{\pi}\int_0^{100°.5} A \cdot dx + \frac{3}{\pi}\int_{79°.5}^{120°} B'' \cdot dx + \frac{3}{\pi}\int_0^{60°} C \cdot dx \quad (30)$$

Substituting the values of i_a, i_b and i_c from equation (21) in equations (26), (28) and (29), and the resulting values of A, B″ and C in equation (30) and integrating, we find:

$$P = 0.2358\ EI \quad (31)$$

That is, 23.6 per cent of the energy which flows through a three-ring converter is inductively transformed by simultaneous and balanced generator and motor action, and the remainder, 76.4 per cent, is transferred from the supply mains to service mains by virtue of the conductive connections through the converter armature.

VI—THE FOUR-RING CONVERTER.

Fig. 6 shows one side of the armature of a two-pole four-ring converter, r' and r'' are two of the alternating-current taps, a and b the direct-current brushes, i_a, i_b and i_c are the values of the currents in the armature parts, as shown at the instant t, E is the electromotive force between the direct-current brushes, and I is the current flowing in at a and out at b. The arrows show the direction in which the various quantities are considered as positive.

The algebraic expressions for i_a, i_b and i_c are as follows:

$$\left.\begin{aligned} i_a &= \frac{I}{2} - \frac{I}{\sqrt{2}} \cdot \cos(\omega t - 135°) \\ i_b &= \frac{I}{2} - \frac{I}{\sqrt{2}} \cdot \cos(\omega t - 45°) \\ i_c &= \frac{I}{2} - \frac{I}{\sqrt{2}} \cdot \cos(\omega t + 45°) \end{aligned}\right\} \quad (32)$$

Furthermore,
Electromotive force between a and r'
$= \frac{1}{2} E (1 - \cos \omega t)$ (33)
Electromotive force between r' and r''
$= E \cos(\omega t - 45°)$ (34)
Electromotive force between r'' and b
$= \frac{1}{2} E (1 - \sin \omega t)$ (35)

In the present case we need only consider the generator and motor actions which occur in the half armature during a quarter of a cycle, namely, from $\omega t = 0$ to $\omega t = 90°$. The integral of the generator actions in the three armature parts $a\ r'$, $r'\ r''$ and $r''\ b$ during the specified quarter of a cycle divided by the duration of a quarter cycle, gives one-half of the inductively transformed power P.

Let A, B and C be the generator actions (motor actions when negative) in

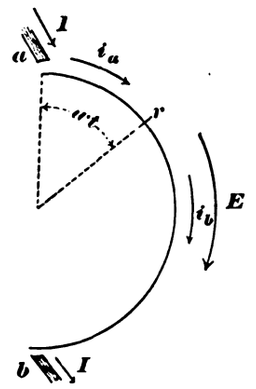

Fig. 4.

the armature parts $a\ r'$, $r'\ r''$ and $r''\ b$ respectively at instant t. Then we have:

$$A = \tfrac{1}{2} E (1 - \cos \omega t) \cdot i_a \quad (36)$$

$$B = \frac{E}{\sqrt{2}} \cdot \cos(\omega t - 45°) \cdot i_b \quad (37)$$

$$C = \tfrac{1}{2} E (1 - \sin \omega t) \cdot i_c \quad (38)$$

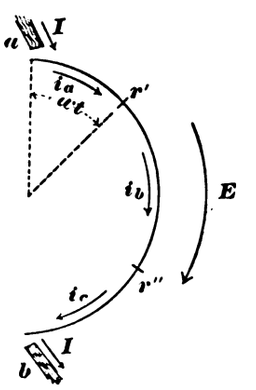

Fig. 5.

From these equations we find
A is *positive* from $\omega t = 0$ to $\omega t = 90°$.
B is *negative* from $\omega t = 0$ to $\omega t = 90°$.
C is *positive* from $\omega t = 0$ to $\omega t = 90°$.
Therefore,

$$P = \frac{4}{\pi}\int_0^{90°} A \cdot dx + \frac{4}{\pi}\int_0^{90°} C \cdot dx \quad (39)$$

in which x is written for ωt.

Substituting the values of i_a and i_c from equations (32) in equations (36) and (38) and substituting the resulting values of A and C in equation (39) and integrating, we find

$$P = 0.1285\ EI \quad (40)$$

That is, 12.9 per cent of the energy which flows through a four-ring converter is inductively transformed by simultaneous and balanced generator and motor action, and 87.1 per cent is conductively transferred from the supply mains to the service mains.

VII—SUMMARY.

ENERGY TRANSFORMATIONS IN THE SYNCHRONOUS CONVERTER.

Number of Rings.	Per Cent of Energy Transformed by Successive and Unbalanced Generator and Motor Action.	Per Cent of Energy Transformed by Simultaneous and Balanced Generator and Motor Action.	Per Cent of Energy Conductively Transferred.
2	31.83	9.517	58.65
3	0	23.58	76.42
4	0	12.85	87.15
Infinite	0	11.53	88.47

The calculation of these results demanded a great deal of painstaking computation; in fact, an amount which is very unusual in problems of this kind. These computations were done chiefly by Professor William Esty, to whom the author wishes to express his thanks.

VIII—ARMATURE REACTION OF THE MANY-RING CONVERTER AND ITS EFFECT IN DISTORTING THE ELECTROMOTIVE-FORCE CURVE OF THE MACHINE.

Consider the distribution of the magnetic field in the gap-space when the load on the converter is zero, and consider the distribution of field in the gap-space when the machine is delivering an amount of direct current I. Let f be the difference in value of these two fields at a point at angular distance β from the direct-current brush a, Fig. 3. Let df be the variation of f in the element of angle $d\beta$. Let l be the magnetic length of the gap-space in centimetres, n the number of armature conductors per centimetre of armature circumference, and let i be the current in the armature conductors at the element $d\beta$. Then from the fundamental relation between magnetomotive force and current turns, we have:

$$l \cdot df = \frac{4\pi}{10} n i \cdot d\beta$$

or

$$df = \frac{4\pi n i}{10 l} \cdot d\beta \quad (41)$$

Substituting the value of i from equation (11) we have

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$$d f = \frac{2 \pi n \mathrm{I}}{10 l} \cdot d \beta - \frac{8 n \mathrm{I}}{10 l} \cdot \sin \beta \, d \beta \qquad (42)$$

Integrating

$$f = \frac{2 \pi n \mathrm{I} \beta}{10 l} + \frac{8 n \mathrm{I} \cos \beta}{10 l} + \mathrm{C} \qquad (43)$$

In which C is a constant to be determined. By symmetry of winding and symmetry of distribution of current in two halves of armature, the value of f when $\beta = 0$ must be equal and opposite to the value of f, when $\beta = \pi$. Applying this condition to equation (43) we find:

$$\mathrm{C} = - \frac{\pi^2 n \mathrm{I}}{10 l} \qquad (44)$$

which substituted in equation (43) gives:

$$f = \frac{n \mathrm{I}}{10 l} (2 \pi \beta + 8 \cos \beta - \pi^2) \qquad (45)$$

This equation holds good on one side only of the armature. For expressing the values of f on the other side of the armature, the angle β must be measured from the brush b, Fig. 3.

If the electromotive-force curve of the converter is determined by using an auxiliary concentrated winding of T turns of wire, then the amount by which the ordinate of the full load electromotive-force curve exceeds the corresponding ordinate of the zero load electromotive-force curve at the point β in volts is

$$e' = \frac{2 \mathrm{LT} v n \mathrm{I}}{l} \cdot (2 \pi \beta + 8 \cos \beta - \pi^2) \div 10^9 \qquad (46)$$

in which L is the length of the armature in centimetres and v is the peripheral velocity of the armature in centimetres per second.

If it is desired to cut away a layer of thickness x from the pole-face, so as to compensate for the armature reaction at full load, causing the machine to give the same electromotive-force curve at full load as it previously did at zero load, this may be done and the thickness x is a function of β. In fact

$$x = \frac{f}{\mathrm{B}} \cdot l$$

in which B is the field intensity in the gap-space at zero load. Therefore

$$x = \frac{n \mathrm{I}}{10 \mathrm{B}} \cdot (2 \pi \beta + 8 \cos \beta - \pi^2) \qquad (47)$$

IX—THE CRITERION OF REALITY OF THE COMPONENT PARTS INTO WHICH A PHYSICAL AGGREGATE IS RESOLVED BY MATHEMATICAL ANALYSIS.

In the derivation of an algebraic expression for a determinate physical variable, two sets of conditions in general apply. 1. The condition or conditions which must be satisfied always and everywhere, that is throughout the interval of time and throughout the region of space over which the expression is to apply. These conditions are in most cases the requirements of the principle of the conservation of energy. 2*a*. The condition or conditions which must be satisfied at the boundary of the region. 2*b*. The condition or conditions which must be satisfied at the beginning of the time. Conditions 1 we will call persistent conditions. Conditions 2*a* may be persistent.

Consider as an example the problem of the vibration of an elastic string. The energy of the string is repeatedly transformed from kinetic to potential and back again, and the constancy of total energy is expressed by the well-known differential equation:

$$\frac{d^2 y}{d t^2} = - v^2 \frac{d^2 y}{d x^2} \qquad (a)$$

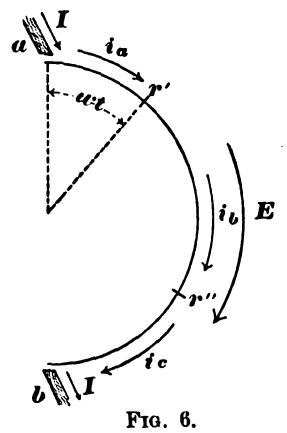

FIG. 6.

which must be always and everywhere satisfied.

At the ends of the string we have the persistent conditions,

$$y = 0 \text{ when } \left\{ \begin{array}{c} x = 0 \\ \text{or} \\ x = l \end{array} \right\} \qquad (b)$$

Any motion of the string is possible which satisfies these persistent conditions. Suppose that at the instant $t = 0$, the string is distorted into the shape represented by the equation,

$$y = f(x) \qquad (c)$$

The solution of the problem is

$$y = \mathrm{A} \sin \frac{2 \pi x}{l} + \mathrm{B} \sin \frac{4 \pi x}{l} + \mathrm{C} \sin \frac{6 \pi x}{l} + \cdots \qquad (d)$$

The various terms in this equation represent the component parts into which the actual motion of the string is resolved by the mathematical analysis of the problem. Each of these component parts satisfies all the persistent conditions of the problem and may therefore actually exist by itself, and there is no reason why we should not look upon each of these parts as real. In general the component parts into which a physical aggregate is resolved by mathematical analysis may be considered as real when each of these parts satisfies all of the persistent conditions of the problem and may exist alone.

Consider, as another example, the problem of the decay of current in an inductive circuit when the driving electromotive force is removed. Placing the rate of disappearance of electro-kinetic energy equal to the rate of generation of heat in the circuit, we have as a result the differential equation:

$$\mathrm{R} i + \mathrm{L} \frac{d i}{d t} = 0 \qquad (e)$$

which equation must be always satisfied. Furthermore, at the beginning, the current has a certain prescribed value I. That is:

$$i = \mathrm{I} \text{ when } t = 0 \qquad (f)$$

The solution of this problem is

$$i = \mathrm{I} \left(1 - t + \frac{t^2}{1'2} - \frac{t^3}{1'2'3} + \frac{t^4}{1'2'3'4} - \cdots\right) \qquad (g)$$

in which R/L has been placed equal to unity for brevity. The various terms in equation (*g*) represent component parts of the current i, these parts do not satisfy the conditions of the problem; they can not exist alone under the conditions of the problem, and therefore these parts can not be looked upon as physically real. In general, the component parts into which a physical aggregate is resolved by mathematical analysis can not be considered as real when they do not separately satisfy the persistent conditions of the problem and when these parts can not exist individually and separately under the conditions of the problem.

Consider the case of the polyphase synchronous converter after it is in full operation. The persistent condition is equality of inflow and outflow of electrical energy and constancy of kinetic energy of armature. The problem of the determination of armature current under these conditions leads to expressions—see equations (11), (14), (21) and (32)—which involve two terms. That is, the armature current is resolved into two parts and these parts correspond to inflowing alternating current and outflowing direct current, respectively. This correspondence strongly suggests the physical reality of these two parts of the armature current; but as a matter of fact, neither part of the armature current satisfies the conditions of the problem, neither part can exist alone under the conditions of the problem, and, therefore, these parts are mathematical fictions and not physical realities.

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The Norwood, Ohio, Telephone Exchange.

By J. E. Peavey.

THE Norwood telephone exchange building, shown in Fig. 1, is one of three new suburban exchange buildings recently completed by the City & Suburban Telegraph Association, of Cincinnati, Ohio. These buildings, as shown, are two stories high, with a well lighted and ventilated basement. The outside is finished with red pressed brick and sandstone trimmings, and the roof is of red tile. All floors in the interior are of ferroconcrete construction, making the buildings absolutely fireproof.

Each of the buildings has an ultimate capacity of 4,800 subscribers lines, and 288 incoming and 280 outgoing trunks, the Western Electric standard common battery equipment being used throughout. The switchboards are located on the second floor, and when all of the sections are installed will be in a "U" shape, making operator supervision easy, as well as an attractive operating room.

The chief operator's desk is mounted on a slightly elevated platform, giving the operator in charge a clear and unobstructed view of the room and switchboard. This desk is equipped with two positions, each having ample line facilities and service-observing circuits. There is also a very conveniently arranged card system, readily furnishing the chief operator with data on any subscriber in the exchange.

On the first floor are located the main frames, relay racks, wire chief's desk, and a very comfortably appointed operators' quarters, consisting of locker room, with capacity for accommodating eighty operators, dining and sitting room, and kitchen and toilet room.

The power plant is located in the basement. At present there are eleven G-7 chloride accumulators in lead tanks, mounted individually on an elevated stand,

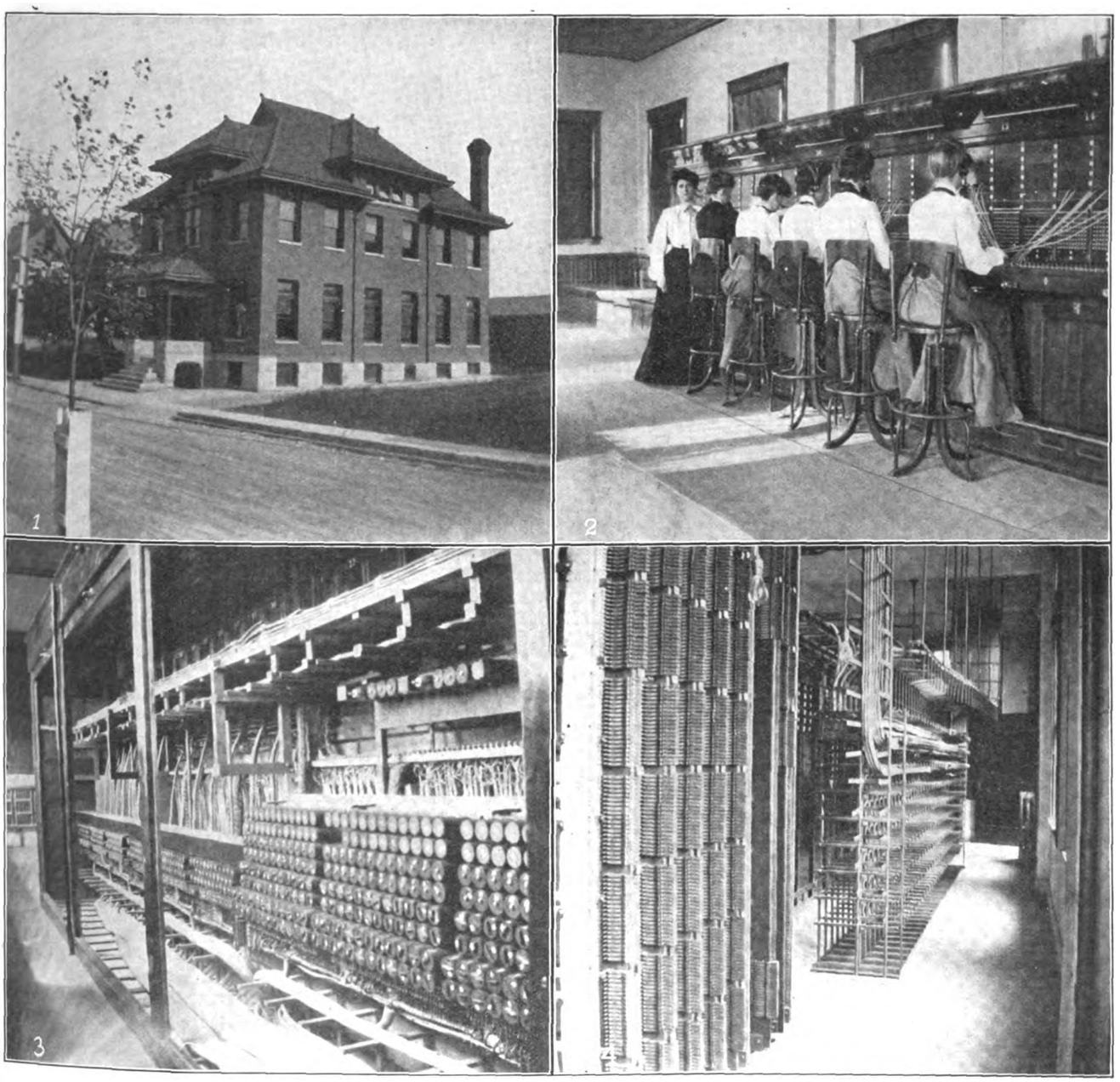

FIG. 1.—NORWOOD TELEPHONE BUILDING. FIG. 2.—FRONT OF BOARD. FIG. 3.—BACK OF BOARD. FIG. 4.—MAIN AND INTERMEDIATE FRAMES

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so that any tank may be lowered away from the plates in case the battery should be in need of repairs.

There are two dynamotor selective ringing machines, one motor-generator charging machine, and one charging generator belted to a Fairbanks & Morse gas engine, making the power almost infallible.

The power switchboard is finished in dark slate, with all wiring and apparatus artistically and neatly arranged.

Figs. 2 and 3 show a part of the front and back of the subscriber line switchboard, and Fig. 4 the main and intermediate frames. The Cincinnati Telephone Company's subscribers' list is increasing at the rate of about thirty-five per cent per annum, this being due principally to the untiring efforts on the part of the management to anticipate the needs, and give to the public the latest equipments and best service obtainable; and with all due consideration, it may truthfully be said that this company has no equal in the enjoyment of the confidence and good will of the public.

The officers are John Kilgour, president; B. L. Kilgour, general manager; R. T. McComas, assistant general manager.

The American Society for Testing Materials.

A committee recently appointed by the American Society for Testing Materials to investigate the subject of "The Magnetic Properties of Iron and Steel," met in New York city on June 26, to outline a series of investigations for the coming year.

This committee, which is headed by Professor J. Walter Esterline, of Purdue University, La Fayette, Ind., is composed of the following experts on the subject of iron and steel, and the results of its investigations will be of interest to electrical engineers, as well as those directly connected with the manufacture of magnetic materials: Dr. R. G. G. Moldenke, consulting metallurgist and chemist, Watchung, N. J.; Mr. J. A. Capp, chief of testing laboratory, General Electric Company, Schenectady, N. Y.; Mr. H. E. Diller, chief chemist, Western Electric Company, Chicago, Ill.; Mr. J. A. Mathews, metallurgist, Sanderson Brothers' Works, Crucible Steel Company of America, Syracuse, N. Y.; Mr. Robert B. Treat, engineer, Crocker-Wheeler Company, Ampere, N. J.; Mr. W. A. Layman, general manager, Wagner Electric Manufacturing Company, St. Louis, Mo.

The committee made its first report at the annual meeting of the American Society for Testing Materials, at Delaware Water Gap, July 1, 1903, and the results of the investigations will be announced at the annual meeting in 1904.

ALTERNATING-CURRENT MOTORS FOR VARIABLE SPEED.[1]

BY W. I. SLICHTER.

1. The impression is very general that a variable speed can not be obtained with an alternating-current motor, and that if an alternating-current plant is to be installed, the idea of obtaining a variable speed drive of any of the tools must be abandoned. That is not so, and the object of this paper is to show the possibilities of this type of motor, and to point out its limitations.

But it must be understood in the first place that it is not claimed for the alternating-current motor that it can compete with the direct-current type where continual variations of speed, throughout a wide range, are required, as the latter motor is usually superior in efficiency under these conditions.

2. Let us assume, then, that the problem to be solved is a case where an alternating-current plant is desirable for general reasons, such as distance of transmission or availability of power, and that a considerable amount of the power is used in constant speed work, but a certain portion of the work requires a variable speed. What is the most appropriate and most efficient method of obtaining the variable speed?

3. The speed of an alternating-current motor may be controlled in a number of ways:

(*a*) By varying the potential applied to the primary of a motor having a suitable resistance in the secondary.

(*b*) By varying the resistance in the secondary circuit.

(*c*) By changing the connections of the primary in a manner to change the number of poles.

(*d*) By varying the frequency of the applied voltage.

For the benefit of those not familiar with the polyphase induction motor, a general view of its characteristics may be desirable.

4. These characteristics are very similar to those of the continuous-current shunt motor—that is, at a constant impressed voltage and frequency the speed tends to be constant, and a considerable change in load will not cause an appreciable change in speed. As the load increases, the speed drops gradually to a critical point, usually about fifteen to twenty per cent below the normal value, and then the motor breaks down completely if the load is any further increased. The same action occurs exactly if the load is kept constant and the voltage is decreased. But if the frequency of alternation of the impressed voltage is decreased, the speed will decrease in exactly the same proportion. That is, for a given frequency and a given number of poles in the motor, the speed is practically fixed and independent of all other effects.

5. The drop in speed from the synchronous value is directly proportional to these losses. Thus, by increasing the resistance of this circuit, any desired speed may be obtained at the expense of these losses. With the increased resistance, the speed at which the motor breaks down may be reduced to a very low value, even to zero speed. Thus, by reducing the voltage applied to the motor for a given torque, the effect is produced of overloading it, and the speed drops.

6. In this connection it should be remembered that a variation of an alternating voltage may be obtained by means of a reactance or compensator with a very small loss of energy, whereas with a continuous voltage the loss of energy is usually proportional to the variation in voltage.

7. Potential Control—In this a suitable reactance or "compensator" reduces the line voltage to the fractional value desired. In this reduction the energy lost is only about five per cent of the amount transformed.

The induction motor should have a very large resistance in the secondary, which is preferably of the squirrel-cage type. This resistance gives the motor a speed characteristic such that its full load speed is some ten per cent less than that of a normal motor, and as the load is increased, the speed will fall to about thirty per cent of this value without the motor "breaking down" or falling out of step, which in the normal motor usually takes place at about eighty per cent of the full load speed.

8. Such a motor would have the following characteristics, assuming its synchronous speed as 100, and the voltage applied as 100. (This is based on a fifty-horse-power, forty-cycle motor, at 800 revolutions per minute, as an instance.)

For constant full load (fifty horse-power) torque at various speeds:

	Speed.	Volts.	Efficiency.	Losses, Motor. Kilowatts.	Kilowatt Compensator. Kilowatts.
Full load speed.....	.89	100	81	8.8	0.0
Three-quarter load speed.....	.67	66	59	18.5	1.0
One-half load speed	.45	57	37	32.0	2.0
One-quarter load speed.....	.22	56	17	45.7	3.5
Normal motor (full speed).....	.98	100	88	5.0	0.0

[1] Abstract of a paper presented at the Saratoga meeting (June, 1903) of the American Society of Mechanical Engineers.

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9. Rheostat Control—In this scheme the secondary or rotor must have a definite winding (as opposed to the squirrel-cage, which is cheaper) with slip rings and brushes to lead out the current. The friction and resistance losses due to these brushes decrease the efficiency of the motor somewhat. The secondary is usually wound for a higher voltage and less current than in the standard or normal motor, to minimize these losses. The action of this method is based on the principal that, in an induction motor, the drop in speed for any given torque is proportional to the resistance of the secondary circuit.

10. This scheme would show the following characteristics for the same motor as before at fifty-horse-power torque, constant:

	Speed.	Volts.	Efficiency.	Losses, Motor. Kilowatts.	Rheostat. Kilowatts.
Full load speed.....	.96	100	86	5	0.0
Three-quarter load speed..	.72	100	65	5	9.0
One-half load speed.....	.48	100	43	5	18.5
One-quarter load speed....	.24	100	22	5	28.0
Normal motor (full).....	.96	100	88	5	0.0

As will be seen, this method gives a higher efficiency throughout, but particularly excels the previous method in having so much smaller losses in the motor itself, thus permitting of a smaller design and less danger of damage. The losses are concentrated in a rheostat, which is a cheaper piece of apparatus and less liable to damage, being of iron and asbestos usually, instead of high grade insulating materials, as in the motor proper.

11. Changeable Poles—By using a pitch of winding which is commensurable with two numbers of poles, we may build a motor which will operate with either four or eight, six or twelve, etc., poles, by a slight change of the connection. Or by a more intricate arrangement of windings a change from four to six, six to eight, etc., may be made.

In this arrangement it is necessary to use a squirrel-cage armature, since it is suitable for any number of poles, and the pitch of the primary coils has to be made some compromise value between the normal pitch of the two combinations, so it is usually not the best or most effective pitch for either number of poles. Therefore the constants of this motor should not be expected to be as good as those of the standard motor.

12. For a motor operating at full and half speeds, say with six and twelve poles for 800 and 400 revolutions, we would have:

	Volts.	Efficiency.	Losses.
Full speed, 50 horse-power.	100	86	5.8
Half speed, 25 horse-power.	100	74	6.6

Thus, for full load torque at half speed we get an efficiency almost double that obtained with the other methods, but what losses there are are in the motor itself, as in the first case. The losses are about the same in the two cases, the speed and thus the ventilation being half in one case, the heating is greater at the lower speed.

13. Variable Frequency—Every induction motor tends to run at synchronous speed—that is, at a speed equal to

$$\frac{60 \times \text{frequency}}{\frac{\text{Poles}}{2}}$$

Thus, if a different frequency is impressed on the motor, it will run at a different speed. Some installations have been made where two or three alternating-current generators are used to obtain different frequencies, and these circuits are carried around the shops by various sets of lines (usually three in each set) and the motor connected to the lines giving the frequency and speed desired. For normal losses in the iron the voltage must vary with the frequency. Thus for full and half speed we have:

	Volts.	Efficiency.	Losses.
Full speed, 50 horse-power.	100	88	5
Half speed, 25 horse-power.	50	87	2.8

14. Generators have been built having two stationary armatures in the same frame and two revolving fields, with a different number of poles on the same shaft to give the multiple frequency desired. An application of this principle, which is very pretty theoretically, is that of a very small variable speed induction motor (whose losses are negligible) which drives a commutator feeding the primary of the load machine; by a suitable control of the little motor any desired frequency may be supplied to the lead machine from zero to full value, thus it may be started and run at any desired speed. A variation of this is to attach the commutator to the shaft of the load machine and the brushes to the shaft of the controlling motor, thus when the load machine is standing still the brushes revolve at almost full speed on the commutator, and a very low frequency is obtained in the commutated circuit. As the load machine speeds up, the difference in the speeds of the commutator and the brushes decreases, and hence the frequency increases until that time when the commutator and brushes are revolving together at the same speed when there is no commutation and the load machine receives full frequency.

15. Summary—From these descriptions it will be seen that the changeable pole and variable frequency methods are the most efficient, but do not permit of a variation through a wide range of speed. The rheostatic control is the simplest and easiest of control, giving a range from standstill to full speed, but is not as efficient as the first two, although more efficient than potential control. The last mentioned has the disadvantages of low efficiency and considerably increased heating in the motor itself, and is also unstable at low speeds, say below one-third speed. That is, a small variation in torque or a smaller variation in voltage will cause a considerable variation in speed.

16. The potential control is used where moderate variations in speed are wanted, not reaching to less than half speed for instance, and where the load is intermittent, not giving the motor a chance to get too hot. Its great disadvantage is the amount of current it takes at starting, which causes considerable disturbance in the supply circuit, flickering of lights, etc., due to the drop in voltage. The motor used is a cheaper one to build (for the same size) than the others, but if anything like continuous running is desired, the motor must be larger, thus much of this advantage is lost.

17. One advantage of this motor is that it may be totally enclosed for use in powder mills, oil refineries or where much dust or corrosive vapor is encountered, as it may be controlled from a distance without increasing the number of wires.

18. The rheostatic method is particularly adapted where frequent starting and low speeds are required, as it causes no unusual drain on the supply system when starting. Thus it is used for hoists, elevators, etc.

The changeable pole system has the same disadvantages in starting as the potential control. For long-continued running at only two different speeds it is excellent, and has constants comparable with those of a continuous-current motor.

19. To vary the frequency of alternation for the motor requires an increased investment in generating station or auxiliary apparatus and line copper, and the greater the number of speeds desired, the greater this complication; but in its action and economy it is equal to any.

One point which is important to bring out is that with the changeable pole and changeable frequency systems the motor will not vary appreciably from the set speed for changes of load, while with either potential or rheostatic control, a change of load will cause an appreciable variation from the desired speed, requiring a readjustment of the potential or resistance to bring the speed to the desired value again.

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Notes from Great Britain.

By Our Special Correspondent.

THE 1903 parliamentary session which is now well on its way toward conclusion has, despite the suspension of all the bills dealing with "tube" railways in London, raised many hitherto undebated points, and many matters which have been fought out in previous sessions have been argued, with opposite results this year. One of the most important of the latter is in connection with the large electric power supply companies. Previous to this year it has been the general custom to exclude from the areas asked for by the companies all large towns already owning electricity supply works, but this session, on the only two bills of the kind which were opposed, the committee decreed oppositely to this, on certain conditions, of course. The two companies in question scheduled large areas in Somersetshire and in the Northwest Midlands, and the parliamentary committees dealing with the bills have set up a precedent which will be largely relied upon in the future, *viz.*, that the company shall not supply any town already owning an electricity works except with the consent of the municipality, but should such consent be unreasonably withheld an appeal may be made to the Board of Trade. The general feeling is that this attitude of Parliament—which, however, may be reversed when the bills come before the House of Commons—is all for the good of the industry, as the already authorized distributors of electricity will always have the possibility of the big company under some pretence or another, appealing to the Board of Trade as to why they should not be allowed to supply any of those particular places. Another matter of somewhat new import, is the sanction to run a service of trolley omnibuses, without rails, in Somersetshire in connection with a system of electric tramways. The idea is to carry on such a service in those less populated portions of the country where the traffic, for the present, is not likely to be very large. The experiment will be watched with interest outside Great Britain, but I believe the promoters have not gone into the details of that part of the scheme yet. Then, again, that much debated question of municipal trading has been largely to the fore in relation to electrical matters. The gas companies, whose undertakings are heavily assessed by the local authority within whose boundaries they are situated, now come before Parliament with the argument that being ratepayers some restriction should be placed upon municipal trading in a commodity—such as the electric light—which is in direct competition with themselves, as in the event of a loss, the deficit upon such competitors' undertakings has, in part, to be made up, per its share of increased rates, by the gas companies. So forcibly has the argument been put before Parliament, that in two instances clauses have been inserted specifying that if, after the first year's working of the municipal undertaking, a loss is declared, the prices shall be increased so as to prevent a loss in future years. It may also be interesting here to note that a joint committee of the houses of Lords and Commons has been selected to consider the whole question of municipal trading. These constitute the main points of electrical interest which have arisen in connection with the year's bills, and it will be interesting to revert to them when they have been dealt with in the House of Commons.

The Wolverhampton Town Council has, after a year's working of some eleven miles of surface contact tramways, come to the conclusion that, mainly on the score of expense, they are unsuitable, and has ordered its consulting electrical engineer to prepare a scheme of overhead electric lines for the borough. This is the only instance of its kind in Great Britain, and whereas both the corporation and the Lorain Steel Company, whose system was adopted, are now being blamed for entering into an agreement of the nature of the one which was entered into, it must be said that it is only now for the first time that the terms of the said agreement have been made public, so that the press had no opportunity of commenting upon this part of the arrangements before. The complaint of the corporation is that it had been misled as to the cost of the working expenses of the system, which, for the electrical energy required alone, worked out at one penny per car mile extra to the average cost for the overhead trolley system here, and the total extra cost per annum over the overhead system for the eleven miles in Wolverhampton is put at nearly £6,000. The attitude of the local authority, therefore, was that looking at these figures in the light of the heavy rates of the borough, the cheapest system of traction, consistent with reasonable safety, should be adopted. The resolution to terminate the agreement with the company was therefore passed, and a subcommittee was appointed to settle the affair up. Unfortunately, the company will be the heaviest loser in the matter, as by the agrement with the corporation that if the tramways, among a list of things, did not prove commercially successful, it would, upon receipt of notice from the corporation, remove all feeder pillars and contact boxes, and reinstate and make good all paving in connection with the tramways, but leaving all cables, and connections laid under the roadways in possession of the corporation, no payment whatever being made by the corporation. It was a sporting offer on the part of the company, but British local authorities, when an opportunity arises for getting something for nothing, are apt to forget to look at things from all points.

The details of the electrical equipment of the North-Eastern Railway Company's lines are being gradually evolved, and the following is some information of what has been decided upon up to date: A single conductor is to be placed in the six-foot way with a return by way of the running rails, current being supplied to the lines at 600 volts continuous. The conductor rail will be of steel, and will weigh eighty pounds per yard, being carried on granite insulators. The Newcastle-on-Tyne Electric Supply Company, which will supply the necessary electrical energy to the railway company, at first intended to supply from its existing generating station, but its general supply business has so largely increased that this has been found to be impossible, and a new power-house will be erected. In this new generating station, the generating plant will be a number of 3,500-kilowatt Parsons turbo-generators, supplying three-phase current at 6,000 volts pressure and forty cycles per second. This current will be supplied to five substations, in which will be situated fourteen 800-kilowatt rotary converters. The train coaches, the bodies of which will be made by the railway company's own workmen, will be fitted with the British Thomson-Houston multiple unit systems of control. Motor coaches will be at each end of the trains, and each will be equip-

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ped with two 150-horse-power G.-E. motors, both being carried on one bogie truck. Four contact shoes will be fitted to each motor car. For the goods service, electric locomotives are to be employed. The British Thomson-Houston Company has the contract for the electrical equipment of the rolling stock and permanent way, the British Westinghouse Company that for the complete equipment of the substations, and Messrs. Siemens Brothers & Company that for the three-phase high-tension, telephone, and pilot cables. Although in no way precisely comparable with the Mersey railway, yet in some directions it may be so compared, and from that point of view the experience gained on the Mersey railway may be useful. But as a perfectly open surface steam railway converted to electrical working, it will afford great interest, especially in view of the possible adoption of electric traction on the main steam lines of the country.

There have been many discussions in Parliament upon the, to some minds, unsatisfactory condition of the postal-telegraph system of Great Britain, but the one which took place in the House of Commons a short time ago was about as comprehensive an affair as has taken place for some time. The occasion was afforded by the proposal to vote a large sum of money for telegraph purposes, and in the debate the faults of the Post Office Department were freely discussed. In the first place, attention was once more drawn to that £1,000,000 loss last year on the telegraph system of the country; then was asked the question as to why the government did not negotiate for the purchase of the submarine cables in connection with Great Britain; this was followed by complaints of the present high tariffs for submarine cable messages, as well as the high rates for telephonic communication between Great Britain and the continent, and on the trunk lines generally. Finally, great indignation was expressed as to the manner in which the government had treated Mr. Marconi in connection with his system of wireless telegraphy. These are quite a sufficient quantity of queries for the Postmaster-General to have to answer "at one go," and it is quite as well that government officials as a rule do not take these trifles too seriously. All the questions enumerated above, be it mentioned, were put by that champion of telegraphic and postal reform, Mr. Henniker Heaton. Among questions put by other speakers was one as to the results of the international telegraph conference, about which a good many would be glad to hear something. Mr. Austen Chamberlain, the Postmaster-General, replying on behalf of the government, dealt seriatem with the queries put to him. The large deficit on the telegraph system he attributed to a variety of causes. He considered the state had paid an exorbitant price when it bought the telegraphs from the old companies, a price which forestalled profit, and exceeded any profits which could be fairly taken into account at the time of the purchase. In addition to this, there had been in recent years repeated demands for concessions to the public, and also for increased salaries to the telegraph employés. It was obvious, he concluded, that with all these forces at work profits could hardly be expected. He hoped to make some reforms however. With the purchase of cables he did not deal, but in connection with the reduction of rates, he pointed out that foreign administrations had to be dealt with, which increased the difficulties, but as a result of the international telegraph conference he hoped to be able to announce some further reductions. Coming to the question of wireless telegraphy, he repudiated the suggestion that the Post Office was trying to stifle that invention. What had been done was to avoid giving away the rights of the Post Office in the way that they had been parted with in the case of telephones to the National Telephone Company. The Marconi Company had not merely asked for the rights at present accorded to the cable companies, but wanted exclusive permanent rights, which he could not give them. In connection with the Post Office telephone system he said that there were now laid in London about 100,000 miles of cables. The greater part of the licenses of the National Telephone Company expired in 1911, and, from past experience, he could never imagine any government would ever allow the service to pass out of its hands. Finally, he dealt briefly with the international telegraph conference. He said this was mainly concerned with the domestic details of the telephonic administration of the world, which was not a very fit subject for public discussion. But with the question of the compulsory adoption of the Berne vocabulary, he felt so convinced of its inconvenience and disadvantage that he had instructed the British delegates to oppose it.

A short time ago announcement was made of the formation of a new scientific society, known as the Society of Electro-chemists. The name of this has now been changed to the Faraday Society, for the promotion of the study of electro-chemistry, electrometallurgy, chemical physics, metallography and kindred subjects. The first president is Mr. J. W. Swan, and in order that the work of the society may not be too long delayed, a meeting was fixed for June 30, and a half session will then be commenced. It may also be mentioned that arrangements are being made for the free distribution to the members of the Faraday Society of the transactions of the American Electro-chemical Society.

Very little has been heard for some time of the mono-rail scheme between Liverpool and Manchester, which Parliament sanctioned a couple of years ago, and like many another similar project, it has soon been forgotten by the public. There have been several reasons why the particular scheme mentioned above has not been yet matured beyond the completion of the surveys, the most important being the inability to raise the capital. The Board of Trade also desired that an experimental length should at first be constructed, in order to demonstrate the safety of the system. To this latter condition the promoters have agreed. Finding money for electrical undertakings of so speculative a character as this one must naturally be a difficult matter, but a separate company has been formed, consisting mostly of stock exchange men, expressly for financing this scheme in particular and similar schemes in general. Ever since the year when Parliament sanctioned the Manchester-Liverpool line, the inventor of the system, Mr. Behr, has lost no opportunity of expounding the merits of the principle, and he has succeeded in convincing a number of eminent engineers. For instance, Sir Frederick Bramwell fully supports the contention that derailment is impossible, and even goes so far as to say that as regards speed and comfort, the mono-rail is far ahead of the two-rail line. Again, Sir William Preece is of the opinion that the idea reduces the cause of accidents on ordinary lines to a minimum. The only experience of such a railway is the experimental line at Brussels, where eighty-three miles an hour has been attained on curves. The Liverpool-Manchester line will be thirty-four and one-half miles of double track, and the rate of progress is put at 110 miles per hour. The cost of working is put at sevenpence halfpenny per train-mile.

A. W.

London, June 27.

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THE TELEPHONE AND THE TECHNICAL SCHOOL.[1]

BY J. C. KELSEY.

In this commercial age, whenever a new branch of science or industry exhibits unusual activity and growing importance, the authorities of our universities are ordinarily prompt in adopting a course of instruction especially adapted to that particular work. Electrical engineering, journalism, insurance and commerce are some of the branches which, in these later days, have received consideration by leading universities. A late and prominent branch of industry is that embraced by telephony, and this lusty offspring of electrical engineering now vigorously demands recognition. But progress will be slow in this direction, if we rely upon scholastic opinion. For prior to the adoption of the course of telephone engineering at Purdue University, enquiries were made of many persons known to be interested in the telephone and of a number of professors of electrical engineering. Nearly every person interrogated, who was interested in the telephone from a manufacturing or operating standpoint, was in favor of the movement, while nearly to a unit the idea was opposed by the college people on the ground that there was no call for such a course.

There is a great deal of justification for the attitude of the teachers. For years they have tried to look into the possibilities of the telephone. There was not much to look into, for the pains taken by the telephone interests of past years to help them were microscopic. In most university laboratories, even to this day, a Blake set and an obsolete drop are the sole representatives of a great branch of electrical engineering. Surely, in these there is not much to attract the teacher or the student, much less induce him to look with favor upon the advantages of studying telephony as a life work.

But changes have taken place. Competition brings out man's best effort. The old and experienced telephone man, with his knowledge of detail, has combined his talents with the later generation of electrical engineers, and as a result a system of engineering has been evolved, which combines all the lighter, as well as much of the heavier, construction features of electrical engineering, making the practice of telephone engineering an acceptable profession. However, to place telephone engineering where it rightly belongs one thing yet remains, and that is, the attention of the scientific world must be attracted by our deeds and words. The American Institute of Electrical Engineers is the body to which we look for the official expression of the electrical profession. Everything good, novel and interesting is brought before this body in the fulness of time. It is discussed freely and honestly, and if found meritorious is given a place in the records for all men to read and to think about. If all the telephone engineers had permission (?) or had the inclination to take broad and comprehensive papers before that body, there is plenty of material, the engineering world would more fully realize the breadth of telephony, and scientific men would take more interest in studying the various and vexatious problems now confronting the practice of telephone engineering. But all that has been thus far brought before the Institute is in general a sort of apology, an evasion of the subject by a prolonged discussion of rates, or an assurance that telephone engineering is a broad profession. It will take more than assurances to establish this fact. How much better it would be if an institute of telephone engineers could be organized and perpetuated on a broad basis.

The general public has not been fully educated as regards the telephone. It has seen demonstrations of light and power and transportation, and has been impressed. But the telephone is not a spectacular agency, and the public is not at all impressed. When students enter college to take mechanical or electrical engineering they think they have a definite idea of what they want, and ask no questions. But regarding the teaching of telephone engineering many, many questions are asked: What do you teach? Of what value is it? Is it necessary? Why can not one learn in practical work? What is there about a telephone that takes two whole years of study? Why, my son could talk from the barn to the house years ago.

And a more intelligent lot of questions are asked, such as: Is it of benefit to the telephone field? Are you training young men for the benefit of manufacturers? Are you trying to make them conversant with the operating sides? Is the work of a practical nature? If we hire your graduates, will they be able to take an active hand in our business? And last, but not least, are you Bell or Independent?

These questions can not be evaded, and will be answered here. There seems to be no neutral ground, and a school naturally has to seek neutral ground, not being so constituted as to recognize business complications. Must the telehpone be an exception? The university works in the open field, and its investigations belong to the world. The apparatus it uses must necessarily come from the open field. Freely it gives, and freely is should receive.

To say what should be taught would be impertinent. We want to know that, for we want to make the course for you, to meet your needs. As now planned and administered, the telephone work begins in the junior year, after the student is grounded in mathematics and the fundamental principles of electricity. The students then take up the regular electrical course, simply substituting telephony for the mechanical engineering subjects in the regular electrical course. The first consideration is a study of circuits, beginning with the old series grounded system, on through the metallic self-restoring drop period, and then into common battery systems. Each and every commercial common battery system is discussed and analyzed in the classroom, and in the laboratory the various relays, impedances and lamps are arranged on tables, not only to show accuracy of connection and transmission, but to enable the student to observe the methods and rules of operation.

After the "A" circuits are well understood, the "B" circuit of each system, with the accompanying order wire device, busy test method and manual and automatic ringing, is taken up. The laboratory is divided, so that the "A" and "B" operators are in separate rooms, thereby making the student appreciate fully the usage of the order wire, the method of disconnection, and the general rule of operation.

After the "B" circuit, with its free interoffice service and its charge for interurban service, is investigated, the toll business is studied. The many phases of operation, the methods of switching and recording, and the auxiliary uses of the toll line are given as much attention as is possible outside of regular business.

Upon this foundation, the second year begins the details of the various systems, and a study of the appliances and circuits connected with the chief operator's, chief inspector's, supervisor's, and manager's desks. Complete specifications and drawings of entire systems are made, also a mathematical investigation of the loaded line is made in association with experimental conditions made as practical

[1] A paper read before the convention of the Independent Telephone Association of the United States, Chicago, June 24 and 25.

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as possible, operating cable being used for that purpose. The limitations of common battery systems, as regards distance of a subscriber from the exchange, affecting transmission and operation of relays; the effects of induction, from one, two or three-phase alternating currents, from 104 to 9,000 volts pressure, or from continuous currents of from 110 to 500 volts, or from series arc systems; quick and efficient methods of cable testing, finding wet spots, open places and crosses under actual working conditions; considerations of patent law; specifications and estimates upon overhead and underground construction; these are among the features of the course.

Is such a course valuable? In the first place, it must be understood that a technical school does not pretend to teach a man a trade or a profession. It only teaches him how to begin; it prepares him as a skilled apprentice, and not as a journeyman. Failure on the part of the student to realize this has frequently put him in a somewhat disagreeable light.

As to the necessity of the course, the experience of electrical engineering may be recalled. Time has disproved the early claims of the futility of such a course, for all the graduates of the electrotechnical schools are hired by the electrical interests before they leave the institutions. So, upon this evolutionary telephone ground, we hope for the ultimate appreciation of the necessity of telephony having its proper place in the technical schools.

These schools can be of benefit to the telephone field by giving the results of research to the telephone public. And if the schools are given knowledge of the various conditions of service, they will help to evolve, if not a standardization, at least a more general understanding of the rules and laws of design and operation. Schools have time in which to collect facts together and look into details and reasons, which the busy commercial man has not. And if a school can do this, it is certainly an important factor in the progress of telephony, and should be approved of and encouraged by every worker in the telephone industry. The authorities of Purdue are fully convinced that it can do all that has been claimed, and are well satisfied with the results of one year's experience with the telephone.

We feel certain of the approval of every one interested in telephony, and of the cooperation of every branch of the telephone industry in our attempt to build up a telephone course and a telephone laboratory that will be a real benefit to the industry and tend to dignify and amplify telephone engineering as a profession.

A New Building for the New York Times.

The spirit of enterprise which is so definite a part of American newspaper practice, is well evidenced in the far-reaching plans which the management of the *New York Times* has formulated in the choice of a site for, and the structural design of, its new building.

On August 4 last it was announced that the *Times* had secured the triangle bounded by Broadway, Seventh avenue, Forty-second and Forty-third streets, New York city, for the purpose of erecting a building, primarily for its own use. The peculiar geographical formation of New York city, and the localizing of almost all of the large metropolitan dailies in the lower part of the town, made it necessary to stick to this quarter of the city for the manufacturing operation of a newspaper plant, to avoid great inconvenience and loss of time. This was in order that the best facilities for the rapid distribution of editions of the paper might be made use of. With the completion of the underground rapid transit system, this condition will be entirely changed. The trains of that railway will run through the basement of the *Times'* new building. Turning on a curve from Forty-second street up Broadway, the tunnel traverses the lot acquired by the *Times,* and will enter the building obliquely about the middle of the Broadway front, passing out at the Forty-third street end. A terminal station of the subway road will also be erected at this point, giving access to trains without leaving the building. It will be possible, therefore, at the early morning hours when the newspapers are printed, to put the printed copies of the paper on board cars standing within a few feet of the presses, for distribution to various parts of the city.

These conditions have been greatly reenforced by the project of the Pennsylvania Railroad for a great terminal on the Manhattan side of the Hudson River; by the project of the New York Central system for greatly enlarging the area and increasing the use of its terminal at the Grand Central Station and by the projects of the Interborough company for connections across the East River.

The fact that the rapid transit subway will go beneath the structure brings with it, however, some grave architectural difficulties. In order to properly accommodate the presses and storerooms of the newspaper printing plant it will be necessary to excavate and occupy a level which will allow of the subway system and the structural supports which are necessary to uphold the trackage. The floor of the *Times'* pressrooms will be fifty feet below the street level, the actual depth being divided into three stories. Ventilation for this lowest part of the building is provided by an inlet of fresh air through a shaft opened for the purpose, while the exhaust for foul air encloses the main chimney, which extends to bed-rock and the top of the tower. Mr. Cyrus L. W. Eidlitz, of New York city, is architect for the *Times'* building, and the work is to be executed by the George A. Fuller Construction Company. The building will be 375 feet high. It is expected to have the lower stories of the building, from the first to the twelfth, inclusive, and including also the basement, ready for occupancy early in April, 1904.

After considerable discussion, it has been decided to adopt water as the motive power in running the electrical transmission plant which the Dunedin Tramways Company, of New Zealand, is about to erect. In order, however, that the operation of the tramways may not be delayed pending the completion of the transmission plant, a temporary steam plant will be put in. The transmission scheme includes the erection of a powerhouse situated on the banks of the river, about twenty miles from the city, where three-phase current will be generated by turbine-driven alternators and transformed up to 15,000 volts for transmission. From a point near the city, the main transmission line will be divided and branch off to the various substations which will be equipped with Westinghouse rotary converters, with storage batteries, and all necessary appliances. The designs for the whole scheme were carried out by Noyes Brothers, of Sidney, Australia, and the work of construction will also be under their control. All motors and other electrical machinery will be supplied by the British Westinghouse Electric and Manufacturing Company, Limited, the cars being furnished by the J. G. Brill Company.

"*The Four-Track News.*"

The Four-Track News for July is more than ordinarily interesting. This paper is growing, not only in size, but in popular fancy, and at this day it can hardly be called a venture, as it has become a well-established fact. The sketches and stories are just the kind that the busy man or the restless woman is pleased to take hold of and read.

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Velocity of Objects Floating in Water.

TO THE EDITOR OF THE ELECTRICAL REVIEW:

I have read with considerable interest the editorial in your issue of June 20, on the velocity of objects floating in running water. I can not, however, entirely agree with either you or General Bentham, nor do I believe the explanation offered by the *American Machinist* to be conclusive.

Your *reductio ad absurdum* fails at the critical point, that is, at the moment when your supposed floating block of ice melts into water and no longer possesses rigidity or tensile strength. General Bentham's explanation is not exact, as will appear later.

Starting with the river-bed, which for the sake of simplicity we will treat as a rough, but uniformly inclined, plane, water, or anything that is placed upon it, will move downward with increasing velocity until the frictional resistance to motion is equal to the component of the earth's attraction parallel with the surface of the plane. If this first body of water be treated as a continually running sheet, and a second sheet of water be superposed on the first sheet, the second sheet will reach a final velocity higher than that of the first, because it is sliding upon a surface itself in motion and offering less frictional resistance.

This argument may be continued until we have any supposable depth of water.

If now an object be placed upon the stream, we might suppose it to act like a superposed sheet of water. However, if it projects into the water to any depth, as a solid floating object would do, the upper parts will be in contact with water moving with greater velocity than the water below. The deeper water will naturally retard its tendency to float as fast as, or faster than, the water near the surface and it will have an intermediate velocity.

It might be possible for a very thin floating object, as a board for instance, to float as fast or nearly as fast as the surface water, and considerably faster than the water at a depth. On the other hand, since the water at a depth would move more slowly than the surface water, it would retard deep floating bodies, and bodies of different shapes would have slightly different velocities.

It is well known to hydraulic engineers that the velocity of water in a stream increases with the distance from the bed and the banks. It is impossible to conceive how a floating body, since it must have depth, could float faster than the very surface of the water, which is in no way tied to the water below it. In your assumed cube of water surrounded by a weightless membrane this condition, of course, does not hold, which destroys the force of your argument. General Bentham's explanation is not correct, since he neglects the retarding action of the water about the lower part of the floating object, although in any case it would have no tendency to move faster than the very surface, unless, indeed, its "skin resistance" were less than that of an equivalent body of water, which is highly improbable.

In the above, the action of the air upon the motion of either the water or the floating object is neglected. Assuming it to be at rest, it would retard the motion of either, and of the floating object more, probably, than of the water.

GEO. H. GIBSON.

Boston, Mass., June 25.

Ventilating Equipment for a Turkish Cruiser.

Messrs. William Cramp & Sons, of Philadelphia, are now building for the Ottoman Empire a large cruiser, to be named the Medjidia. One feature which has been looked after with particular care is the ventilation, which is of great importance in a vessel serving in tropical or subtropical waters. Nine electrically driven centrifugal fans are provided to ventilate the hull of the Medjidia. Fan No. 1 is a forty-inch steel-plate "exhauster," which will supply air above the protected deck, forward, while No. 2, of the same size, will supply air below the protected deck forward. Fan No. 3 is an exact duplicate of No. 1 and will supply air between frames 65 and 66 aft. No. 4, of the same size, will furnish air aft of frame 66. No. 5, which is a fifty-inch steel-plate "exhauster," will supply air to the dynamo and evaporating rooms. No. 6, a "Monogram exhauster" having a cast-iron housing, will supply air to the crew's quarters between frames 10 and 24. This fan is bolted to the ceiling and is driven by an electric motor supported on the side of the fan. Fan No. 7, which furnishes air to the crew's quarters between frames 24 and 34, is similar to fan No. 2. Fan No. 8, for the crew's quarters between frames 34 and 35, is a duplicate of fan No. 6, and No. 9, of the same size and character, furnishes air to the officers' quarters between frames 55 and 83. The forty-inch fans are capable of supplying 4,260 cubic feet of air at one ounce pressure when running at 822 revolutions per minute and one and one-half ounces when running at 1,010 revolutions. The fifty-inch fan will supply 3,690 cubic feet at one ounce pressure at 660 revolutions, and one and one-half ounces at 808 revolutions. The four "Monogram" fans can supply 2,110 cubic feet of air at one ounce pressure running at 822 revolutions per minute or at one and one-half ounces when running at 1,030 revolutions per minute. The entire ventilating equipment above described was furnished by the B. F. Sturtevant Company, of Boston.

BOOK REVIEWS.

"A Few Remarks." Simeon Ford. New York. Doubleday, Page & Company, publishers. Price $1.00.

This book is a life-lengthener. It is full of dry humor and quaint philosophy. A delightful vein of sarcasm prevails in all its chapters, thirty-seven in number, each an address delivered as an after-dinner address. Mr. Ford's "Remarks" are a unique and entertaining addition to humorous literature. In them he treats of the automobile and the electric railway, as viewed by the observer on the street and the passenger on the car. The book will be read and enjoyed by many, and we all hope there will be more from the same sprightly, good-humored pen.

"American Street Railway Investments." Published annually by the *Street Railway Journal*. New York. McGraw Publishing Company. Cloth. 9¾ by 13 inches. 350 pages. 25 maps. Supplied by the ELECTRICAL REVIEW at $5.00.

This is the tenth annual volume, and contains reports of 1,361 companies, showing in detail the physical and financial condition of the properties. Of this number nearly 1,300 reports are of an official character, the information being furnished by the railroad companies themselves. The figures include both operating and leased roads, and also data of all new roads. Figures are given for all important consolidations during the year, and a valuable feature is the arranging of the reports of companies by states instead of alphabetically by towns, as heretofore. The volume contains about twenty-five folding maps, some of these in colors, of the most important street railway systems in the United States. A table is given showing by comparison the gross receipts of all companies earning $25,000 or more for the years 1901 and 1902. The report in each case is followed by the date of the information as supplied by the street railway company making the report. It is surprising to those who have had occasion to answer enquiries of this nature, how much a work of this description is appreciated. This volume does for the street railway interests what is absolutely essential for all the other branches of electrical industries. The information is given in a way that can be easily comprehended, the indexing is very complete, and the maps are of great advantage in determining geographical as well as physical conditions. The book is, and ought to be, very popular.

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The National Electrical Contractors' Association Third Annual Convention, Detroit, Mich., July 15, 16 and 17.

THE third annual convention of the National Electrical Contractors' Association of the United States will be held at Detroit, Mich., July 15, 16 and 17. In connection with this exhibits will be made by electrical manufacturers at the Light Guard Armory. A New York Central & Hudson River Railroad special from New York to Detroit will leave New York, Grand Central Station, on Monday evening, July 13, at eight o'clock. Going, tickets will permit stop-over at Buffalo for delegates who may wish to attend the meeting of the United Electrical Contractors' Association of New York State on Tuesday, July 14. The New York state members will go up to Buffalo on July 14, and gathering forces at this point will leave Buffalo over the Michigan Central line at 6.25 P. M., July 14, arriving in Detroit at 12.25 A. M., July 15; or they may go by way of steamer, leaving Buffalo at 5.30 P. M., July 14, arriving in Detroit at 7.30 A. M., July 15.

The National Electrical Contractors' Association of the United States was organized in Buffalo, July 17, 1901, at a meeting called for this purpose by the United Electrical Contractors' Association of New York State.

The electrical contractors have for a long time been a factor in the building business of the country, and as the trade increased in magnitude the necessity of organization became apparent. The association movement was first started by the formation of local associations in the different cities in New York State. In August, 1899, these local associations met and formed the United Electrical Contractors' Association of New York State. This organization proved to be such a benefit to the members, that in 1901 it was decided to issue a call for a meeting of electrical contractors from all parts of the country, to be held in Buffalo in July of that year.

This meeting was largely attended and enthusiastic inauguration of the National Association participated in. Since that time, the organization has grown steadily, and at the present moment has a membership list including contractors from all parts of the country and thoroughly representing the electrical contracting business. In connection with the association, a monthly paper called *The National Electrical Contractor* is issued. This paper is not in any way a technical journal, but is devoted to the interests of the electrical contractor.

The object of the association is to formulate plans for the equitable carrying out of business in every quarter of the country. Much good can be accomplished by the getting together of the men who represent large expenditures of capital and the manipulation of large numbers of laboring men. The accompanying photographs and sketches will give a fair idea of the characteristics of the gentlemen who make up the personnel of this organization.

CHARLES L. EIDLITZ.
President National Electrical Contractors' Association.

Mr. Charles L. Eidlitz, National president, is the son of Marc Eidlitz, who was the founder and first president of the Building Trades' Association. Mr. Eidlitz is thirty-six years old and was born in New York city. He graduated at Columbia University in the class of 1888, and was a member of the famous boat crew of 1885. He has been engaged in electrical engineering and contracting in New York city for the past fourteen years, and several hundred of the more prominent buildings in New York city are equipped with apparatus and material installed by his company. A notable installation which was made by Mr. Eidlitz is the new headquarters of the New York Stock Exchange, which was elaborately described a short time ago in these columns. While Mr. Eidlitz is a phenomenally busy man, he is at all times approachable and has the reputation among his business associates and those who are working for him of being the fairest minded employer in the city. His personality is one which convinces the observer of great forcefulness and at the same time an expression of cordial good will is always evident in his bearing. Mr. Eidlitz is a member of the Electrical Contractors' Association of New York city, the Electrical Contractors' Association of New York State, and is now president of the Building Trades Employers' Association. As the organization of the National Electrical Contractors' Association was largely due to the work of Mr. Eidlitz, he, in conjunction with Mr. E. S. Keefer, issuing the first call for the national body, so he is the leading spirit in the Building Trades Employers' Association. Credit is entirely due to Mr. Eidlitz for the formation of this organization. It was following his speech before a large gathering of building trades employers in New York city that the Building Trades Employers' Association was launched, and he was immediately elected first president. He is a member of the New York Electrical Society; president of the Charles L. Eidlitz Company, electrical engineers and contractors; treasurer of the Metropolitan Switchboard Company, and he is also interested in the Goetz Manufacturing Company. In 1889, Mr. Eidlitz was married to Miss Margretta Ruth Lydon, daughter of one of the prominent contractors of New York city in the earlier days. They have one child, a daughter, thirteen years of age.

Mr. G. M. Jones, of Minneapolis, Minn., is the first vice-president of the association.

Mr. E. T. Cooke, of St. Louis, Mo., second vice-president, is one of the pioneers among the electrical contractors, starting wiring and bell-hanging as far back as 1867.

Mr. H. K. McCay, of Baltimore, Md., third vice-president of the association, is a graduate of the United States Naval Academy of the class of 1884. He resigned immediately from the navy and took up special technical training under Professor Helmholtz, in Berlin, Germany, continuing this work for nearly

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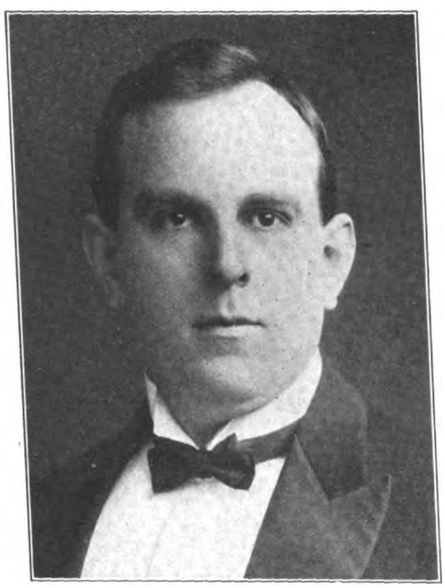
two years. Upon returning to the United States, he immediately joined forces with the Marr Construction Company and assisted in installing many of the present Edison illuminating companies, including the Wilkesbarre, Scranton, New Orleans, Birmingham and many other similar installations. After installing the Birmingham station, he took charge of this station for three years, until it was bought up by a competing company and consolidated therewith. Following this venture, he assumed charge of the Lighting and Street Railway Company, of Amsterdam, N. Y., and operated this company, constructing a large portion of the extensions to track and overhead work of the company.

E. T. Cooke.
Second Vice-President.

In 1890, he founded the McCay Power Engineering Company, which was later absorbed by the McCay Engineering Company. This company has developed into one of the largest constructing companies in the South, installing principally lighting and power plants throughout this territory. One of the largest pieces of engineering was the laying of three submarine cables for the United States Weather Bureau. These cables were successfully laid from Key West, a distance of ten miles, to Sand Key; from the South Farallone Islands, Cal., a distance of twenty-five miles, to Point Reyes; and from Glen Haven, Mich., a distance of eight miles, to South Manitou Island. Mr. McCay personally managed the work of installing all three cables, and has received many congratulations on the successful consummation of this engineering project. The Farallone cable is remarkable, owing to the fact that it is the longest gutta-percha cable ever manufactured and laid in this country.

Mr. George R. Mathieu, of Pittsburg, Pa., treasurer of the association, has served in this capacity since the inauguration of the body. In addition to this, he has been president of the Association of Electrical Contractors in Pittsburg and western Pennsylvania for four years, and when in last July a number of its members dropped out and formed a new body known as the Pittsburg Electrical Contractors' Exchange, he was made president, and also formed the Electrical Contractors' Association of the State of Pennsylvania in 1902, of which association he was made president, and has served that office ever since. Mr. Mathieu has been in the electrical business in Pittsburg for fourteen years, and in that time he has wired some of the largest and finest residences and business houses there. He has also installed the electric work in several of the modern skyscrapers in Pittsburg. Mr. Mathieu is a public spirited man, and is connected with several of the public institutions, and is secretary of the board of directors of the East End Hospital.



George R. Mathieu.
Treasurer.

Mr. Walter H. Morton, of Utica, N. Y., secretary of the association, is a popular figure in this field. He was born in Springfield, Mass., and is the son of Judge James H. Morton and grandson of Governor Marcus Morton. He was educated in the public schools of Springfield, Mass., and afterward took a three years' course at the Gunnery School, Washington, Ct. In 1889, he went to Schenectady, N. Y., and took a student's course in the General Electric Company's works. After completing this course, he had charge of the testing department of the Schenectady works until 1885, when he went to Utica, N. Y., and engaged in the electrical contractors' business with the firm of Nightingale & Johnson, of which he was soon made a partner. In 1897, the firm became Johnson & Morton, and since that time it has done a large contracting and manufacturing business. Mr. Morton was four years secretary of the United Electrical Contractors' Association of New York State, and is still a director in that organization. He has been secretary of the National Association since its formation, and is manager of the *National Electrical Contractor*, a monthly paper devoted to the interest of the electrical contracting trade.

Mr. J. C. Sterns, of Buffalo, N. Y., sergeant-at-arms of the association, is the senior partner of J. C. Sterns & Company, of Buffalo, N. Y., his partner in business being Mr. Walter Cary. Mr. Sterns was born in 1860, and has been interested in electrical engineering for some twenty-five years. In the year 1890, he entered into copartnership with Mr. F. P. Jones and carried on business under the name of F. P. Jones & Company. In February, 1897, Mr. Sterns dissolved partnership with Mr. Jones, Mr. Sterns and Mr. Cary carrying on the business since that time. The principal specialty of this firm is electric light and power equipment, special attention being given to Niagara Falls power installations. Mr. Sterns has been active in the organization of the Electrical Contractors' Association since its first inception in Buffalo in 1892, when the first Electrical Contractors' Association in the country was formed. Mr. Sterns is at present a di-

W. H. Morton.
Secretary.

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rector in the New York State Contractors' Association, being treasurer of this body.

Mr. Edmond D. McCarthy, of Buffalo,

E. D. McCarthy.
Director from the State of New York.

N. Y., is one of the directors from the state of New York. He is president of the Buffalo Electrical Contractors' Association. Mr. McCarthy started in the electrical contracting business with Little, McDonald & Company, of Buffalo, in 1890, remaining with this company and its successors until March 1, 1898, having filled the positions of superintendent, assistant superintendent and general

James Hilton.
Director from the State of New York.

manager, when he resigned and entered the field of electrical work on his own account with Mr. Eugene J. McCarthy and Mr. Henry R. Ford, under the firm name of McCarthy Brothers & Ford, doing a general electrical manufacturing, engineering and supply business.

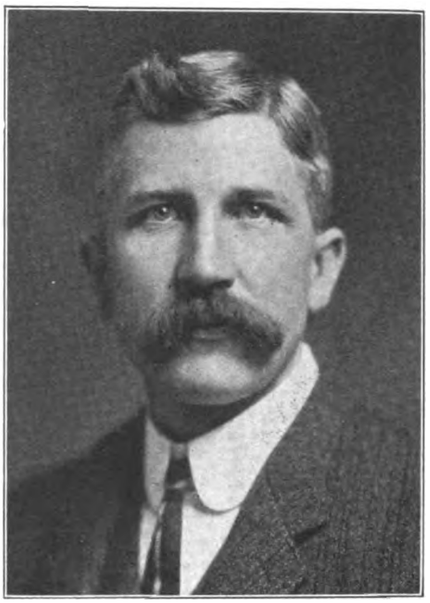
Mr. James Hilton, one of the directors from the state of New York, started in the electrical business with the Thomson & Houston Electric Company at Lynn, Mass., in 1887. In 1890, he left this connection to take charge of the electrical repair department of the Electrical Engineering and Supply Company, of Syracuse, N. Y. In March, 1894, with Mr. F. S. Rogers, he formed the firm of Rogers & Hilton. He is president of the Syracuse Local Association of Electrical Contractors and a director of the State Association ever since it was formed.

Mr. Howard A. Loeb, of Philadelphia, Pa., is the director for the state of Pennsylvania. Mr. Loeb was born in Philadelphia, April 25, 1873, graduating from the University of Pennsylvania with the

H. A. Loeb.
Director from the State of Pennsylvania.

degree of Bachelor of Science in 1893. In 1894, this university gave him the degree of Mechanical Engineer. Since that time he has been a member of the firm of Messrs. Francis Brothers & Jellett, Inc., mechanical and electrical engineers and contractors, with offices at No. 245 North Broad street, Philadelphia, and 47 East Eighteenth street, New York city.

Mr. E. McCleary, of Detroit, Mich., is the director for the state of Michigan. Mr. McCleary is a member of the firm of McCleary & Colquitt Company, Ltd., electrical contractors and dealers, Detroit, Mich. Mr. McCleary is one of the most popular men in the national organization. He not only possesses a thorough training as an electrical engineer, but has a knowledge of the law which has been of inestimable value in all sessions of the directors of the association. He has been actively interested in the national body since its organization, and was early recognized as a leader in the organization. His selection by the nominating committee as next president of the National

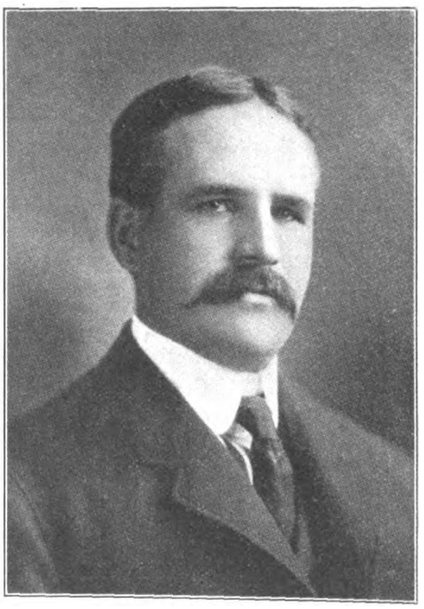


E. McCleary.
Director from the State of Michigan.

Association is in recognition of his great fitness for this position of trust. He is a man of pleasing personality, and his friendship is greatly valued.

Mr. W. I. Gray, of Minneapolis, Minn., is the director for the state of Minnesota. Mr. Gray is a member of the firm of W. I. Gray & Co., engineers and contractors, Minneapolis, Minn.

Mr. John K. How, of Baltimore, Md.,



W. I. Gray.
Director from the State of Minnesota.

is the director for the state of Maryland. Mr. How started in the electrical business in 1882 as an employé of the Edison company for isolated lighting in New

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York city, and was with this company until 1886, when he started as an electrical contractor in Baltimore, Md. He has been engaged in this business since that time in this city. Mr. How was one

JOHN K. HOW.
Director from the State of Maryland.

of the organizers of the Electrical Contractors' Association of the State of Maryland, and has taken an active part in its affairs ever since. When the National Electrical Contractors' Association was formed two years ago, he was chosen a director, which position he has held since that time.

F. E. NEWBERY.
Director from the State of Missouri.

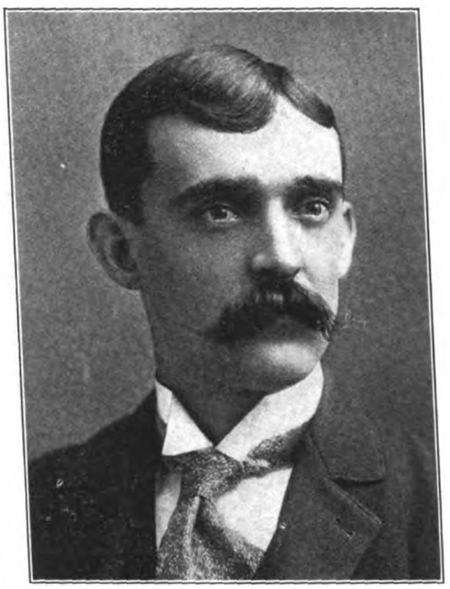
Mr. F. E. Newbery, of St. Louis, Mo., is the director for the state of Missouri. Mr. Newbery is a graduate of the Finsbury Technical College, London, England, and has been engaged in the electrical engineering and contracting business in the United States for the past fifteen years. He has been located in St. Louis, Mo., and has built up a very successful business under the firm name of F. E. Newbery & Company, installing a line of heavy work covering the field of California in the West, Georgia in the Southeast and Texas and New Mexico in the South. The advent of the Louisiana Purchase Exposition has materially increased this firm's business this year, as it has been awarded the permanent work in connection therewith.

Mr. G. N. Sanborn, of Indianapolis, Ind., is the director for the state of Indiana. Mr. Sanborn has been engaged in the electrical contracting business in Indianapolis for the past twelve years.

G. M. SANBORN.
Director from the State of Indiana.

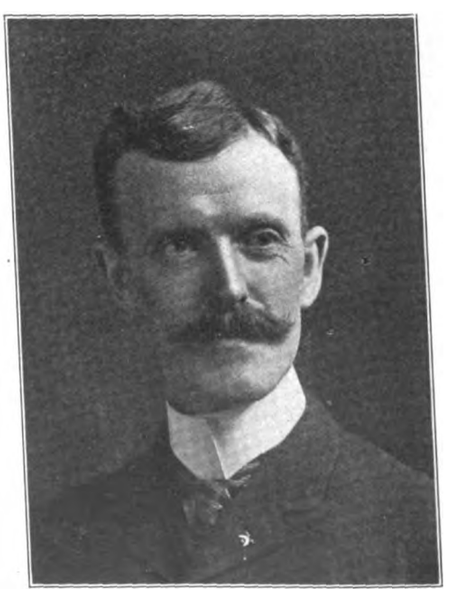
He organized the Sanborn Electric Company, which two years ago consolidated with the Advance Electric Company, incorporating under the firm name of the Sanborn-Marsh Electric Company. Mr. Sanborn is president of this firm. He has taken an active interest in the National Electrical Contractors' Association since its organization, having served on the board of directors and as chairman of the Underwriters' Committee which met with the Underwriters' Electrical Committee in December, in New York. It was under his leadership that this committee was successful in bringing to the attention of the underwriters the importance of cooperation with the contractors. This matter of methods of inspections and underwriters' rules is a specialty with Mr. Sanborn, and his services have been of great value to the electrical industry at large.

Mr. David Marsden Anderson, of Washington, D. C., is the director for Washington, D. C. Mr. Anderson is thirty-seven years old and was born in Fayetteville, N. C., and is a direct descendent of James Matthews, who was a



D. M. ANDERSON.
Director from Washington, D. C.

General of the Revolutionary War and prominent in the early history of the state of Virginia. Mr. Anderson, like many other boys of the South at that time, was by the fate of war denied the advantages of a college education. He preferred the mechanical training, and at an early age entered a railroad loco-



E. M. LAWTON.
Director from the State of Ohio.

motive shop where he learned the first principles of what was to be his life work. His ambition carried him to Richmond, Va., and when the old Sprague company came there to build the electric street

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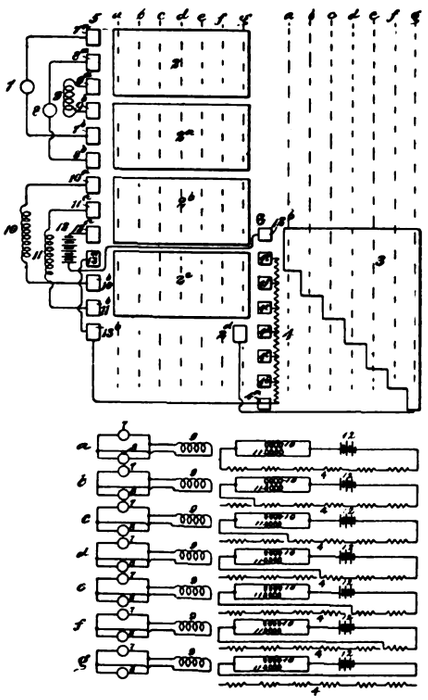
railway he secured a position with it, and by his great application to the business soon rose to positions of importance. The company sent him from Richmond to Ohio as assistant in charge of the construction of a railway to be built there, and later he was sent to other places as superintendent of construction in full charge of all its work. At this time, he was but twenty-two years of age. He was also superintendent of construction of the old Edison General Company at its southern office, and has been identified with the installation of electric railways and lighting plants in the states of New York and Pennsylvania, and throughout the South, as well as in Central and South America. For the past four years Mr. Anderson has been in the electrical contracting business in Washington, D. C., and has taken an active interest in the Electrical Contractors' Association, being among the first to start activity in this line. He was the first from this district to represent the electrical contractors on the National Board of Directors. Mr. Anderson is now the head of the firm of D. M. Anderson, Mariner, Son & Company.

Mr. Ezra Mills Lawton, the director for the state of Ohio, is a native of that state and was born in Ironton in August of 1864. Mr. Lawton is not a college man, but a graduate of public schools, and for some years looked upon the medical profession as his future work. While employed as civil engineer with one of the leading railroad systems, a romantic meeting with his future wife convinced him of the futility of his ambition toward his career as a physician, and it was an easy step from civil engineer to electrical work. For a number of years Mr. Lawton was superintendent of construction of the combined Cincinnati Lighting Companies. He has filled many electrical positions, his first work dating back some seventeen years. He has had great success in telephone engineering, working as operator, lineman and superintendent of exchanges, and has filled places in lighting and power installations from the most humble position to the head of a department. For the past eight years, Mr. Lawton has been actively engaged in contracting, and as president of the Lawton Electric Company is doing a prosperous business in Cincinnati, Ohio.

Electrical Patents.

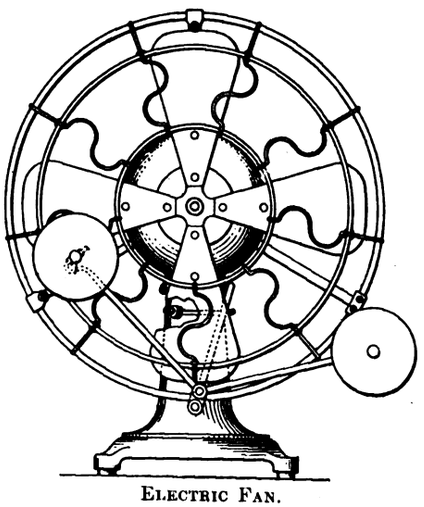
The Westinghouse Electric and Manufacturing Company has obtained control of a patent issued to Mr. Ernest R. Hill, of Wilkinsburg, Pa., on a new electric brake. The invention relates to means for braking electrically propelled vehicles, and particularly to such means as utilize the propelling motors to generate current for energizing the magnets of brake-shoes when the current supplied to the motors is cut off and their armatures are propelled by the momentum of the vehicle acquired during the time when the machines were operating as motors or by the momentum due to the grade of the track. In the operation of electric or electromagnetic brakes, as heretofore generally practised, the field magnet and armature windings of the motors are connected in a closed circuit with a considerable amount of external resistance when the main line current is cut off, so that the motors then act as series-wound generators to supply



ELECTRIC BRAKE.

energy to the brake magnets. In the use of the motors in this manner, since all of the current generated must pass through the field-magnet windings, these windings become heated to a high temperature. The magnetic density of the armature cores is also raised to a high point by reason of the large current in the field-magnet coils, and the resulting iron losses cause a high armature temperature. Furthermore, the large amount of external resistance necessarily included in the circuit at the beginning of the braking operation is such that the brakes do not act as quickly as is sometimes desired, since the energizing current for the brake magnets is cut down to a very small amount by such resistance. In order to obviate these objectionable features, Mr. Hill proposes to connect the field magnets and armatures of the motors in separate circuits for braking purposes and to energize the field magnets by current from a separate source of current, preferably a battery of the secondary type. With this proposed arrangement there need be, and preferably will be, no external resistance in the armature circuits, the variable resistance or other means for varying the field magnet excitation, and consequently the braking effect, being all included in the field magnet circuits. A further feature incident to the invention resides in the fact that an independent source of current for the field magnets ensures a certain amount of braking action under conditions that would preclude such action if the energizing current were derived from the armatures.

Another improvement in oscillatory buzz fans has been invented and patented by Mr. Charles A. Eck, of Belleville, N. J. A suitable base is employed having a standard provided with a vertical socket in which is journaled by means of ball bearings a vertical spindle. This spindle carries at its upper end the usual motor and fan, the latter being surrounded by an ordinary wire guard. Secured to the bottom of this guard is a fixed sleeve in which is journaled a rock shaft. The outer end of the rock shaft carries a pair of divergent arms having hook-shaped terminals. Upon these terminals are adjustably mounted vanes which are adapted to swing into and out of the current of air from the fan and on opposite sides of the centre of the same when the rock shaft is swung. The inner end of the rock shaft is provided with an upstanding finger located between the rear of the fan and the standard of the base. Upon this standard are adjustably attached two outstanding stops located in the path of movement of the finger. The vanes are so arranged that when one is in the path of the current of air produced by the fan, the other is out of such path, and consequently the force of the air coming from the fan will tend to move the vane out-



ELECTRIC FAN.

wardly. As already stated, this vane is on one side of the centre of the fan, and, as a result, the fan will be swung upon its vertical axis. As soon as the upstanding finger at the inner end of the rock shaft comes into contact with one of the stops of the standard, the rock shaft will be swung, thus bringing the opposite vane into the current of air, while moving the first-mentioned fan out of such current. The movement of the fan is thus reversed. The speed of oscillation can be varied as desired by inclining the vanes to any extent.

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Electrical Notes from Europe.

From Our Special Correspondent.

THE southern section of the Paris Metropolitan is now in construction and is making rapid progress. This new portion makes a semi-circular turn through the southern districts of the city, on the same general plan as the north section, which has been previously described, and is now practically finished. The two lines will make practically a circle and when completed will form a continuous belt line around the city. The old Metropolitan, which runs east and west and parallel to the Seine, will bisect the circle, and at the two points of junction will be two important stations, one in the eastern and the second part of the city. The western station has already been completed, under the Place de l'Etoile, as from this point a short section of the new southern line was constructed as far as the Seine shortly after the old Metropolitan, and now terminates at the underground station of the Trocadero. The new line which is now in construction starts from this point and runs underground for a short distance. It then comes out near the river bank and will cross the Seine on a specially designed bridge not far from the Eiffel Tower. After leaving the bridge the line continues upon an overhead structure which is erected in the middle of the principal boulevards and is supported upon iron columns. After passing over the low-lying districts near the Seine it then runs in an underground section which continues for some distance, and then comes out upon a second overhead portion which is about half as long as the first, which was needed owing to a depression in the ground at this point. The length of the viaduct over the Seine valley is 8,278 feet, while the second overhead part is 2,818 feet long, making the total length of the overhead structure 11,096 feet, which is more than one-third of the entire line which is about five and a half miles long. The trusses have been mounted as low as possible, with a minimum of seventeen feet above the ground, this height being sufficient to allow the double-decked cars to pass. Most of the spans are from sixty-five to eighty feet long, but in a few cases the length of the span reaches 145 feet. There will be fifteen stations over the whole section, which, added to the three which already exist on the Etoile-Trocadero part, make eighteen stations in all over the total length of five and one-half miles. At the terminus of the section at the Place d'Italie (from which a branch is to join on to the old Metropolitan) there will be two underground stations side by side. One of these belongs to the present line and the other is the main terminus of a new line which is to be constructed later. The passengers can pass from one station to the other to change cars. The station of the present line will be of the usual type, with a platform thirteen feet wide on each side of the track. Of the fifteen stations on the southern line, six will be built overhead on the viaduct part, and here the construction is somewhat widened to form the station platforms, and the outer parts are supported on masonry columns somewhat as in the northern section. The other stations will be nearly at the ground level, as they are placed at the points where the line passes from the overhead part into the tunnel. This is carried out on an easy grade and the cutting which leads to the tunnel will be partly roofed over on a level with the street. The new bridge which will be erected to carry the road over the Seine will be of considerable size. The contract for this work has been lately awarded to Daydé & Pillé, a large construction firm. As there is a small island in the middle of the river, the bridge will be built in two parts. From the underground section trusses of 280 feet total length will lead to the bridge proper, which has a central span of 170 feet with a ninety-eight-foot span at each end, or 376 feet in all. The length of the second part is about 300 feet. The first level of the bridge will be used for ordinary traffic, while the Metropolitan tracks will be carried upon an upper structure supported from the first platform by iron columns.

A new method of measuring the frequency of alternating currents has been devised by M. Pierre Wyss, of Paris. For this purpose he uses a vibrating cord which can be stretched at varying tensions and brought into resonance with the current. The cord is an iron wire which is stretched upon a suitable support. At the middle point of the wire is mounted a small electromagnet carrying the current whose frequency is to be measured. The cord is fixed at one end, while the free end is attached to one arm of a right-angled lever. The second arm of the lever has a spring attached to it and by varying the tension of the spring the wire can be stretched more or less tightly over the board. To a point near the spring is fixed a needle, which is mounted so as to move over a graduated dial as the tension of the spring is increased; the dial is graduated in frequencies. On turning the wire so that it has double the number of vibrations of the alternating current it comes into resonance with the latter and the magnet has a more powerful action upon it, causing a great increase in the amplitude of vibration. This produces a visible effect and the moment at which the cord comes into resonance with the current is easily observed and the point of the dial corresponding to the frequency is noted. This forms a very simple device and it works very well in practice. With one of these instruments which reads from forty to sixty cycles the frequency can be easily determined within one-tenth of a cycle.

An electric railway system of some interest is shortly to be constructed in the south of France, in the Pyrenees region, and as it traverses a mountainous district its construction will present some special features. The road will be built in two lines. The first of these will start from the branch of the southern railway system which leads from the Mediterranean coast as far west as Villefranche, and will run from this point for a distance of thirty miles, ending at the Spanish frontier. The electric road will make a steep climb for the first eighteen miles as the difference of level is 3,900 feet over this distance. The second electric line will start from Axat, which is the terminus of another railroad branch somewhat further north, and will run directly south through the valley of the Aude, joining on to the first line at Mont Louis. This road will be about twenty-five miles long, with a climb of 4,000 feet from Axat to Mont Louis. From the latter point the two lines continue together to the frontier, and it is proposed to make connection from this point with the main railroad line which runs to Barcelona. The new roads will traverse a mountainous district of considerable interest, and will prove of great benefit to the inhabitants of the region as well as to the numerous tourists which frequent this picturesque locality. The character of the country over which the road passes will make it necessary to construct a great number of tunnels and viaducts and the

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road will contain many short curves and steep grades. Besides the passenger cars it is proposed to run freight trains which will carry heavy loads of ore as well as granite and marble and other products of the region, also heavy forest timber. To supply power for the road several large hydraulic plants are to be built which will employ different mountain streams of the Pyrenees region. This enterprise is to be one of the most important in southern France.

The municipality of St. Petersburg is shortly to transform the sixty miles of lines which it controls from animal to electric traction. The trolley system is to be used, both on the city and suburban lines. Within the city limits the road-bed is to be constructed of armed beton, using Phenix rails, but in the suburbs wood ties will be used, with Vignole rails. The power for the electric system will be furnished from a large plant which is already used for the lighting system. A substation is to be erected in the Alexander Gardens, where the alternating current supplied from the central station will be transformed to continuous current by a set of rotary converters with their transformers. Later on it is expected to erect a number of other substations. The new system will start with fifty-five cars, divided into first and second-class compartments. These cars, which will contain fifty-two places in all, will have a central platform with one of the compartments at either end.

Electric traction on main railroad lines is now occupying considerable attention in Italy, and some interesting work is to be expected in this direction. The Minister of Public Works is now making plans for running electric trains over the existing tracks between Rome and Naples, as well as for constructing a new road between the two cities especially for electric traction. On the other hand, the Mediterranean Railroad Company is shortly to introduce the electric system on some of its lines. The first step will be to transform the Rome-Albano-Nettuni and four other branches which have a total length of 200 miles. It is estimated that 14,000 horse-power will be needed for this extensive system. The two lines from Rome to Naples will no doubt take 20,000 horse-power, while if electric traction is applied on the Roccasecca-Arenza branch, as proposed, 17,000 horse-power will be needed for the latter. The whole system will thus take no less than 54,000 horse-power, which is to be supplied from a number of hydraulic plants to be constructed for the purpose. The Valtellina electric railroad is now in successful operation and an order has lately been given to the Ganz Company for three new electric locomotives of fifty-five tons each, which will be used either for passenger or freight trains. The locomotives will be mounted on four axles with a motor on each axle, and will be the heaviest which have yet been built in Europe. They are to draw the passenger trains at a speed of forty miles an hour and the freight trains at twenty miles. Another important project in Italy is that which is to be carried out by the Oerlikon Company, which is to erect a large hydraulic station for light and power distribution to Brescia and the different industrial plants in the neighborhood, which are especially engaged in electrochemical work and use a large amount of power. One of the remarkable features of this plant is that the distribution is to be made at 40,000 volts, which is the highest tension that has been yet employed in the country. The Caffaro River, which is a tributary of the Chiesa and has its origin in the Tyrolian Alps, will furnish the power. Two plants are to be erected near each other on this stream, and together they will take about 12,000 horse-power. The first of these plants is now being constructed at Bageline and is to use 7,500 horse-power with a seventy-five-foot head of water. The canal leading the water from the river to the station will be 13,500 feet long, of which three sections or 7,000 feet will be laid in tunnel. The station will contain turbines of 2,000 horse-power which drive three-phase alternators, giving 9,000 volts at forty-two cycles. A series of step-up transformers will raise the tension from 9,000 to 40,000 volts for the line. Venice is also to be supplied with a light and power system from a hydraulic plant which will be erected in the neighborhood. A large company has recently been formed for this purpose and it has already obtained the concession from the municipality. The power of the Cellina River is to be used and a generating station is to be erected at a point near Varci within the next two years.

One of the new Swiss electric plants is that of Vouvrier, which is erected on the bank of the Rhone a few miles from the point where it leaves the Lake of Geneva. The hydraulic power which is thus obtained is 3,000 horse-power, on an average, which is furnished by a head of water of 2,700 feet. The plant takes the water directly from the lake by a natural fissure which affords a flow of sixty gallons per second. The water is brought from there to the station by a canal 1.2 miles long. To the end of the canal is joined a steel penstock 1.7 feet in diameter which is laid underground. The penstock, which is 2,080 feet long, ends in a basin from which lead two branch conduits of smaller diameter; the latter run for 5,850 feet to the station building. The turbines and alternators are installed on the upper floor, leaving the lower for the water system. The station contains two alternators of the Brown-Boveri pattern which are driven by 500-horse-power turbines. The latter have been furnished by the Piedboeuf firm of Düsseldorf. The exciters of these machines are mounted on the same shaft opposite the turbines. Two other alternators of the Thury pattern, which are of the monophase type, giving 6,000 volts at fifty cycles, are driven at 1,000 revolutions per minute by 500-horse-power turbines built at the Vevey works. The Thury alternators are excited by two small direct-current turbine groups of twenty-five horse-power. This plant can be run in parallel with a second station in the same region at Vuargny, which is operated by the same company, and the two plants are used to distribute light and power in the surrounding districts.

C. L. DURAND.

Paris, June 27.

Electric Process of Making Castings.

C. A. Keller, of Paris, has patented in France and England a process for the electric heating and refining of metals and other substances. An auxiliary feed chamber is employed in connection with electric or other smelting furnaces, which takes the form of a tapping ladle mounted on a movable truck. This can be moved close to each furnace of a battery, in order to receive the metal tapped from it. It is then passed under a group or groups of vertical electrodes, which are plunged into the fused material coming from the furnace. This material is thus placed in the electric circuit and maintained at the requisite temperature for mixing and refining in the auxiliary refining chamber, and for subsequent casting into moulds. The electrodes are arranged vertically and in groups comprising two or more positive and negative electrodes, so that one electrode can be easily replaced without the necessity of stopping the operation. Another arrangement consists of a cupola, the front basin of which replaces the ladle, and receives the fused material. Vertical electrodes dip into the material, and maintain it at a temperature required for refining the cast and transforming it directly into steel.

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INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Electricity in Mining.

In both coal and metallic ore mining electric power is being successfully applied to hoisting, hauling, drilling, cutting, ventilating, pumping and lighting. Unequaled ease of control in the operation of machinery, the great flexibility of electric circuits, and the facility with which the mining machinery may be carried into inconvenient places make the use of electricity of great practical advantage. From time to time there have been brought to the attention of engineers the alleged dangers which arise from electric current when used in deep levels in mining, but the great development which has been made in recent years has, without doubt, overcome many, if not all, of these difficulties. There are many instances of operation in present-day mining, where work would have to be abandoned entirely were recourse only to be had to the older forms of mining machinery. With the ability to carry the electric conductor into the deepest recess of the bottommost level, and with the high quality of insulation which is now possible, the electric motor can be made use of in hundreds of practical ways. Not only is the electric motor useful for working the cutting machines, driving the ventilating fans and operating the pumping machinery, but it also has a valuable application in connection with hoisting machinery for haulage and where conditions make it possible for operating locomotives carrying the coal bunkers from the headings to the shaft entrances, or the openings of the pits.

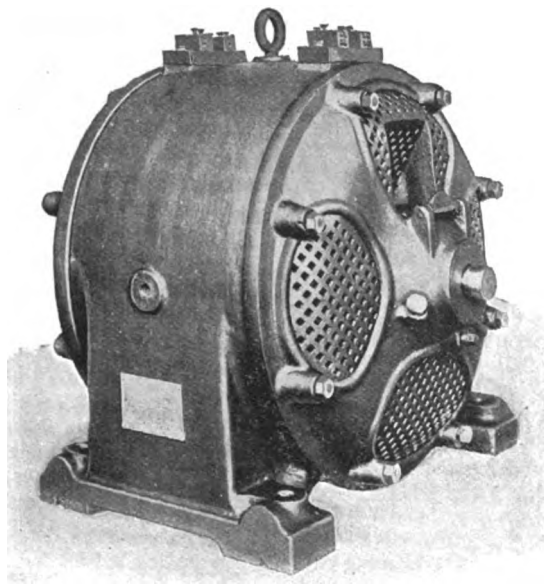

FIG. 1.—TWENTY-HORSE-POWER INDUCTION MOTOR.

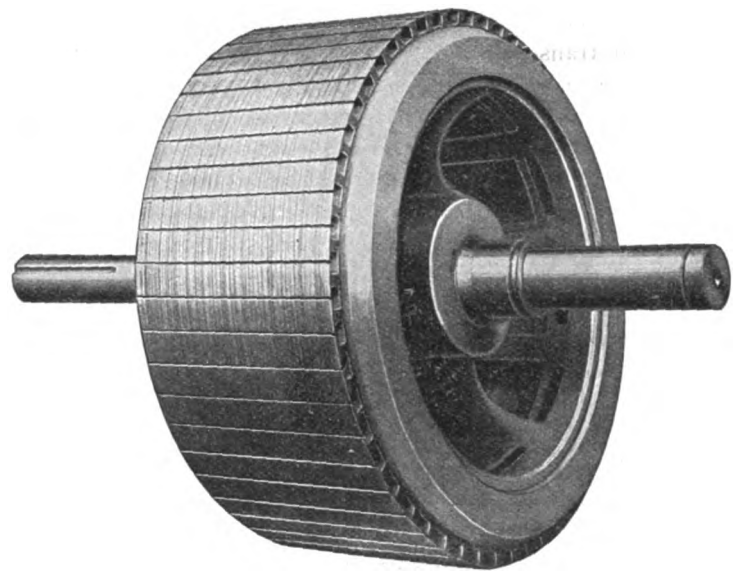

FIG. 2.—ROTATING PART OR SECONDARY OF INDUCTION MOTOR.

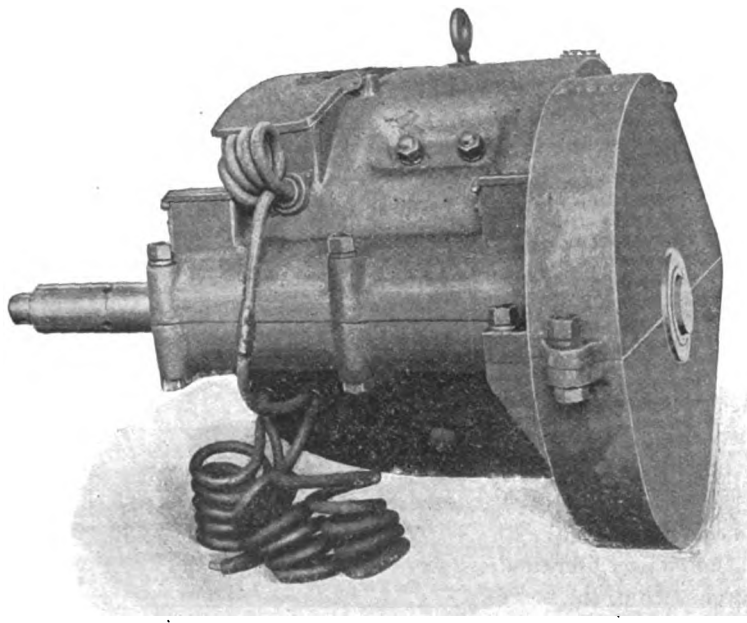

FIG. 3.—DIRECT-CURRENT SERIES-WOUND MINING MOTOR, WITH SINGLE REDUCTION GEAR.

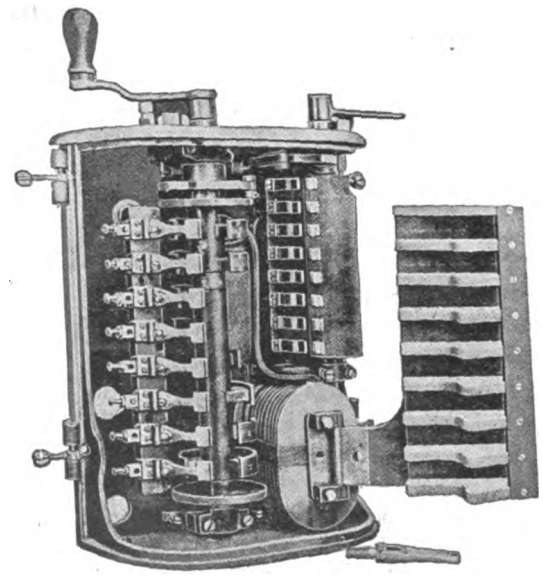

FIG. 4.—CONTROLLER.

The Westinghouse Electric and Manufacturing Company, Pittsburg, Pa., has developed a line of apparatus which is

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especially adapted for mining purposes. This apparatus is the result of years of concentration and specializing along the lines most needed for such service. While this line is standardized to a considerable degree, the company makes careful investigation of the conditions to be satisfied, and only those types which perform with the greatest efficiency are suggested for installation.

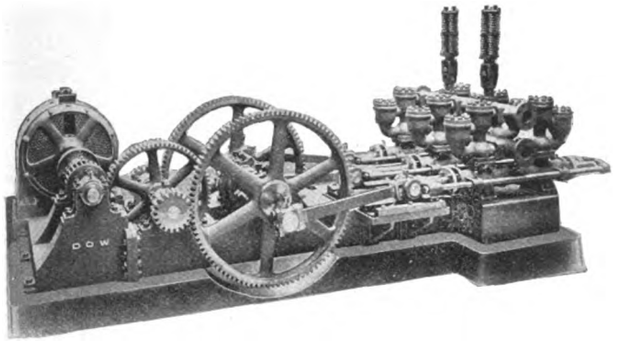

FIG. 5.—DOW TRIPLE AND DOUBLE PLUNGER PUMP, DRIVEN BY INDUCTION MOTOR.

The accompanying illustrations show some of the apparatus which the Westinghouse company has now on the market, which is especially adapted for use in mining installations. Fig. 1 shows a twenty-horse-power Westinghouse type C induction motor, Fig. 2 showing the rotating part or secondary. This motor has neither commutator nor brushes nor any other moving contacts. The winding consists simply of copper bars bolted at their ends to brass rings.

The stationary part of this machine is permanently connected to the main circuits, and the rotating part has no electrical connection with any external circuit, or, in fact, any contact or adjustments except the friction of the shaft in the bearings. The standard motors for 200 horse-power and smaller sizes are provided with a hollow cylindrical frame of cast iron, in which the primary is mounted. This frame forms a base for the machine, and also supports the two end brackets carrying the self-oiling bearings. The housing entirely encloses the primary and secondary elements, and protects them from any external damage.

The primary element consists of a hollow cylinder built up of laminated rings of sheet steel, slotted on the inside to receive the conductors. The rings are rigidly supported by the cast-iron housing that encloses the primary and forms the frame of the motor. The conductors are usually machine-wound coils of wire that are thoroughly insulated before being placed in the slots of the primary iron core. Instead of wire, in some of the larger motors a copper strap, bent to the proper form, is used for the coils.

The secondary, which is shown in Fig. 2, is built up of laminated discs made of a high grade of steel, mounted upon a spider, and carries the rectangular copper bars of the winding in partially closed slots around its periphery. This construction is practically indestructible by heating, and obviates any possible displacement of conductors or any accidental short-circuit.

Fig. 3 shows the Westinghouse direct-current series-wound mining motor, with a single reduction gear and gear case. These motors are most suitable for hoisting work, and the series motor has great practical value where a very high starting torque is desirable, but where close speed regulation is not required. Where there is any possibility that the motor might race, the compound-wound motor is used. The compound-wound motor has the high starting torque of the series motor, and, like the shunt motor, will not exceed a certain speed when the load is thrown off. Suitable controllers are supplied with these machines, consisting of an iron box containing resistance, a commutator composed of a number of contact blocks, each of which is connected to the resistance at suitable points, and a set of brushes mounted on a rocker-arm. The direction of rotation of the motor depends upon the direction in which the controller handle is moved from the neutral point. A typical controller is shown in Fig. 4. Fig. 5 shows a Dow triple and double plunger pump, four inches by six inches, driven by an induction motor.

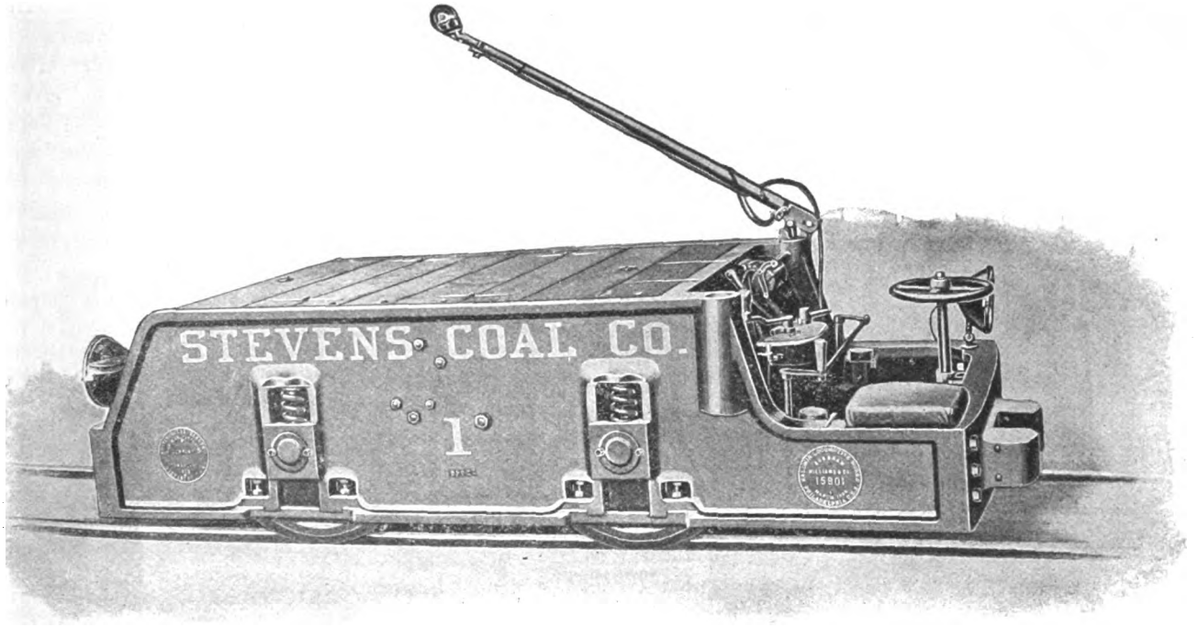

FIG. 6.—BALDWIN-WESTINGHOUSE MINING LOCOMOTIVE.

Fig. 6 shows the Baldwin-Westinghouse electric mining locomotive. Elec-

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tric locomotives for mining service are divided into two classes—locomotives for surface haulage and for underground mine haulage. The use of these locomotives for mining purposes has passed the experimental period, and some of the largest mines in the country have been equipped with them. The amount of saving effected by the use of the electric locomotive for mine haulage in place of mules or other means of haulage will, of course, vary with the conditions that exist in each particular case. The cost of attendance is the chief item in which economy is found over the other methods of haulage, the cost of fuel, etc., being fairly comparable to that of feed, and a similar relation holding in depreciation charges. The saving in the item of attendance, however, has been found to be so great as to amount to a thirty per cent dividend upon the cost of electric installation.

The compactness of the electric locomotive makes it adaptable to low and narrow entries. There are no moving parts exposed to external injuries, the mechanism is of the simplest character, the running parts are readily accessible, and the cost of maintenance is brought to a minimum.

A valuable feature of the electric locomotive for mine service is that, while there is a variety of power service demanded in the mine, the power for operating the electric locomotive may conviently be furnished from the same electric generating plant that supplies current for lighting the mine, and the same is true equally of the pumping, ventilating, hosting, drilling and other work. At the same time, the electric system affords a simpler method of power distribution.

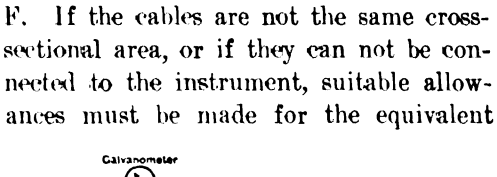
The standard type of locomotive frame consists of heavy cast-iron side and end-pieces, securely bolted together, and kept square by machine joints and shoulders, accurately fitted. Interchangeability of all parts is effected. The pedestal caps are forgings made to templet, and are fitted so as to relieve the frame from breaking strains in case of severe shocks. The driving-wheels and axles, bearings, brake equipment, operating platform, spring supports and accessories, in the way of levers and mechanical fittings, are all of the most substantial character, and designed to correspond with the highest type of locomotive building.

The locomotive is driven by two motors, separately spring-supported, one geared to each axle by single reduction gearing, the gears being enclosed in neat casings. The motors are designed especially for mine service, and are of the four-pole steel-clad enclosed railway type. The armature is of the ironclad type, the coils being held in slots below the surface, and secured from displacement as in the most improved railway service.

The current controller or starting device is of the latest type, with magnetic blow-out to prevent arcing at the contacts. It is provided with various speed changes, and is operated by handles for starting and reversing.

Fault Detector.

A simple portable instrument for the localization of faults on electric light and power mains is based on Mr. F. C. Raphael's principle, and gives a direct reading of the distance of the fault from the station by a simple balancing test. The test is independent of the resistance of the cables and by its means a fault of high resistance may be localized, as well as a dead earth or short-circuit. The connections for this instrument are shown in the diagram. The faulty cable is connected to terminal F, and a sound one, used to complete the loop, is connected to the terminal L. A sliding key S is set to indicate the length of the cable loop. Then the portable key P is shifted until a point is obtained where by pressing the galvanometer key K no deflection is obtained. The reading of the key P indicates the distance of the fault from the terminal F. If the cables are not the same cross-sectional area, or if they can not be connected to the instrument, suitable allowances must be made for the equivalent



Circuit of Fault Detector.

lengths of the cables. This instrument is being manufactured by Messrs. Nalder Brothers & Company, of Queen Anne's Gate, S. W., London.

Heating and Ventilating Telephone Exchanges.

The New England Telephone and Telegraph Company, of Boston, Mass., has given a great deal of attention to the heating and ventilating of its exchange. The ventilation is especially important, and arrangements are provided by which it can be maintained constant in volume independently of the amount of heat required or the state of the weather.

In the present plant, the fan, which is direct-connected to a vertical engine, forces the air through a steam heater composed of pipe coils, enclosed within a steel-plate housing. The heater, however, is by-passed, so that a greater or less proportion of the air may be forced into the distributing pipes without passing through it, and this by-pass is fitted with a special hot and cold damper arrangement which is automatically controlled by Johnson thermostats located in the several rooms of the building. The B. F. Sturtevant Company, Boston, Mass., by whom the fan and heater were installed, also supplied the galvanized iron piping elbows, fittings, registers and screens, together with the direct steam-heating work, automatic control and the boiler and boiler setting. The steam is delivered to the engine at twenty-five pounds pressure, and the exhaust passes into the heater.

A somewhat similar equipment was furnished by the above company to the Twin City Telephone Company, of St. Paul, Minn., some time ago. In this case special precaution was taken to purify the air supply. It has been stated that about ninety per cent of the trouble caused by imperfect contact in the switchboard connections can be prevented by thoroughly cleansing the air as it enters the building. Many experiments have been tried in the way of dry-cleaning by filtering through screens of wire and cheese-cloth or cotton-batting.

The action of the air-purifying and cooling apparatus adopted by the Twin City Telephone Company consists in thoroughly saturating the air with water by passing it through a fine spray and afterward precipitating the moisture with the collected impurities and discharging it into the sewer. The water which is taken up at high velocity and held in mechanical suspension is extracted by centrifugal force by passing it through a series of tubes in which spirals are so placed as to give the air a whirling motion, causing the suspended particles, which are heavier than the air, to be thrown outward and brought in contact with the tubes, from which they flow through perforations to a drip-pan below.

The washing process imparts about seventy per cent humidity at a temperature of seventy degrees Fahrenheit in the operating room. This is considered the most desirable for health and comfort and avoids the excessive dryness resulting with other systems of heating and ventilating which often require a humidostat to correct the defect. Moreover, in the summer time, with the temperature outside of eighty degrees Fahrenheit and with the normal temperature of the city water, the air delivered to the rooms can be readily reduced to seventy degrees.

The air after being tempered, washed and dried is blown by the fan through the reheating coils into the tempered air-chamber. A mixing damper is placed with connections to both, so arranged that the hot or tempered air, under the control of the Power's thermostat in the operating room, is mixed automatically to the proper degree, maintaining throughout the year a constant temperature in the room with uniform air delivery and humidity.

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Some New Telephone Specialties.

The accompanying illustrations show a number of telephone specialties which have been developed by the De Veau Telephone Manufacturing Company, of 27 Rose street, New York city. Figs. 1 and 2 show the De Veau push-button telephone. This resembles the ordinary push-button, and can be used as such, but is still a complete telephone instrument, and may be used for intercommunicating,

FIG. 1.—PUSH-BUTTON TELEPHONE.

FIG. 3.—SIDE VIEW.

switchboard or straight line work. The instruments are equipped with double-pole receiver and long-distance transmitter. All springs are of phosphor-bronze, have a long leverage, and are not turned at short angles. The base of the instrument is of composition, and the metal parts can be finished to match the hardware. The instrument is simple, compact and reliable.

These push-button telephones are so constructed that they can be used in intercommunicating, switchboard or straight line work, without making any changes in the connections. Complete wiring diagrams, showing connections for all the systems, are furnished with each instrument.

Fig. 2 shows the same type of telephone as Fig. 1, with the addition of an intercommunicating plug block. This arrangement has many advantageous features. The plug sets into a metal head, ensuring a perfect contact at all times. It is held by a chain, which ensures the availability of a plug at all times. The plug may be left in any jack, and the station can be called. This makes the instrument automatic, as it is not necessary to return to the home station to receive a call. With this type of telephone, together with a twelve-station outfit, six pairs can be talking at one time without interference.

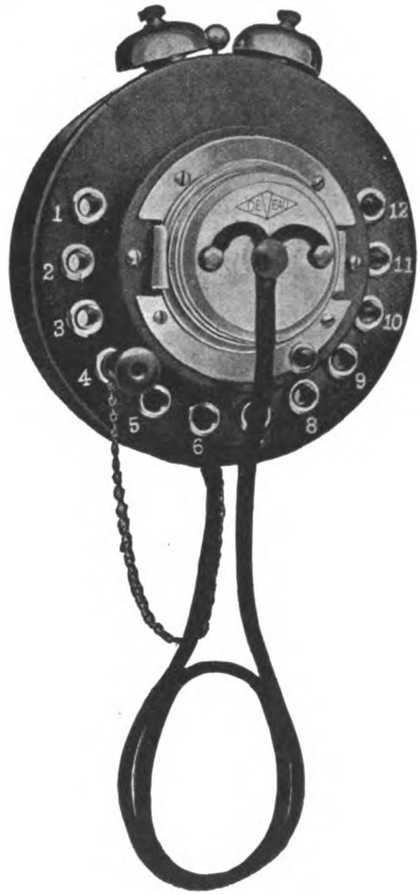

FIG. 2.—PUSH-BUTTON TELEPHONE, WITH PLUG CONTACTS.

Figs. 3 and 4 show the side view and the receiver removed, showing the transmitter. The watch-case receiver is of aluminum, and the push-button is of hard rubber. There has been a prejudice against the button in push-button telephones being placed in the centre of the receiver. This trouble has been obviated by placing the button in the transmitter frame-plate, it having no connection whatever with the transmitter or receiver.

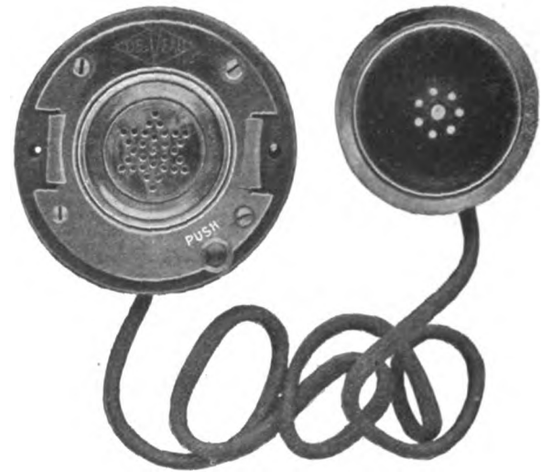

FIG. 4.—RECEIVER REMOVED.

Fig. 5 shows the De Veau patented automatic combination telephone and messenger call box. This is a telegraphic messenger system, only one battery being employed for any number of instruments and circuits. The line is normally open to battery, except when in actual use. The circuits are never open at any time, either

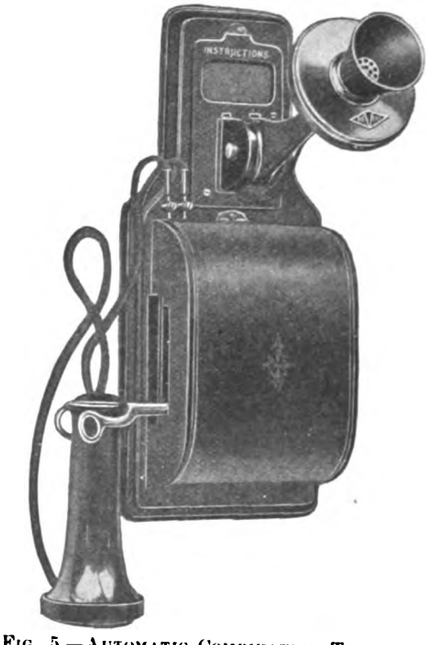

FIG. 5.—AUTOMATIC COMBINATION TELEPHONE AND MESSENGER CALL.

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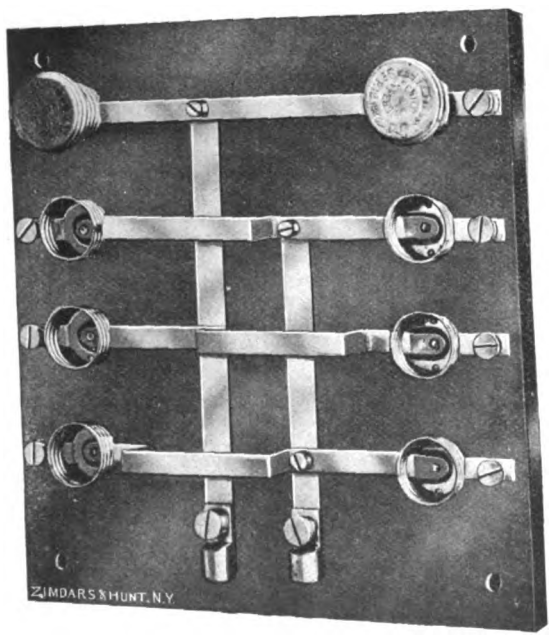
in conversation or in signaling. Signaling central office is accomplished by adding a ground. To make any desired call, by adjusting the teeth contacts, in and out of path movements of the inner arm contacts, designate any desired number that is necessary. The number of instruments on a line is not limited. When the instrument is hanging normal it is shunted out of circuit. It is noiseless, wheelless and springless. No contact springs or wheels are in the circuit. Subscribers can not converse with each other over this system, as no battery is on the circuit until "central" plugs in and gives it. An open wire does not affect the instrument in signaling over the line. If a "central" and a subscriber are talking, and a second subscriber comes in on the line, the signal is unheard by the first subscriber, but it is received by "central."

The valve in this instrument can be so adjusted that the call will be registered in the central office by the time the subscriber gets the telephone receiver to his ear.

A New Zimdars & Hunt Panel-Board.

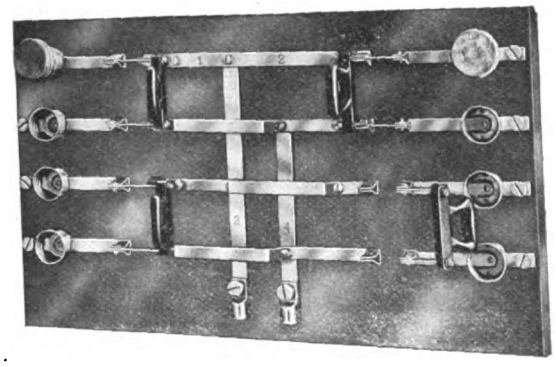
Zimdars & Hunt, of 127 Fifth avenue, New York, have just added to their line



NEW TYPE PANEL-BOARD.

a new type of panel-board which it is believed will meet with considerable favor. These panel-boards are made to take the common Edison plug, that old standby for protecting low-tension circuits carrying a few amperes. It seems eminently proper that a form of panel-board should be designed to make a more extended use of this device than that heretofore afforded by the common porcelain cutout block, for, of the many devices introduced in the earlier days of electric lighting, it is one of the very few that has not since been altered into unrecognizable form or discarded altogether.

The panel-boards now being introduced



NEW TYPE PANEL-BOARD.

by Zimdars & Hunt, two forms of which are shown in the illustrations, are made in all of the usual forms demanded in panel-boards generally, such as with and without branch or main switches, meter loops, fuse connections in mains, etc., and with two or three-wire mains. These panel-boards in other respects embody the well-known Zimdars & Hunt features to be found in all of this concern's panels.

A New Cable Bracket Frame.

Among the exhibits at the National Light Association convention, held in Chicago recently, was that of C. M. Gest, expert subway contractor of Cincinnati and New York.

Mr. Gest has invented and placed upon the market many valuable specialties for use in conduit construction, one of which,

NEW CABLE BRACKET FRAME.

"the Gest bracket frame," is illustrated herewith. The frame is made of angle iron heavily galvanized. As can be seen, the frame is supplied at top and bottom with anchors which, with the frame itself, are built in the wall, the face of frame being flush with the wall, thereby taking up no room in the manhole at all.

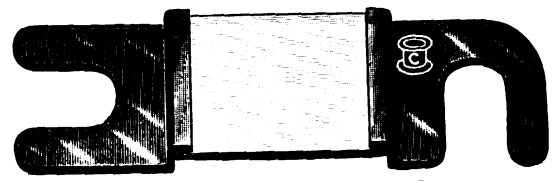
The cable bracket (galvanized cast iron) is secured to the frame by means of a galvanized T head-bolt with a special nut so designed that the bracket is removed by being lifted straight up. By means of the special nut the bracket can be adjusted to any angle, and as the slot in the frame is unobstructed from top to bottom the bracket can be adjusted to any height desired. The frames are made in the following lengths, twelve inches, twenty-four inches, thirty inches, thirty-six inches, forty-two inches, and the brackets are made in three sizes, single, double and triple. Longer frames than the above are made to special order.

The bracket bolts are removable at any time and very little time is required to change from a single bracket to a double or triple type.

All parts being heavily galvanized they will last as long as the conduit system itself.

Terminal for Copper-Tipped Fuse Links.

The Chicago Fuse Wire and Manufacturing Company, of Chicago, New York and Buffalo, has recently been granted a patent, No. 730,906, covering an improved terminal for copper-tipped fuse links. One form of this device is



TERMINAL FOR COPPER-TIPPED FUSE LINKS.

shown in the illustration herewith, this fuse being specially adapted for use in main cutouts and for dynamo fuses.

The manufacturer claims as special features a strong and reliable connection between the fuse and terminal, as the contact surface is very great. Another prominent point is the enhanced appearance of the completed fuse. It is also very compact.

The Chicago Fuse Wire and Manufacturing Company has been using this style of connection for some time, principally in connection with the larger sizes of fuses which are made from strip. The company will be glad to send its latest catalogue No. 14 upon request, showing a full line of its well-known fuse wire, strip, fuse links and telephone supplies.

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CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

BOSTON-WORCESTER TROLLEYS—A new trolley line between Boston and Worcester, Mass., was scheduled for opening on July 1. The first car run over the new street railway was on the occasion of the official tour of inspection, and the railroad commissioners and officials of the road made the trip in a special car on Friday morning, June 26.

ST. LOUIS LIGHT CONSOLIDATION—The Union Electric Light and Power Company, of St. Louis, Mo., is to be a consolidation of the Imperial Electric Light, Heat and Power Company and the Citizens' Electric Lighting and Power Company with the Missouri Edison Electric Company. The company is capitalized at $10,000,000, and is at present erecting a large central power station at a cost of over $2,000,000, with a capacity of $50,000 horse-power. A ten-year contract has just been entered into with the St. Louis Transit Company, to supply the latter with a minimum of 12,000 horse-power.

MANILA ELECTRIC PROJECT—The Manila Electric Railroad and Lighting Corporation, of Hartford, Ct., with an authorized capitalization of $6,000,000, has filed a certificate of incorporation with the Secretary of State. The incorporators are Arthur L. Shipman, Charles W. Gross and Charles A. Goodwin. According to the terms of the charter the purpose of the company is to acquire, construct, equip, own, lease and operate in the city of Manila, Luzon, Philippine Islands, etc., street railroads, lighting, power and ice plants, ferryboats and vessels. The company is authorized to conduct its operations in any of the possessions of the United States, and to have its offices outside of the state of Connecticut.

JOHNSTOWN-CHAMBERSBURG TROLLEY—A movement is under way for the consolidation of all the electric railways and electric lighting plants between Cumberland, Md., and Johnstown, Pa., a distance of seventy-two miles. The entire mileage will be 150, and considerable new construction will have to be done in the way of connections. Among those announced as interested are Thomas T. Boswell, of Baltimore; S. J. Graham, of Cumberland; O. W. Kennedy, general manager of the H. C. Frick Coke Company; L. F. Rutn, Connellsville, Pa.; William Gibson, formerly general superintendent of the Baltimore & Ohio Railroad, and Charles Donnelly, president of the Pittsburg & Terminal Railway. To carry out this consolidation the Johnstown & Cumberland Electric Railway Company has been incorporated in New Jersey.

MEXICAN ELECTRICAL DEVELOPMENTS—American interests are to build another extensive power transmission system in Mexico. A new project is to furnish the cities of Chihuahua and Parral, and mines along the route, with energy for lighting, traction, manufacturing and general power purposes. The Conchos River Power Company will build the plant and operate the system. The power plant is to be located at La Joya, on the Conchos River. The initial equipment will be a 3,200-horse-power plant, although it is expected that 30,000 horse-power will be generated ultimately. Four units of 800 horse-power each will be employed in the present installation. The available head is 125 feet. Chihuahua is eighty miles distant from the power-house site, and Parral is eighty-six miles away. The transmission line will operate at 40,000 volts. The concession was originally granted by the Mexican authorities to R. M. Burke, formerly United States consul stationed in Chihuahua. Mr. Frank H. Wright is at the head of the installing company. Two other important power transmission lines are now under construction in Mexico. These are the Guanajuato Light and Power Company and the Mexico Light and Power Company, Limited. The Guanajuato company is building a large power-house on the Douro River, the power to be transmitted a distance of some 125 miles. The Mexico company will ultimately generate 80,000 horse-power, the power-house to be constructed near Huauchinango, the energy being transmitted to Mexico City, ninety miles distant.

GEORGIA LIGHTING INTERESTS MERGED—It is announced that the entire street and house lighting facilities of Atlanta, Ga., are now under the control of the H. M. Atkinson interests, a merger of the Georgia Railway and Electric Company and the Atlanta Gas Light Company having been effected. The following statement has been issued from the office of Preston S. Arkwright, president of the Georgia Railway and Electric Company: "The parties interested in the Georgia Railway and Electric Company and the Atlanta Gas Light Company have arranged for an exchange of the stock of the companies. By the terms of the exchange the present stockholders of the Atlanta Gas Light Company will become largely interested in the Georgia Railway and Electric Company. They hold at present $600,000 par value preferred stock, and $1,014,625 par value of the common stock of the Atlanta Gas Light Company. They receive in exchange for this a like amount, par value, of the common and preferred stock of the Georgia Railway and Electric Company. There will be no consolidation of the two companies, but they will continue to be operated as separate and independent organizations. By the exchange, however, the ownership of the two companies is common, and they will be brought in closer touch with each other, will be able to purchase their supplies jointly, and by this means it is believed that economies in the operation of each can be effected and higher efficiency and better service accomplished in all departments of both companies. The management of each company will remain the same as it is now."

ELECTRIC LIGHTING.

WINONA, MINN.—An electric light plant will be installed at Spring Grove.

HACKENSACK, N. J.—It is stated that Park Ridge is to have a municipal electric lighting plant, to cost $15,000.

MILWAUKEE, WIS.—The Milwaukee Electric Railway and Light Company has begun active operations on its plant at West Allis.

GRANDVIEW, TEX.—A franchise has been granted to W. B. Head for an electric light plant, which will be put in as soon as possible.

ROCKVILLE, MD.—The town of Rockville has entered into an agreement with Joseph Schreiber, of Baltimore, to light the town with electricity.

WASP, IOWA—At a special election it was decided to install an electric light plant, to be in operation within ninety days. The contract was awarded to J. K. Alline, of Fort Dodge.

MARION, IND.—A company with a capital of $25,000 has been orgainzed at Converse for the purpose of taking over the public utilities of the town, including the electric light and telephone plant.

MACON, GA.—Work is progressing on the dam which is being built on the Oconee, near Milledgeville. The object of this work is to secure power for generating electricity for Macon and other cities and towns in this section. It is expected that 25,000 horse-power will be developed.

OCEAN SPRINGS, LA.—A contract has been entered into with the Biloxi Electric Light and Street Railway Company to light the streets of the town for a period of ten years. The company was granted a twenty-five-year franchise to erect and maintain an electric light system in this city. The system will be in operation in about six months.

TROY, N. Y.—The Edison Electric Light and Power Company, of Amsterdam, has been incorporated with the Secretary of State, the company being the outcome of the merger of the Edison Electric Light and Power Company and the Amsterdam Arc Light Company. The new company proposes to operate in the counties of Montgomery, Fulton, Schenectady, Herkimer, Schoharie and Saratoga. Its principal place of business is to be in Gloversville. The capital stock is $23,000.

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ELECTRIC RAILWAYS.

CINCINNATI, OHIO—The Cincinnati, Milford & Loveland Traction Company has closed a deal whereby it acquires the right of way, privileges and interests of the Cincinati, Milford & Eastern Traction Company.

PHILADELPHIA, PA.—The Bustleton & Byberry Rapid Transit Street Railway Company has been chartered with a capital of $120,000, to build a road twenty miles long between Frankford and Byberry. Building will begin shortly.

LANSING, MICH.—Articles of incorporation of the Jackson, Ann Arbor & Detroit Traction Company, capitalized at $2,500,000, have been filed with the Secretary of State. The company will extend the Boland electric line and operate it.

JANESVILLE, WIS.—The council has granted a franchise to the Janesville Traction Company, which proposes to construct a line from Janesville to Madison, by way of Stoughton and Edgerton. The line is to be completed in three years.

NASHVILLE, TENN.—All the property of the Nashville Railway was sold recently by a special master of the United States Circuit Court. The purchaser was Colonel A. M. Shook, representing the former stockholders, and the price paid was $500,000.

OMAHA, NEB.—Callahan Brothers & Katz have been awarded the contract for building thirty-five miles of electric road from Indianapolis to Rushville, Ind. Tne road will be double-tracked all the way, and will cost in the neighborhood of $1,000,000. Work will begin at once.

LANSING, MICH.—The Grand Rapids & Southern Traction Company, organized with $1,300,000 capital to build an electric road from Battle Creek to Gull Lake, Prairieville, Gun Lake and other places to Grand Rapids, has filed articles of incorporation with the Secretary of State.

ALBANY, N. Y.—The Court of Appeals has sustained the permission granted by the State Railroad Commissioners for a third-rail electric railroad by tne Portchester Electric Railroad, from the Harlem River, through Westchester County to Porchester. The road is to connect with the New York subway.

CINCINNATI, OHIO—The Cincinnati, Lawrenceburg & Aurora Electric Street Railway Company will shortly begin extending its line from Aurora to Rising Sun, Ind., nine and one-half miles. The surveying of the right of way has been finished. The company expects to have cars running by the last of the year.

DES MOINES, IOWA—Articles of incorporation for the Western Iowa Interurban Railway Company, which is to have its principal place of business in Des Moines, were filed recently with the county recorder. The capital stock is placed at $100,000. The company will build a line from Des Moines to Council Bluffs.

TOLEDO, OHIO—The Louisville & New Albany Traction Company has been incorporated with a capital stock of $3,000,000. James W. Dunbar, of New Albany; J. F. Stratton, of Jeffersonville; Samuel Insull, representing R. W. White and other Chicago interests, and J. O. English are directors. The length of the lines will be nearly 200 miles.

AUGUSTA, GA.—Messrs. George E. Coughlin and Frank Wilson are at the head of an enterprise to build an electric line from Anderson to Greenville, a distance of thirty-six miles. It will pass through the towns of Piedmont, Belton, Williamston and Pelzer. Power will be generated from the water power of the Savannah, Tugalo and Saluda rivers. About $1,000,000 will be invested.

KINGSTON, N. Y.—The property and franchises of the New Paltz & Poughkeepsie Traction Company, which operates over the Poughkeepsie Bridge, have been sold at auction under foreclosure of a mortgage by the Franklin Trust Company, of New York, to Charles J. Rowe, a New Jersey lawyer, for $20,000. The mortgage was for $1,000,000. Mr. Rowe is believed to represent the trust company.

ALBANY, N. Y.—The Ithaca-Cortland Traction Company has been incorporated with a capital of $200,000, to operate from Cortland to Ithaca a street surface railroad. The directors are Howard L. Chandler, Ogden Armstrong, F. C. Howell, J. B. Staley and C. T. Leland, of Philadelphia; C. J. Harrington and J. W. Laughran, of New York city; J. P. Archer, of Camden, N. J., and E. H. Chandler, of Atlantic City.

TELEPHONE AND TELEGRAPH.

RICHMOND, VA.—The Salisbury Telephone Company is building a system in Spencer.

OAKLAND, CAL.—It is said that Colton is soon to have a telephone system under city ownership.

CHICAGO, ILL.—The Chicago Telephone Company will build a $25,000 exchange building in Austin.

GREENVILLE, TENN.—A new telephone line will soon be built from Sacteels Mill into Greenville.

INDIANAPOLIS, IND.—The Lynn Local Telephone Company has filed a notice of an increase in capital stock from $8,000 to $15,000.

LEAVENWORTH, KAN.—The Missouri & Kansas City Telephone Company will build a new telephone exchange building in this city.

LITTLE FALLS, N. Y.—A telephone line is to be established from Grant to Gray and thence to Cold Brook, a distance of about fourteen miles.

MUSCATINE, IOWA.—The Madura Telephone Company has filed articles of incorporation. The company will operate in Muscatine and Louisa counties.

MEMPHIS, TENN.—The city council has granted the Cumberland Telephone and Telegraph Company a thirty-year franchise over and under the streets of the city.

HARTFORD, CT.—The Gagnon Selective Telephone Company has been incorporated with a capital of $10,000. Amos Gagnon, Michael F. Brown and Michael Gillicuddy, of Stafford Springs, are the incorporators.

NEW INCORPORATIONS.

PENN YAN, N. Y.—Friend Telephone Company. $5,000.

FITCHVILLE, OHIO—The Clinton Air Telephone Company. $1,000.

SUMPTER, ORE.—Sumpter Light and Water Company. $150,000.

HARRISBURG, PA.—The Pottsgrove Traction Company. $130,000.

TAZEWELL, VA.—Clear Fork Telephone Company. Increased to $4,000.

CANANDAIGUA, N. Y.—People's Telephone Company. Increased to $25,000.

BAY CITY, TEX.—The Bay City Ice, Light and Power Company. $50,000.

DOYLESTOWN, PA.—The Hatboro & Hartsville Street Railway Company. $36,000.

BURLINGTON, IOWA—The Modern Telephone Company. $300,000. Incorporators: W. W. Copeland, H. A. Brown, J. H. Pettibone.

BOZEMAN, MONT.—The People's Electric Light and Power Company. $50,000. Directors: F. L. Benepe, George Flanders and G. L. Hogan.

JEFFERSON CITY, MO.—Cape Girardeau Bell Telephone Company. $20,000. Incorporators: John F. La Peck, Henry L. Rozier and Edgar J. Rozier.

PARKERSBURG, W. VA.—The Southern States Telegraph and Telephone Company. $25,000. Incorporators: H. Tisdale, John Stander, Samuel Trissler and Harry Budd.

RICHMOND, VA.—The Carolina & Henrietta Telephone Company. $10,000. Incorporators: Edward Thompson, R. P. Scruggs, Jr., Thomas P. Rennolis, J. M. Turnley, B. B. Doggett and others.

FRANKLIN, MINN.—Franklin Local and Rural Telephone Company. $3,000. Incorporators: C. W. Parsons, Henry Dittes, A. J. Olin, Daniel Whetstone, R. E. O'Keefe, H. B. Cole, L. H. Kirwin, and others.

CHARLESTON, W. VA.—Salem Terminal Traction Company. $260,000. Incorporators: C. E. Barnes, Pittsburg, Pa.; J. T. McGraw, Grafton; H. B. McKinley, Salem, W. Va.; J. E. Law, Clarksburg; W. T. Henis, of Uniontown, Pa., and others.

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ELECTRICAL SECURITIES.

The hopes that the past week would see a decided rally in market prices were evidently discounted by reason of the holiday spirit which pervaded the exchanges in general. Outside of the apathy which has prevailed for some months, the methods of several large and influential speculative interests have caused a tendency toward conservatism and a leaning to bear operations. The present outlook is more or less clouded, due to the conflicting reports from industrial and agricultural centres. The July crop report will do much to shape and influence buying for the balance of the year. Half-yearly statements from centres of industry will also give a better view of these conditions, and there is every possibility that with the recurrence of high-class statistics the market will continue firm, even if prices are not advanced for some time.

ELECTRICAL SECURITIES FOR THE WEEK ENDING JULY 4.

New York:	*Closing.*
Brooklyn Rapid Transit	58⅜
Consolidated Gas	192½
General Electric	177
Kings County Electric	200
Manhattan Elevated	137
Metropolitan Street Railway	123
New York & New Jersey Telephone	155
Westinghouse Manufacturing Company	190
Philadelphia:	*Closing.*
Electric Company of America	8⅝
Electric Storage Battery common	62
Electric Storage Battery preferred	62
Philadelphia Electric	6
Union Traction	45
United Gas Improvement	88½

Electric Company of America directors have declared the regular semi-annual dividend of thirty cents per share out of the earnings for the six months ending June 30 last. The dividend, which is at the rate of six per cent per annum, is payable July 31 to stockholders of record July 20. Books close July 20 and reopen August 1.

Boston:	*Closing.*
American Telephone and Telegraph	132¾
Edison Electric Illuminating	245
Massachusetts Electric	83¼
New England Telephone	130
Western Telephone & Telegraph preferred	89
Chicago:	*Closing.*
Chicago Telephone	124
Chicago Edison Light	150
Metropolitan Elevated preferred	66
National Carbon common	23
National Carbon preferred	93
Union Traction common	3½
Union Traction preferred	32

Metropolitan Elevated, for the half year ended June 30, has maintained an average gain of ten per cent over the corresponding period of 1902. The daily average for the half year is $114,000, against $103,500 for similar period last year.

PERSONAL MENTION.

PROFESSOR R. B. OWENS has received the degree of Doctor of Science from McGill University, Montreal, Canada.

MR. O. F. CONKLIN, head of the electrical department of the Robbins & Myers Company, of Springfield, Ohio, was a New York visitor last week.

MR. THOMAS M. GOGIN, treasurer and manager of the American Thermo-Call Company, of Boston, Mass., was a visitor to New York city last week.

MR. HENRY W. BROOKS, JR., has resigned as director and treasurer of the McCreary Electric Company, and will hereafter devote his attention to his construction interests.

MR. WILLIAM CURRIE, of the Stanley Electric Manufacturing Company, who for some time has been at the Pittsfield works as Mr. C. C. Chesney's assistant, has been appointed sales engineer of the Chicago office of the company.

MR. TITUS ULKE has recently been transferred from the position of assistant inspector to that of mechanical draftsman of the ordinance department of the Watervliet Arsenal, near Troy, N. Y.

MR. WILLIAM W. DEAN, for many years an engineer with the Kellogg Switchboard and Supply Company, has resigned to accept an appointment as consulting engineer for the Consolidated Fire-Alarm Company, of New York city.

MR. G. A. BOWERS, who recently resigned as master mechanic of the Southern Railway, at Alexandria, Va., has been appointed master mechanic of the Baltimore & Annapolis Short Line and the Washington, Baltimore & Annapolis, at Annapolis, Md.

MR. B. H. SCRANTON, president and general manager of the American Electrical Heater Company, of Detroit, Mich., has been at the Park Avenue Hotel, New York, for ten days, and during his return trip spent a few days at Madison, Ct., his birthplace.

PROFESSOR WILLIAM ESTY has been placed at the head of the electrical engineering department of Lehigh University, Bethlehem, Pa. The department of engineering is now a separate function from that of the department of physics at the university.

MR. J. A. HOLMES, chief of the department of mining and metallurgy of the Louisiana Purchase Exposition, has returned to St. Louis after a prolonged eastern trip, where arrangements have been made by him for a very complete exhibition of iron and steel processes and products.

M. HENRI POINCARE has received the honorary degree of Doctor of Science from the University of Oxford; the honorary degree of Doctor of Laws of the University has been conferred upon His Royal Highness Prince of Wales, Lord Kelvin and Lord Lister, and the honorary degree of D. C. L. of Durham University has been conferred upon Dr. Joseph Larmor.

MR. ALFRED H. SMITH has been appointed general manager of the New York Central & Hudson River Railroad, assuming the new position on July 1. Mr. Smith began his railroad career twenty-five years ago, in the office of the Lake Shore Railroad, in Cleveland, and for two years carried messages for the officers of that company. His rise has been gradual, though steady, and he has been, in turn, brakeman, conductor, telegraph operator, train despatcher, division superintendent and general superintendent. Mr. Smith has for a year and a half been general superintendent under William C. Brown, third vice-president and general manager. Mr. Smith will relieve his chief, Mr. Brown, of a part of his work, which, as a result of combining the four operating departments, has grown considerably since Mr. Brown came from Cleveland in February, 1902.

OBITUARY NOTICES.

MR. J. A. HESSE, of Atlanta, Ga., died suddenly in Boston, Mass., on June 29, while on a business trip to that city. Mr. Hesse has been identified with the commercial side of the electrical industries for many years, and for the past four years has represented the Fort Wayne Electric Works in the South. Mr. Hesse was well known to many of the pioneers in the trade. Announcement of his death will be read with great sorrow by a large acquaintanceship in the field. The funeral was held at Lima, Ohio, Thursday, July 2.

MR. CHARLES C. BARTON died on June 28 at his home, 29 West Twenty-sixth street, New York city. Mr. Barton was born in Rochester in 1840, and was the son of the president of the Barton Tool Company. He was graduated from Rochester University, and at the breaking out of the Civil War joined the Ninety-eighth New York Volunteer Regiment. He won promotion during the war, and served on the staff of General Halleck and General Grant at Vicksburg. Since the war he had devoted himself to invention, chiefly along electrical lines, and had invented several appliances now in general use.

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INDUSTRIAL ITEMS.

THE HART MANUFACTURING COMPANY, Hartford, Ct., has moved into a large new building well equipped for manufacturing purposes. This company makes the celebrated "Diamond H" switches.

THE NATIONAL TELEPHONE SUPPLY COMPANY, Cleveland, Ohio, is manufacturing a new form of cable hanger, which is claimed to be especially adapted for telephone and electric light line service and to be extremely simple and permanent.

THE GLACIER METAL COMPANY, of New York and London, has recently opened an office at Richmond, Va., to facilitate the handling of its increased trade in that locality. "Glacier" metal is a high-grade Babbitt used for high-speed and heavy running machines.

THE NATIONAL WIRE CORPORATION, New Haven, Ct., manufacturer of wire, rods and wire nails, has issued a new bulletin giving special prices on galvanized telegraph and telephone wire and wire strand. This bulletin may be had on request to the company.

THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, Chicago, Ill., and Rochester, N. Y., has recently sold a magneto switchboard to the Deerfield Telephone Company, North Benton, Ohio, and a large number of bridging telephones to the Clinton Telephone Company, Wilmington, Ohio.

THE ELECTRIC APPLIANCE COMPANY, Chicago, Ill., is sending out an illustrated circular descriptive of the new cartridge fuse designated as the McBride "Arkless," for which this company is the selling agent. The fuse is adapted for all classes of work, and is made for 125 and 250 volts, and in capacities from three to thirty amperes.

THE JEFFREY MANUFACTURING COMPANY, Columbus, Ohio, celebrated its eighteenth annual outing on Saturday, June 27, at Olentangy Park, Columbus, Ohio. A number of athletic events were held, valuable prizes being awarded to the winners. After the athletic events, a four-act play was given, which was followed by dancing.

THE C. W. HUNT COMPANY, West New Brighton, Staten Island, N. Y., will be pleased to send its latest catalogue, entitled "Coal-Handling Machinery," to any one interested, upon request. This describes and illustrates coal-handling machinery for power stations, boiler rooms, coaling stations, gas companies, coal yards, shipping docks, manufactories, etc.

THE REYNOLDS ELECTRIC FLASHER MANUFACTURING COMPANY, 225 Fifth avenue, Chicago, Ill., manufacturer of the improved Reynolds electric sign flashers, will be pleased to send on request its pamphlet, "What's a Flasher," which describes in a short, terse manner what these flashers may be used for, and of their business bringing and money saving possibilities.

THE CANADIAN GENERAL ELECTRIC COMPANY, Limited, Toronto, Province of Ontario, Canada, is now representing the Electric Storage Battery Company in the sale of the chloride accumulator and the exide accumulator throughout Canada. All enquiries from Canada, in regard to storage batteries, should be addressed to the Canadian General Electric Company, Limited.

MR. H. T. HOCHHAUSEN has sold his business to the Metropolitan Engineering Company, of which firm he will assume the entire management. The company will be located at 27 Sixth avenue, Brooklyn, N. Y. It will have a splendidly equipped factory for the manufacture of signs of every description. The specialty will be electrical signs and effects. This company will be pleased to correspond with electric light men regarding signs and fixtures.

THE PEERLESS ELECTRIC COMPANY, Warren, Ohio, is about ready to occupy its large, new factory, for the manufacture of power motors and transformers, the motors being a new line with this concern. Mr. H. E. Temple, for the past seven years with the Bullock Electric Manufacturing Company, of Cincinnati, Ohio, becomes general superintendent of the Peerless company's plant.

THE AMERICAN STEEL AND WIRE COMPANY, Chicago, Ill., has recently published a number of interesting bulletins descriptive of its products. These include wire of every description, wire hoops, electrical wires and cables, telegraph and telephone wire, rail bonds, wire rope, nails, staples, spikes and tacks, barbed wire and woven wire fencing, springs, Venetian red and oxides of iron, poultry netting, wire rods, horseshoes, shafting, cold-drawn steel, and plates and sheets.

THE INTERNATIONAL POWER COMPANY, 253 Broadway, New York, operating the George H. Corliss Engine Works, at Providence, R. I., and builders of the Diesel engine, has recently conducted a series of tests on an American engine eleven and one-quarter inches by twenty inches, built in America, and a German engine ten and fifteen-sixteenths inches by sixteen and one-sixteenth inches, built in Germany. These tests showed a large advantage in favor of the American-built engine. The International Power Company will be pleased to answer any correspondence regarding statistics concerning the Diesel engine.

THE ADVANCE THRESHING MACHINE COMPANY, the J. I. Case Threshing Machine Company, the J. I. Case Implement Company, the Bement-Darling Company and the Adland Transfer and Storage Company, five of the prominent implement and machine jobbers of Minneapolis, Minn., whose buildings are located in close proximity, are figuring on the advisability of putting in a joint plant for the purpose of heating, lighting and furnishing power for their buildings. Four of these buildings are each seven stories high and the fifth is five stories high. The J. I. Case Implement Company, 622 and 628 South Third street, Minneapolis, Minn., will have charge of the installation.

THE MICHIGAN CENTRAL (the Niagara Falls Route) has published a handsome booklet descriptive of summer tours to the Thousand Islands, the White Mountains, the Adirondacks, Saratoga, the Berkshires, Poland Springs, the New England coast, New York and the seashore. The reading matter is supplemented by numerous half-tone engravings, depicting typical scenes in different parts of the country traversed by this system. A number of routes and rates are added, the classifications making a quick survey possible. A large map in colors helps the reader to a ready understanding of the topography of the country. Mr. R. H. L'Hommedieu is the general superintendent, at Detroit, and Mr. O. W. Ruggles is the general passenger and ticket agent, at Chicago.

THE JOSEPH DIXON CRUCIBLE COMPANY, Jersey City, N. J., has issued an attractive circular describing its graphite pipe-joint compound. This graphite pipe-joint compound has been on the market now for more than twenty years, and its chief feature lies in the fact that graphite is a lubricant, and does not form with the oil a hard, brittle compound which would bind the joint against any future release. This compound rubbed on the surface of gaskets enables them to be removed easily, so that they can be used again. It also has a useful application in slushing bolts for insertion into green woodwork, preventing entirely any rusting of the bolt. The applications are, in fact, very numerous, and the length of time this material has been on the market, during which time it has won commendation from all classes of users, is a guarantee of its merit.

THE OTIS ELEVATOR COMPANY, 71 Broadway, New York city, is distributing a handsome booklet descriptive of its electric elevators. This company has in actual operation more than 6,000 electric machines in the United States and foreign countries. The electric elevators are particularly well adapted for private residence service, as with the improved push-button system of control a regular attendant is unnecessary. The machine can be operated both from the car and hallways. By pressing a button placed in a hallway, the car can be brought to that floor, stopping automatically when opposite the landing. Inside the car is placed a series of buttons, numbered to correspond with the various floors, and by pressing one of these the passenger can send the car to the desired landing, or, by pressing the safety button, can stop the car at any point in its travel. While the car is in motion the hall buttons are inoperative, giving the person in the car entire control of the elevator. The enclosure doors are provided with an automatic interlocking door fixture which prevents the opening of any door until the car is opposite it, and prevents the moving of the car until the door is securely closed.

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CHARLES W. PRICE . . . . PRESIDENT and EDITOR
STEPHEN H. GODDARD . SECRETARY and MANAGER
RUSSELL HOWLAND . GENERAL REPRESENTATIVE
WM. HAND BROWNE, JR. . . . TECHNICAL EDITOR
AINSLIE A. GRAY . . . . . ASSISTANT EDITOR

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FAN MOTORS.

These are the days when the fan motor declares dividends of many hundred per cent in fresh air and cooling breezes. Many offices and salesrooms are rendered fairly comfortable, which, without their use, would be unbearable. We may safely say that no one who has a fan motor would be willing to part with it during the hot spell, if he could not easily replace it.

It may not be out of place to say a word about the proper location of the fan. It should be placed near a window or other opening, so that it may draw in fresh air from the outside, or, in some cases, drive out heated or vitiated air, allowing fresh, cool air to flow in from another opening. Far better results will be obtained if attention is paid to this matter than if the fan motor is put in some corner where it merely stirs up the air. One is apt to think that he is obtaining the best results if the current of air is directed toward him, but more real comfort is derived when, in addition to keeping up the circulation, the motor supplies fresh air.

STREET-CAR OPERATION.

Some time ago attention was called to the opportunity for improving street-car service by making fewer stops, emphasis being laid upon the saving in time. In a recent article by Mr. W. Park, in the *Tramway and Railway World*, London, another phase of this same question is touched upon.

Service Improved by Fewer Stops.

Mr. Park shows that the greatest part of the energy required to drive the cars is used in acceleration, and that by far the greater part of this is later dissipated in the form of heat when the car is stopped by means of the brakes. This loss, of course, increases directly with the number of stops, so that by appointing fixed stopping-places and adhering to them, not only could the schedule be improved, but the car could be operated more efficiently.

The Motorman's Responsibility.

It is a rather singular thing in street-car operation that the best skill is employed in designing the generating station and the distributing circuits, and that great additional expense is incurred over what would be necessary to do the work in order that the cost of producing the power may be reduced. It is also true that much money and labor have been spent in developing the railway motor, so that it stands to-day as one of the triumphs of the electrical designer. We may have, then, a traction system which delivers the power to the car at the lowest cost for generation and distribution, and we have on the car apparatus designed to use this effectively and efficiently. But the method in which this power is used is not determined so much by the generating station and the car equipment as by the motorman, so that it may be true that this one link in the long chain from the coal pile to the car wheel is responsible for a good part of the wasted energy. The engineer's responsibility ends when he has furnished the operating department with a suitably equipped car and power for running this; but the way in which energy is applied to run the car is under the control of another department. The motorman is instructed, in the first case, in the proper way of starting and stopping, but after that he is left largely to his own pleasure. If he is lazy, he not only makes riding exceedingly disagreeable to the passengers, but causes excessive wear of the equipment and unnecessary waste of energy. The violent starting and the almost as sudden stopping of some of our street cars is undesirable and, in many cases, unnecessary. Reliable service requires close adherence to the running schedule, and this point is urged upon the car crews as of the first importance. It seems rather surprising, to say the least, for a company to lay out so much capital in order to generate power efficiently, and yet pay so little attention to its effective use. The comfort of the passengers certainly counts for something, and energy generated through expensive machinery is worth saving. It would seem as though attention to these points would pay better than a stricter adherence to the running time.

Drifting the Car.

Mr. Park also calls attention to the great saving which can be effected by allowing the cars to drift for a longer time. In the case considered the efficiency was raised from forty-nine per cent to sixty-two per cent, but with a resulting lower average speed. However, the lower speed decreases the earning capacity of the car by reducing the possible car-miles per day. The whole question is an interesting one, which seems well worthy the attention of operating engineers. Street cars are intended to carry passengers, and it should be the object of the roads to get them to their destinations; but there are many ways of doing this, and every road should endeavor to determine the best way.

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A WIRELESS TELEGRAPH INCIDENT.

A short time ago, while Dr. J. A. Fleming was delivering a lecture at the British Institution, a practical demonstration of the Marconi system of wireless telegraphy was made during the meeting. Messages from Poldhu were received successfully until near the close of the hour, when it became evident that some one was interfering with the working of the system. Dr. Fleming naturally was much provoked, and in a letter to the London *Times* expressed freely his opinion of the perpetrators of this—as he called it—"scientific hooliganism."

This letter brought a reply from Mr. Nevil Maskelyne, in which he acknowledged the soft impeachment, explaining that the attempt at interference was carried out for the benefit of the public, and that he had allowed the transmission of messages to go on for almost the entire hour without breaking in. Mr. Maskelyne says that in the announcement of the lecture it was stated that experimental illustrations of syntonic electric wave telegraphy would be given, and the interfering transmission system which he had set up had not been tuned in any way. He holds that his tests show either that Marconi's syntonic system is not proof against interference from an untuned transmitter, as in that case he could not have interferred, or that the experiments were not carried out according to the syllabus of the lecture.

Since then a number of letters have appeared in the *Times*, from Dr. Fleming and Mr. Maskelyne, each writer insisting upon the justness of his side of the squabble. At this distance it is imposible to see who is in the right. One can sympathize with Dr. Fleming when, instead of an expected message from Poldhu, he received the word "rats." One can also appreciate the temptation to Mr. Maskelyne to show that he too knows something about wireless telegraphy. He has been diligently catching and studying the messages sent out from Poldhu for some time past. It is not clear what will be the outcome of the discussion, nor how it will affect wireless telegraphy in England. Dr. Fleming said he would receive messages from Poldhu, and he made good his word. Mr. Maskelyne undertook to interfere, and he was successful. There seems to be no denial of these two facts, but when one tries to resolve the discordant note of the quarrel into its rights and wrongs he finds the fundamental entirely masked by the harmonics of accusation and denial.

THE STORAGE BATTERY IN SUBSTATIONS.

The paper on "The Storage Battery in Substations," read at the recent convention of the American Institute of Electrical Engineers by Professor Goldsborough and Mr. Fansler, is a timely addition to the discussion that has been carried on for several years as to the economic value of storage batteries as equalizers in power plants supplying current to loads which fluctuate rapidly.

Complete Test Not Possible.

While it has been the general impression that equalizing batteries lead to more economical generation and distribution of electrical energy, it is by no means universally admitted. Professor Goldsborough, however, in the discussion that followed the reading of his paper, stated that the attempt to test the plants discussed with the batteries out of commission was stopped by the officers of the railway, because of the undue and excessive strains on the machinery and the unsatisfactory character of the service as supplied by the generating and substation machinery alone. This, in view of the low *efficiency of equalization* and the fact that the railway and plant are both large, is important.

Efficiency of Equalization.

The term *efficiency of equalization* is a good one and fills the requirement for some short term or phrase to represent the percentage of change in the normal generator current under an external fluctuating load. An unchanging generator current with a load fluctuating between zero and a maximum represents 100 per cent "efficiency of equalization"—all the excess above normal current being supplied by, and the deficiency being absorbed by, the battery.

Factors Affecting the Efficiency of Equalization.

This efficiency of equalization is not, however, a function of the size or character of the battery, provided there are approximately enough cells in series. The size of the booster and the character of its windings are really the determining factors. In the stations tested by the writers of the paper the efficiency of equalization was less than twelve per cent, which is remarkably low. In present practice eighty-five per cent is easily attained and is not uncommon. The use of a flywheel on a booster, as suggested in the paper, while unnecessary when proper size of driving motor is used, would no doubt allow the capacity of the driving motor to be reduced, but a good shunt motor with an armature of low resistance gives a sufficiently constant speed to take care of any possible load fluctuation.

Driving Motors Too Small.

It is stated in the paper that the driving motors were not large enough to hold up to the average speed with the heaviest loads on the line. This appears to be an unusual condition and one not generally encountered, as the tendency is to make the motors too large rather than too small. The proper motor capacity is subject to very close calculation and there seems to be no reason why undersized motors should ever be employed.

Fuel Saving Due to Battery Not Determined.

It is unfortunate that the test could not be made on the system with the batteries out of service, as the most vital of all questions involved—the decrease in coal consumption effected by equalizing and maintaining a constant load on the generator—could have also been settled for this particular case, at least, and the results would have had a practical bearing on nearly all cases where regulating batteries are employed.

Value of Battery Installations.

Altogether the inability to operate successfully the railway without the batteries seems to indicate their desirability, even if the coal consumption were not reduced, and in view of the knowledge concerning the relative economy of steam engines on constant and on fluctuating loads, it is not conceivable that the load equalization is without beneficial effects on the coal pile.

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METHODS OF COMBINING RESISTANCES—IV.

BY EDWIN F. NORTHRUP.

(Concluded.)

OTHER COMBINATIONS OF COILS.

The only combinations of *four* coils which will give the decade in the above manner are the coils *n* (1 — 1 — 4 — 3) and the coils *n* (1 — 3 — 3 — 2) as given. Here *n* may have any value. The decade may also be obtained in a manner similar to the above by using the following arrangements of *five* coils, *n* (1 — 1 — 2 — 2 — 3) and *n* (1 — 2 — 2 — 2 — 2) and *n* (1 — 1 — 1 — 1 — 5). Eleven values, namely, 0 to 10, inclusive, may be obtained from the following arrangements of *five* coils.

n (1 — 2 — 3 — 2 — 2)
n (1 — 5 — 1 — 1 — 2)
n (1 — 3 — 1 — 3 — 2)
n (1 — 1 — 1 — 3 — 4)
n (1 — 1 — 1 — 4 — 3)
n (1 — 1 — 4 — 1 — 3)
n (1 — 3 — 1 — 3 — 2)
n (1 — 2 — 1 — 4 — 2)

The method may be indefinitely extended so as to obtain any number of successive values with the use of very much fewer coils than the values obtainable. Thus from the seven coils *n* (1 — 1 — 3 — 1 — 3 — 3 — 2), we can get fifteen consecutive values inclusive of 0.

With the above methods sliding contacts or dial switches can be used in place of a plug for making the connections. The switch or dial construction has the very great advantage of it not being necessary to use any sliding contacts or flexible cords for carrying the current into the switch at its centre, as the brush which travels over the blocks will consist merely of a short-circuiting piece.

MULTIPLE ARRANGEMENTS.

Resistance coils may be connected in parallel either for obtaining regularly increasing values of current, the applied electromotive force remaining constant, or for obtaining regularly increasing values of resistance.

The principle of the first case is more generally employed for current regulating purposes than for precision work. The connections are usually made when plugs are used as shown in Fig. 24.

The resistances (lamps are often used) are all of the same value, and as plugs are inserted from right to left, the current increases by regular increments. The resistance, however, assuming there are ten coils, decreases according to the series 1, $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{5}$, $\frac{1}{6}$, $\frac{1}{7}$, $\frac{1}{8}$, $\frac{1}{9}$, $\frac{1}{10}$.

The principle of the second case in which regularly increasing values of resistance are obtained may be applied in the matter indicated by Fig. 25.

It may be shown that when ten coils have the values *n* (2, 6, 12, 20, 30, 42, 56, 72, 90, 10) ohms, where *n* has any value their resistance, when all are connected in multiple, is *n* ohms. Also the nine coils *n* (6, 12, 20, 30, 42, 56, 72, 90, 10) have the resistance 2 *n* ohms when connected in multiple, the eight coils *n* (12, 20, 30, 42, 56, 72, 90, 10) the resistance 3 *n* ohms, the seven coils *n* (20, 30, 42, 56, 72, 90, 10) the resistance 4 *n* ohms, etc., to *n* (10) which has the resistance 10 *n* ohms. Thus with the ten coils having the values indicated in Fig. 25, if the plugs 1, 2, 3 to 10 are all in, the resistance from *a* to *b* is one ohm. If

FIG. 24.

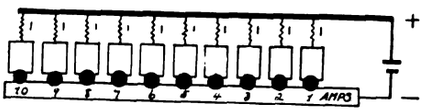

FIG. 25.

the plug 1 is removed the resistance is two ohms, if the plugs 1 and 2 are removed the resistance is three ohms, etc., that is, the resistance obtained between *a* and *b* will always be that which is stamped opposite the last plug toward the left, which is not removed.

Since the current passes through all the plugs in parallel which are not removed, their contact resistances have little influence. Also each of the coils has current-carrying capacity of the combinations of coils.

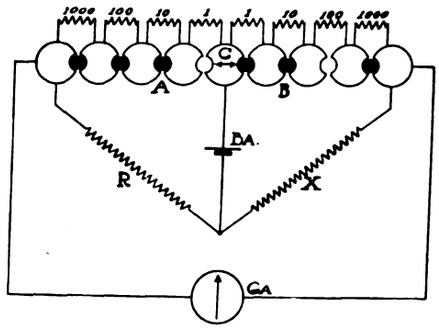

FIG. 26.

In consequence of the above considerations, this method is an excellent one to a considerably higher resistance than that obtained between *a* and *b*, and further, the lower this resistance the greater is the employ when it is required to obtain ten regularly increasing values of very low resistance, as for example, 0.001, 0.002, 0.003 to 0.01 ohm. Much greater precision of adjustment can be got and maintained by this parallel arrangement of coils of relatively high resistance than can be obtained from any arrangement of low-resistance coils in series.

In constructing a rheostat based upon this principle and having several decades, it would only be required to have the values run from 0 to 9 *n* in all decades except the one of lowest denomination. In this case the proper values for the coils to be joined in parallel are *n* (2, 6, 12, 20, 30, 42, 56, 72, 9).

Rheostats constructed on the above plan may, of course, make use of dial switches instead of plugs, each switch consisting of a semi-circular wing which makes contact with a semi-circular row of studs.

RATIO COILS.

Most boxes intended to serve as a Wheatstone bridge are furnished with a set of coils which form the arms of proportion or ratio coils of the bridge.

There is a choice of several different ways of arranging these coils.

The simplest arrangement, which is used in boxes not intended for high accuracy, is shown in Fig. 26.

The required ratio as 1 to 100 is obtained in this case by withdrawing a plug from each of the arms A and B. This simple arrangement is open to the objection that the contact resistance of the plugs which remain in is always included with the resistance unplugged.

All the other objections also to be urged against the use of many plugs, where a few will do, apply here. The method has the limitation that it is not possible to reverse the arms of the bridge; that is, to transpose the arms A and B. This limitation may be overcome by using a set of reversing blocks.

Fig. 27 shows the connections that would be employed in a Wheatstone bridge in which the ratio arms may be reversed.

The arrangement shown in the figure is classical, being that used in the English Post Office type of Wheatstone bridge. It is open to the objections which apply to the use of several plugs and of having to withdraw a plug to obtain the required resistance. A superior arrangement is the following.

SCHÖNE'S RATIO ARMS.

The first reference that we have seen to this method is in an article by O. Schöne, in *Zeitschrift für Instrumentenkunde*, May, 1898.

According to this arrangement all the

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ratio coils have one of their terminals connected to a common terminal, which corresponds to the block marked C of Fig. 26. The other terminal of each coil is joined to a separate block. The bar A, Fig. 25, on one side of these blocks, is joined to the rheostat and the bar B, on the other side, to an X post.

In the ordinary use of this set of ratio coils two plugs only are used. One plug is inserted between the bar A and one of the blocks, 1, 1^1, 10, 10^1, etc., of the central row, and the other plug is inserted between the bar B and any one of the other blocks of the central row. There are two ratio coils of each value. In high-grade sets the values indicated in Fig. 28 would be used.

To obtain an even ratio, as 1000 to 1000^1, one plug would be inserted between the block 1000 and the bar A, and the other plug between the block 1000^1 and the bar B. This disposition of the plugs connects the end of the 1000-ohm coil to the rheostat, and the end of the

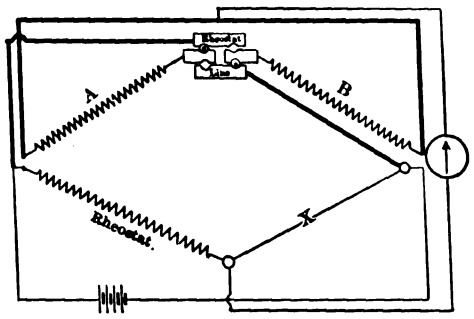

FIG. 27.—A : B :: R : X.

1000^1-ohm coil to the X post. If now one plug is inserted between 1000^1 block and the bar A, and the other plug between the 1000 block and the bar B, the ratio arms are reversed; that is, the 1000^1-ohm coil is joined to the rheostat, and the 1000-ohm coil to the X post.

When uneven ratios are used the same ratio can be obtained by four different combinations. If we wish to obtain the ratio one to ten, we can plug between A and 1 and B and 10 and get 1 to 10. Or between A and 1^1 and B and 10 and get 1^1 to 10. Or between A and 1 and B and 10^1 and get 1 to 10^1. Or between A and 1^1 and B and 10^1 and get 1^1 to 10^1.

To obtain the reciprocal set of ratios, like the above, we would plug A and 10, B and 1, and get 10 to 1; A and 10^1, B and 1, and get 10^1 to 1; A and 10, B and 1^1, and get 10 to 1^1; A and 10^1, B and 1^1, and get 10^1 to 1^1.

By using more than two plugs and connecting certain of the coils in parallel combinations, a large number of other ratios may be obtained. For example, we can plug between A and 100 and A and 100^1, and between B and 1000 and get the ratio 50 to 1000. Or we can plug between A and 1000 and A and 1000^1 and between B and 100 and get the ratio 500 to 100.

With this arrangement of ratio coils

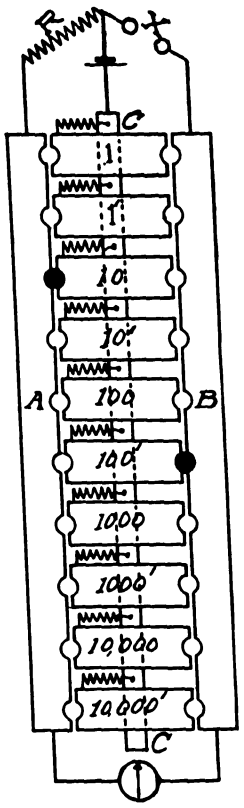

FIG. 28.

it is seen that errors due to plug contacts become practically nil, because only two plug contacts enter the circuit, while with even ratios it is only the *difference* in the resistance of the two plug contacts, which effects the result.

Schöne's arrangement of ratio coils is by far the best that has been devised and should ultimately displace all others on high-grade resistance sets.

COMMUTATOR METHOD.

The following method was devised by the writer to be used in connection with the commutator rheostat described in the first section of this article, Figs. 14 and 15.

in connection with portable testing sets with excellent results. Fig. 30 shows how the connections would be made. The method may be varied by using in place of the brushes two plugs that travel between a central bar to which the point (2), Fig. 29, is attached and the blocks corresponding to the segments on the commutator. It should be stated in general, that almost all methods for operating either ratio coils or rheostats, in which the desired values are obtained by putting plugs in are to be preferred to methods in which the values are obtained by taking plugs out.

It may be stated, in conclusion, that most of the general methods described above for combining resistances apply also to the combining of other elements of an electric circuit, such as condensers or standard coils of self-induction.

Many of the commutator methods for combining circuits might find useful application in decorative electric lighting, where many lamps are to be thrown in

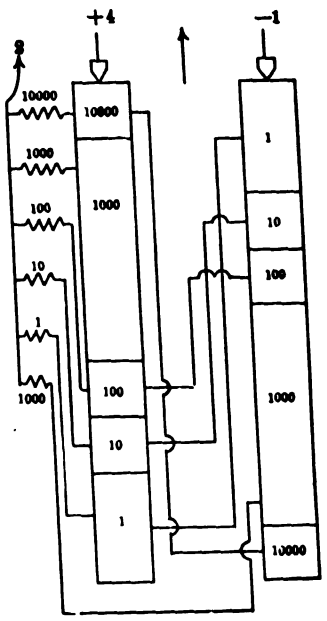

FIG. 29.—COMBINATION CONNECTION FOR A RESISTANCE SET.

circuit in various combinations. Combining commutators have also found extensive application in synchronous printing telegraphy. In this latter case relays would take the place of resistances, and impulses would be sent through the printing magnet at given intervals, according to the combinations of closed relays which the combination commutator throws in circuit.

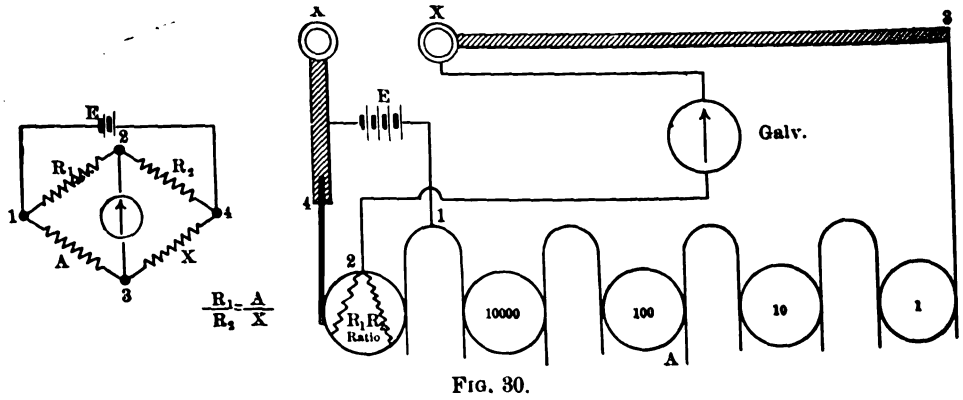

FIG. 30.

The method of obtaining the ratios is evident from Fig. 29 without further explanation. Either the brushes may move or the brushes may remain stationary, and the commutator with the coils attached may move. This method has been employed by the writer in practice

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Some Typical California Installations.

The Municipal Plant of the City of Riverside; the Power Development Company, of San Francisco; the San Bernardino Gas and Electric Company; the Merced Gas and Electric Company; and the Standard Consolidated Mining Company, of Bodie.

By J. H. Rusby.

MUNICIPAL ownership of lighting plants has been much discussed of late, as regards the economic advantages. A plant which has given much satisfaction under municipal control and operation is that of the city of Riverside, Cal.

The plant was originally constructed by the city in 1896. The station was then twenty-six by twenty-six feet. Since then the plant has been enlarged several times as the city grew, and to-day, after another recent addition which leaves the station considerably larger than the exterior view shows, the dimensions and outfit are as follows:

The station is built of red brick, 75 by 150 feet, including the pump rooms. Outside, some distance from the station, are two oil tanks of 35,000 gallons capacity each, which feed the boilers and supply also the city and county with oil for oiling the roads, a treatment which is given the roads of California pretty generally.

The boiler outfit consists of four Stirling boilers of 100 horse-power each. These supply steam for two Woodberg simple Corliss 350-horse-power engines, 20 inches by 42 inches, eighty revolutions per minute with fourteen-foot flywheel, weighing 16,500 pounds. These are belted to two General Electric 175-kilowatt, triphase, 7,200 alternations, sixty-cycle, 2,300-volt, revolving-field compensating generators.

Current is taken through three and six-kilowatt General Electric series equalizers to two primary gray marble panels, fitted with main oil-break switches and General Electric fittings and instruments, to the main switchboard of two gray marble panels fitted with all accompanying fittings, including double-throw, oil-break switches, by means of which the bus-bars may be loaded from either this station or the Redlands plant of the Edison Electric Company, of Los Angeles.

In addition to power generated here, at Riverside the station receives some 600 horse-power from the Redlands station. This power is received over a three-phase line at 10,000 volts, and part is taken through eighty-five-kilowatt, Wagner, water-cooled transformers, stepping it down to 2,300 volts for street circuits along with the power generated at the Riverside station, which is distributed at 2,300 volts to General Electric pole transformers and at 200 volts to local power consumers, and 100 volts for local incandescent lighting. The regulating and recording instruments for Redlands power are Bristol's, including potential regulator, ammeters and voltmeter.

The city also supplies power to the Riverside and Arlington Railway Company, operating about ten cars.

The 10,000 volt current enters three forty-kilowatt General Electric intermediate step-down transformers, bringing it down to 360 volts, whence it enters a 100-kilowatt rotary converter, which trans-

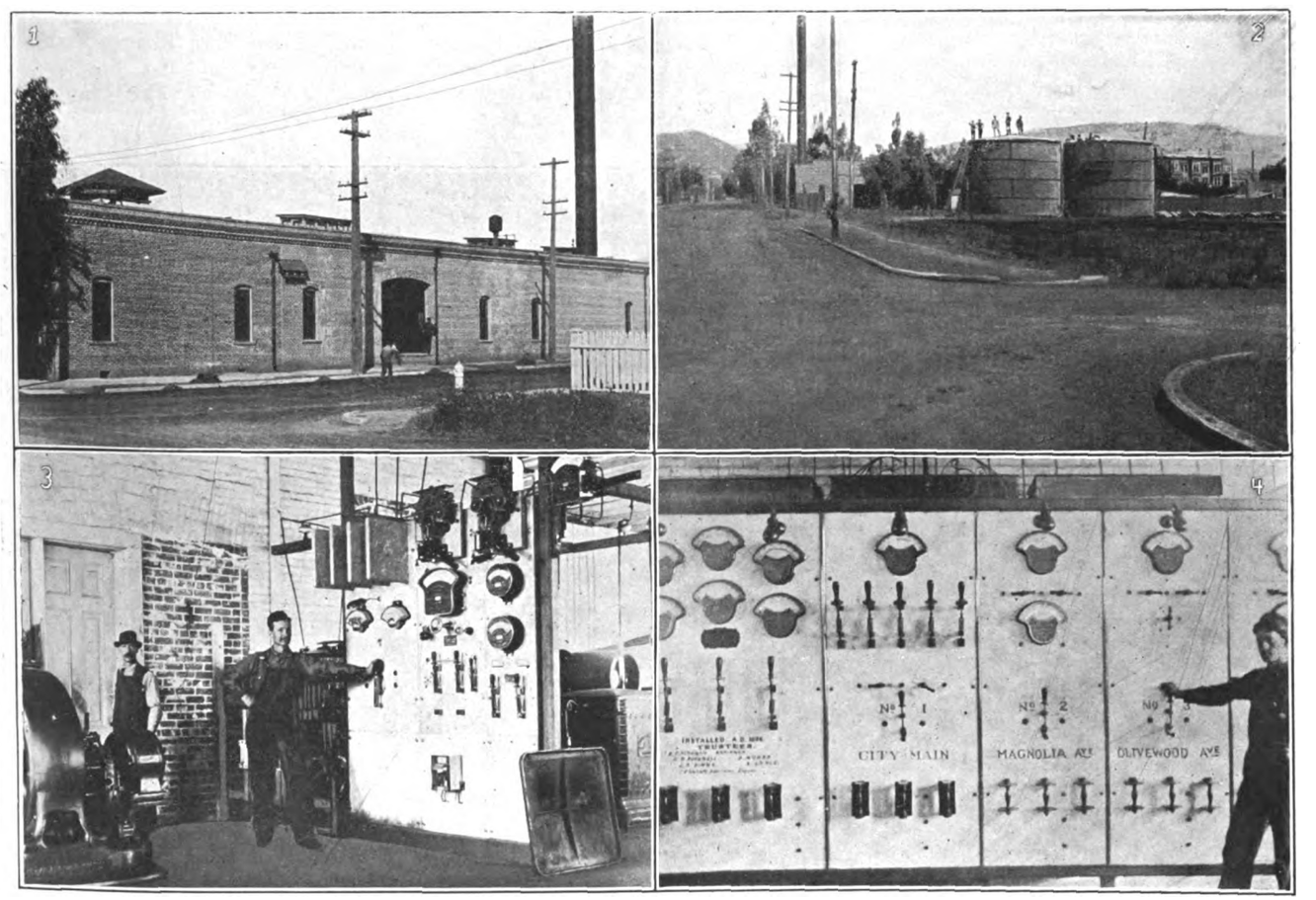

FIG. 1.—THE RIVERSIDE, CAL., MUNICIPAL LIGHT AND POWER PLANT BUILDING. FIG. 2.—THE 35,000-GALLON STORAGE TANKS FOR THE FUEL OIL. FIG. 3.—THE HIGH-TENSION SWITCHBOARD. FIG. 4.—THE DISTRIBUTING PANELS.

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forms to 560 volts direct-current for outside car line use.

In addition to the power purchased from the Redlands plant of the Edison company, the city has contracted for the total output of the East Riverside Power Company, now erecting its plant, with a capacity of 600 horse-power, which will be run into the Riverside station over a 10,000-volt, triphase line, and will be stepped down through three 200-kilowatt transformers to 2,300 volts for distribution.

The city furnishes nearly all the motive power for the various industries about town, including laundries, packing houses, lumber and planing mills, pumping stations, etc. In fact, it is quite extraordinary to see a private steam plant in town.

one of 220 horse-power, and one of 150 horse-power. These engines are belted to one end of a line shaft running through the station.

The other end of the shaft is fitted with a 150-horse-power, Stilwell-Bierce water turbine, for use when water is abundant.

To this line shaft are belted three generating units, as follows: one 150-kilowatt, 2,400 volt, triphase, 7,200 alternating, sixty-cycle, for day and night incandescent lighting; two Wood arc machines, 4,000-volt, eighty horse-power each, for series arc lighting.

The alternator is separately excited by direct-current, 125-volt machine. Power is distributed through a two-inch gray marble board, fitted with General Electric instruments and plain quick-break knife switches, for the incandescent lighting, and Wood instruments for the arcs.

in the country is shown in the following description of the Bakersfield plant of the Power Development Company, of San Francisco, Cal.

The generating station of this plant, which was originally installed in 1897 under the charge of Dr. C. T. Hutchinson, of New York city, electrical engineer; Messrs. Cobb and Hesselmeyer, of San Francisco, mechanical and hydraulic engineers; W. R. Macmurdo, of Bakersfield, civil engineer, and Walter James, of Bakersfield, consulting engineer. The whole work being in direct charge of Mr. C. N. Beal, secretary and treasurer of the Power Development Company, has undergone some important alterations since the original installation.

The generating station is located at the mouth of the Kern River cañyon on the western slope of the Sierra Nevada mountains, sixteen miles northeast of Bakersfield, Cal.

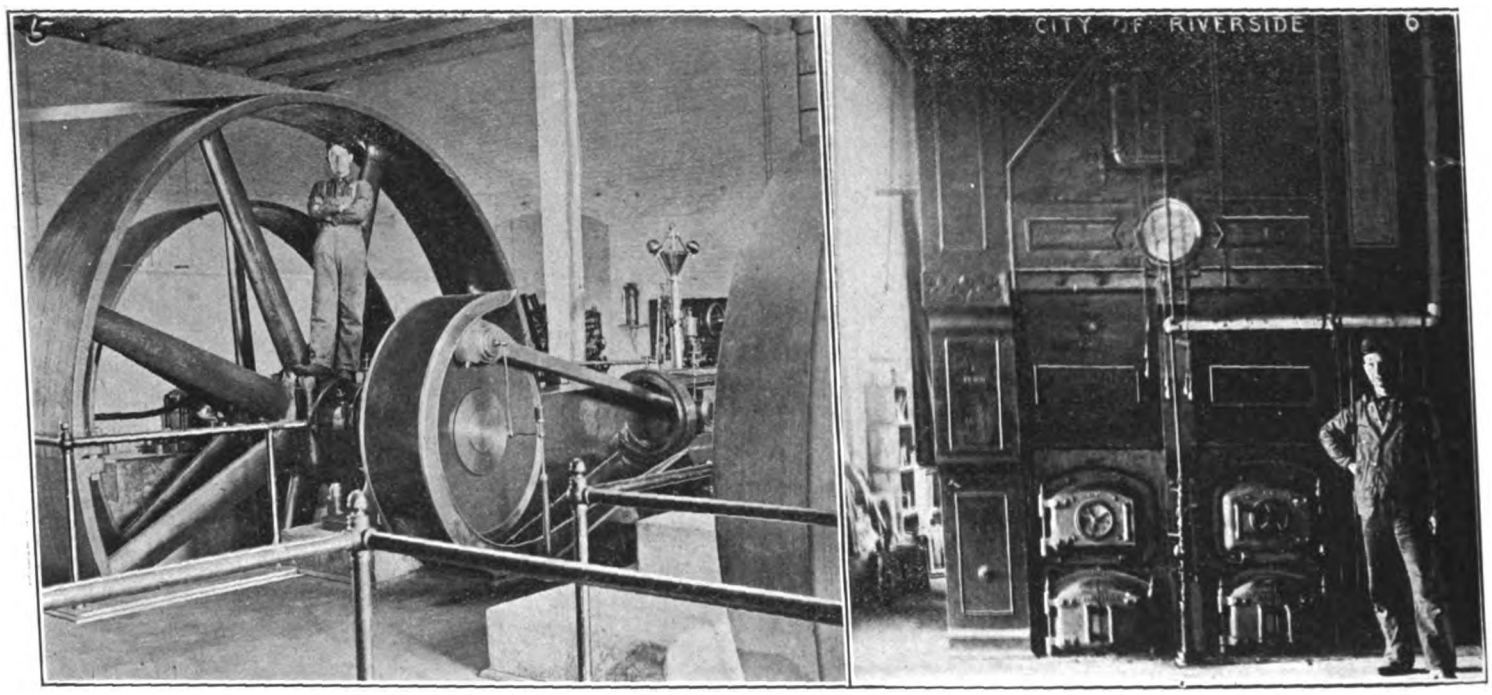

FIG. 5.—ONE OF THE ENGINES, RIVERSIDE, CAL., MUNICIPAL LIGHTING AND POWER PLANT. FIG. 6.—ONE OF THE BOILERS.

In this city station the fire department batteries are kept, consisting of about eighty-five standard sized cells. The prospect bespeaks a very bright future for the city of Riverside as regards the lighting and power department. We are indebted to Mr. F. A. Worthley, superintendent, for descriptive matter, and to Mr. Weidman, chief engineer, for views.

THE SAN BERNARDINO GAS AND ELECTRIC COMPANY, SAN BERNARDINO, CAL.

This company has two generating plants or stations, the Mill street and the Highgrove. The Mill street station includes two 16 inch by 66 inch return tubular, 145-pound Philadelphia Boiler Company's boilers, having a combined capacity of 300 horse-power, oil fuel being used; two tandem-compound Ball engines,

The alternating current at 3,400 volts supplies a load of 4,000 incandescent lights through pole transformers, and the arc circuits a load of 160 arc lamps. Edison base sockets and lamps are used throughout. These Mill street machines run in balance with the Highgrove station, which includes the following apparatus: One Stilwell-Bierce double water turbine of 280 horse-power capacity, driving a line shaft to which is belted a 150-kilowatt General Electric, 2,400-volt, triphase, 7,200-alternating, sixty-cycle alternator, separately excited. From this alternator current is taken through a brown slate board fitted with necessary instruments to reinforce the Mill street circuits.

THE POWER DEVELOPMENT COMPANY, SAN FRANCISCO, CAL.

One of the highest grade and most interesting engineering efforts for its size

The river which is third in size in California here furnishes ample power for generating purposes, 7,000 horse-power being secured at this point the year round by tapping the stream some two miles above the station site.

Originally the water was carried down a redwood flume eight feet wide and six feet deep, with a fall of 5.28 feet per mile, giving 14,400 cubic feet of water per minute.

As this flume possessed certain disadvantages in operation, however, principally due to rock and timber falling into it, in spite of a cover, a tunnel six feet by seven feet was bored one and three-quarter miles through solid granite, in 1901, which settled for all time all trouble in that direction.

The generator driving power was originally provided by four Girard water wheels. These have been taken out and replaced by three Knight 750-horse-power

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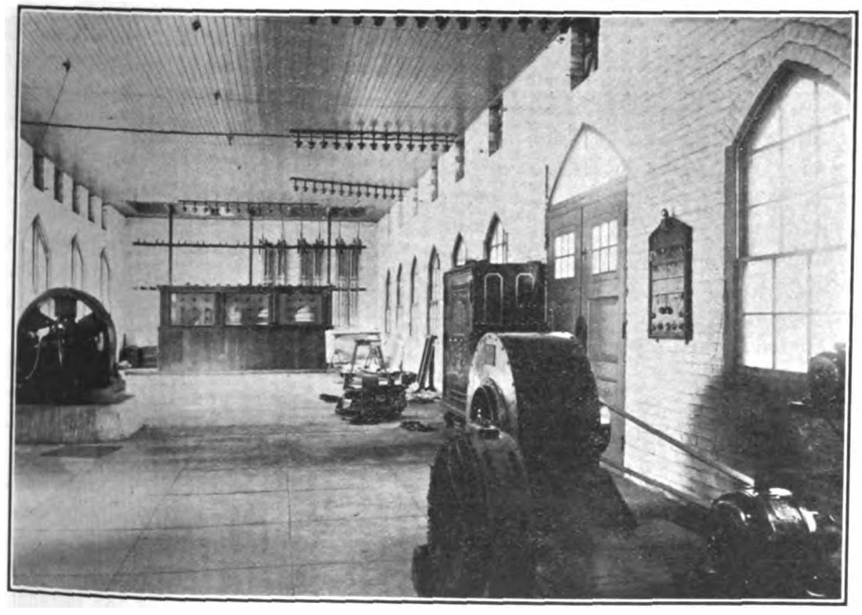
undershot wheels, which are direct-connected to three 450-kilowatt, triphase, twenty-eight-volt, 7,200 alternations per minute, 550-volt, General Electric generators. These generators are excited by two seventeen and one-half kilowatt, General Electric, multipolar, direct-current units, separately direct-connected to Knight wheels.

Current is then taken at 550 volts through nine 100-kilowatt, air-blast transformers, stepping up to 10,000 volts, and thence through a switchboard of two-inch gray marble, fitted with complete outfit of General Electric instruments, including knife switches, whence it is led out through lightning arresters and kick coils to the line, which consists of two three-wire circuits of No. 4 soft-drawn bare copper wire, run on redwood poles twenty-four feet above ground, six by six inch top and nine by nine inch butt. Current enters the substation at Bakersfield, fourteen miles distant, through the customary devices, including high-potential, triple-pole, multiple-break fused switches, especially designed by Mr. Whoof, superintendent, to three banks of three each seventy-five-kilowatt air-blast transformers, stepping down to 2,080 volts, for local distribution by a secondary board, fitted out with all instruments and appliances, to street lines and street transformers which deliver the power to consumers at 115 volts.

Edison base sockets and lamps are used. Bakersfield and Kern territory is supplied, together with certain outlying consumers along the line from the generating station. The present load is about seventy-five series enclosed arcs and 25,000 incandescent lamps; also the Bakersfield & Kern Electric Railway Company is supplied by means of a 100-kilowatt rotary converter, started by means of a 4.2-kilowatt induction motor. This railway equipment consists of four single-truck, twenty-five-horse-power Holman closed cars and three duplex-truck, twenty-five-horse-power Holman combination cars.



POWER DEVELOPMENT COMPANY, SAN FRANCISCO, CAL.—INTERIOR OF BAKERSFIELD SUBSTATION, SHOWING ROTARY CONVERTERS, ETC.

THE MERCED GAS AND ELECTRIC COMPANY, MERCED, CAL.

The main generating station is situated at Merced Falls, Cal. Four Leffel water-wheels, aggregating 600 horse-power, under a seventeen-foot head, transmit running power to one 240-kilowatt and one 135-kilowatt Stanley, three-phase, 7,200-alternation-per-minute, sixty-cycle, 2,400-volt generators, from which the current is transmitted through air-blast transformers, stepping up to 10,000 volts, to a white marble board, fitted with the regulation instruments and plain knife switches, to the line. This is composed of three No. 6 bare copper wires, and stretches to the Merced substation, twenty-four miles distant, where it enters through lightning arresters and kick coils to air-blast transformers and is stepped down to 2,400 volts, whence it is transmitted through a secondary switchboard of white marble, fitted with Whitney and Thompson instruments and knife switches

POWER DEVELOPMENT COMPANY, SAN FRANCISCO, CAL.—INTERIOR OF BAKERSFIELD SUBSTATION, SHOWING TRANSFORMERS AND SWITCHBOARD.

to outside street lines at two-phase current and through street transformers to various consumers at 100 volts.

The present load is six enclosed arcs and 3,000 incandescent lamps. It is intended soon to supply the Mount Gaines gold mines along the high-tension line with power and lights.

At the Merced substation the company has a reserve plant consisting of the following: One two-phase, 7,200-alternation-per-minute, sixty-cycle, 2,400-volt, 135-kilowatt, and one two-phase, 7,200-alternation-per-minute, sixty-cycle, 2,400-volt, thirty-five-kilowatt generators, excited by two 125-volt, direct-current exciters, this whole outfit being belt-driven by one Ideal 150-horse-power and one Ball sixty-horse-power steam engine, fed by one 100-horse-power and one eighty-horse-power oil fuel boilers.

THE STANDARD CONSOLIDATED MINING COMPANY, BODIE, MONO COUNTY, CAL.

The generating plant is situated at Green Creek. Four twenty-one-inch Pelton wheels under a 350-foot head drive, one Westinghouse alternating-current, 120-kilowatt, single-phase generator.

Current is stepped up by Westinghouse transformers to 10,000 volts, and transmitted over a circuit of No. 1 bare copper wire on two and one-half mile pile line, containing sixteen and one-half tons of copper, to Bodie, where it is stepped down and drives a Westinghouse 120-kilowatt synchronous motor. This drives a twenty-stamp and ten-pan mill. The plant is supplied with Westinghouse fittings and instruments.

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The Fifth International Congress for Applied Chemistry, Held in Berlin, June 2 to 8, 1903.

Report by John B. C. Kershaw, London.

[Specially written for the ELECTRICAL REVIEW.]

THE international congress of applied chemistry, which was held in Berlin from the second to the eighth of last month, was the fifth of the series, inaugurated at Brussels in 1894. The succeeding congresses have been held at intervals of two years in Paris, Vienna and Paris, respectively, but three years have elapsed since the last congress (held in Paris in the exhibition year 1900), and it is probable that the congress will now become a triennial fixture in the chemists' calendar. The aim of these congresses is threefold. In the first place, by bringing chemists of all nationalities together they serve to break down political and national barriers to knowledge and friendship, and assist in widening the field of human intercourse. In the second place, by the opportunities they offer for reading papers bearing on the application of chemistry in the arts and industries, they help to spread the knowledge of what is being done in those countries which are most advanced, and they thus serve to raise the level of industrial efficiency the wide world over. And, finally, by the appointment and labors of international commissions, which hold sittings and report to succeeding congresses on the questions submitted to their members, these congresses assist in the attainment of international action and regulations in matters of the highest importance to the chemical industries. By many, this last is held to be the most important and useful branch of their work, and when the members of these commissions are wisely chosen, and are thoroughly representative of the different nationalities, there is evidence that the results of their labor are appreciated and receive international sanction and adoption.

In this report of the proceedings of the fifth international congress, which was attended by over 2,000 members, and at which the enormous number of 456 papers and reports were planned for reading before the eleven sections into which the congress was divided, it will be impossible to give the titles of all the papers actually read, and detailed notice will be restricted to those papers and reports which may be supposed to have a special interest for readers of the ELECTRICAL REVIEW. Section X of the congress was devoted to electrochemistry and physical chemistry, and it is chiefly to the papers read before this section that attention will be directed.

The congress was formally opened on Wednesday morning, June 3, in the large assembly hall of the Reichstag Gebäude, one of the largest and finest buildings in Berlin.

The action of the government in placing the whole of the Imperial Parliament building in the hands of the organizing committee for the congress week is characteristic of the German official attitude toward science, and a building more admirably adapted for the general and sectional meetings of the members of the congress it would have been difficult to find.

The president of the congress, Professor Otto Witt, of Berlin, opened the proceedings on Wednesday with a few words supplementary to his speech of the previous evening, and then called on Count von Posadowsky and Dr. Studt, the representatives of the Imperial Government, to greet the congress in the name of the state authorities.

The official representatives of foreign governments and of foreign scientific societies were then formally received, and each in turn spoke a few words to the assembly. France was represented at this meeting by Professor Moissan (the popular figure at the congress); Great Britain, by Professor Tilden; Austria, by Professor Ludwig; Russia, by Professor Jackowkim; Spain, by Don Vincente de Lafitte; the United States, by Professor Clark; Italy, by Professor Paterno (another popular figure at the congress), and Switzerland, by Professor Lunge. As speeches in German, French, English, Italian and Spanish were delivered, the claim of the congress to the title of international was fully justified, and there were probably few members present of sufficient linguistic ability to understand every word that was spoken at this inaugural meeting of the congress.

The real work of the members commenced on Wednesday afternoon, with the inaugural meetings of the sections I to XI. These sectional meetings were continued daily, with morning and afternoon sessions, up to Monday, June 8, when the third and final general meeting of the congress was held. The only interruption to the daily work of the sections was on Friday, June 5. On this date the second general meeting of the congress was held, and the following addresses were delivered:

1. "The Hydrides of the Metals." Professor Moissan, Paris.
2. "Modern Views on Matter." Sir William Crookes, London.
3. "The Formation of Natural Salt Deposits." Professor Van t'Hoff, Berlin.
4. "A Survey of the Ammonic Soda Industry." M. Solvay, Brussels.
5. "Auto-Oxydation." Herr Engler, Karlsruhe.
6. "New Investigations Relating to Coal-Tar." Herr Kraemer, Berlin.

Sir William Crookes' address was considered by many the best delivered at the second general meeting of the members of the congress, and it will be reproduced in full in the ELECTRICAL REVIEW at a later date. None of the other addresses dealt with subjects of special interest to electrical engineers.

As regards the work of the sections, the papers read in sections I to VI dealt with subjects outside of the province of the readers of this journal, but the following list of sections, presidents, and total number of papers planned for reading in each of the sections will no doubt prove of interest, and will show the wide field covered by the congress, and the wealth of matter provided for the consideration of its members.

Section I. Analytical chemistry—methods, apparatus and instruments. President, Professor von Knorre, Berlin. Papers to be read, fifty-two.

Section II. Chemical industry of the inorganic products. President, Dr. A. Heinecke, Berlin. Papers to be read, thirty-nine.

Section IIIA. Mining and metallurgy. President, Professor Weeren, Berlin. Papers to be read, twenty-three.

Section IIIB. Explosives. President, Professor Witt, Berlin. Papers to be read, twelve.

Section IVA. Organic products, including tar derivatives. President, Pro-

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fessor Wichelhaus, Berlin. Papers to be read, forty-four.

Section IVB. Coloring matters, and their utilization. President, Dr. A. Lehne, Berlin. Papers to be read, thirty-three.

Section V. The sugar industry. President, Professor Herzfeld, Berlin. Papers to be read, thirty-three.

Section VI. The fermentation and starch industries. President, Professor Delbruck, Berlin. Papers to be read, forty-one.

Section VII was devoted to papers on Agricultural Chemistry, and was presided over by Professor Kellner, of Leipzig. The first paper read before this section at its afternoon session of Wednesday, June 3, was by Dr. Frank, of Charlottenburg, and the subject was one of some interest to electrochemists, namely, the "Fixation of Atmospheric Nitrogen and Its Use in Agriculture." The writer has more than once referred in these columns to the experimental plant of the Atmospheric Products Company, at Niagara Falls, and to the production by this company of nitrates from the air by the aid of the high-potential electric discharge. Dr. Frank in his paper described a new electrical method of obtaining nitrogen from the air. In this case calcium carbide is utilized to fix and combine with the nitrogen, and a compound known as calcium cyanamide is obtained. This substance contains from fourteen to twenty-two per cent nitrogen, and it can be employed directly for mixing with the soil, since on treatment with water it yields compounds of the uric acid series. In answer to questions, Dr. Frank stated that with cheap water power, calcium cyanamide could be produced at a price which would admit of competition with sodium nitrate and sulphate of ammonia. None of the remaining thirty-three papers planned for reading before this section was of exceptional interest to electrical engineers.

Section VIII was divided into two subsections—VIIIA being devoted to papers on the chemistry of food stuffs; and VIIIB to papers on hygiene, medical and pharmaceutical chemistry.

Dr. Merck, of Darmstadt, presided over the joint meetings of this section, and fifty-eight papers were planned for reading before the members in section VIIIA and section VIIIB. Detailed mention can only be made of the two papers on the "Utilization of Ozone for Water Purification," read at the Friday afternoon session of section VIIIB. The first of these was by Herr Proskauer, of Berlin, and dealt with the general aspects of the question of water purification by ozone. Some details of the early experimental trials by Tyndal, Marmier and others were also given. The bacteriological examination of the water used at the Martinikenfelde ozonizing plant of Messrs. Siemens & Halske was next discussed, and reference was made to the methods used by Drs. Ohhmuller and Krall, to prove the absence of pathogenic germs in the sterilized water. Dr. Erlwein followed Herr Proskauer with a second paper on the same subject, and gave a lengthy description of the water purification plants erected by Messrs. Siemens & Halske at Schierstein, near Wiesbaden, and at Paderborn, in Westphalia. Drawings of these plants, a model of the ozonizing battery and a full-sized ozonizer of the Siemens & Halske type were exhibited and explained, and the numerous automatic safety appliances, devised for cutting off the current of electricity or of water in the case of breakdown, were described. The total cost of treatment by the Siemens & Halske system of purification was stated to be 0.85 pfennig per cubic metre. A lively discussion followed the reading of this paper.

Section IX was devoted to the chemistry of photography, and was presided over by Professor Miethe, of Berlin. Of the twenty-four papers planned for reading before this section none was of special interest to electrical engineers.

The meetings of section X, electrochemistry and physical chemistry, were organized by the Deutsche Bunsen-Gesellschaft (the German society of electrochemists), and the annual meeting of the latter society had been timed to coincide with that of the congress. As a consequence of this arrangement, the meetings of section X were very numerously attended, and were held not in the Reichstag Building, but in the lecture theatre of the Physical Institute of the Berlin University. At the inaugural meeting of the section on Wednesday afternoon, June 3, fully 250 members were present, and this number was more than once approached during the later sessions of the section. Dr. Böttinger, as president of the Deutsche Bunsen-Gesellschaft, presided over section X, and a programme of fifty-one papers and reports was arranged for the consideration of the members. The more notable of these are referred to at some length below, and the following account of the meetings of section X contains a list of all the papers read, with the names of their authors.

WEDNESDAY, JUNE 3—AFTERNOON SESSION.

Dr. Böttinger opened the proceedings with a few words of greeting, and the first paper was read by Professor Traube and Herr Teichner, of Berlin, upon "An Experiment Relating to Critical Density."

The authors by an ingenious application of very minute graduated glass floats have been able to prove that considerable differences of density exist within the gaseous mixture contained in sealed glass tubes raised above the critical temperature of the liquid contained, and that the value of (*b*) in Van der Waal's formula is therefore not a constant, but varies with the temperature and pressure. Using carbon tetrachloride as the liquid, a temperature of 290 degrees centigrade and a pressure of 410 atmospheres within the sealed tube, the authors gave a practical demonstration of the experiment, and showed that after the meniscus had disappeared, considerable differences of density still existed in different portions of the tube. The experiment proves that the molecular constitution of liquids and gases near their critical temperature is not fully explained by the generally accepted theories.

The second paper was by Professor Nernst, of Göttingen, and related to "Vapor Density Determinations at High Temperature." Hitherto no satisfactory method of determining vapor densities at high temperatures has been worked out, but Professor Nernst has solved the very great difficulties involved in such work, and has elaborated a method applicable to gases and liquids within a temperature range of 2,000 degrees centigrade. A special form of electric furnace was devised and employed for heating the pure iridium tube containing the gases, and a novel method of measuring the temperature was also used. A new form of balance, capable of weighing with an error of not more than one ten-thousandth part of a milligramme, was also constructed and used for this work. Professor Nernst therefore surmounted the difficulties, chiefly by the exercise of his inventive skill in devising apparatus suited for the work in hand. The results obtained at the high temperatures used show that in all cases dissociation had occurred, and that the gases were present in the atomic, and not in the molecular, state. In the case of sulphur, thirty per cent of the total weight used in the experiment was dissociated, while by an indirect method of observation it was proved that oxygen likewise underwent the dissociation at a temperature of

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1,900 degrees centigrade. Professor Nernst's paper received much applause.

The third and final paper read on Wednesday afternoon, June 3, was by Dr. Frohlich and dealt with a "New Material for Electric Resistance Furnaces."

The author has discovered a mixture of earths which conducts at ordinary temperatures, and can therefore be used as heating material for resistance furnaces, without any decomposition occurring at the higher temperatures. Its exact nature and composition were not revealed by the author, but it is believed to be a mixture of the rare earths with some impurity, that renders it conducting at the normal temperature. The three remaining papers set down for reading at the first session of section X were not read, owing to the absence of their authors when called upon.

THURSDAY, JUNE 4.

At the morning session the following papers were read and discussed:

1. "Colloidal Zirconium," by Dr. Wedekind, Tübingen.

The author has prepared this product and showed specimens of it in solution and as a dry powder. The metal zirconium in the colloidal state still acts as anion, and drifts toward the negative pole under the influence of the electric current.

2. "The Electrolytic Reduction of Unsaturated Compounds," by Professor Marie, Paris.

This paper was read by the author in French, and owing to the rapidity with which it was read, the writer is unable to give any intelligent abstract of its contents.

3. "The Use of Electrolysis for the Preparation of Inorganic Products," by Professor Foerster, Dresden, and Direktor Brandeis, Aussig.

In the first of the two papers Professor Foerster dealt chiefly with the theoretical side of the subject, and gave a useful tabular summary of the present theory of the electrolytic decomposition of the alkali metal chloride solutions. Professor Foerster's own work on this subject has proved that in the electrolytic production of chlorates, bromates and iodates there is a gradual extension of the range of secondary reactions, and whereas in chlorate formation these only occur in weak acid solutions, when bromates are being produced, the secondary reactions occur in neutral and alkaline solutions also.

According to Professor Foerster, all the higher oxygen salts of the alkali and other metals are now produced industrially by electrolytic methods.

The second of the papers on this subject—that by Direktor Brandeis—dealt with the practical applications of electrolysis in the production of oxygen, bromine, iodine, hydrogen, chlorine, copper, nickel, gold, silver, aluminum, sodium, chlorate, hypochlorites, soda, permanganates and bichromates. It was chiefly a résumé of facts already published, but contained the statement that the Aussig "bell" process for alkali manufacture is working at four places, and can only be operated with very low-current intensities.

4. "Electrolysis with Alternating Currents," by Professor Le Blanc, Karlsruhe.

The author has found that when working with cyanide and other solutions of copper and cadmium, electrodes of these metals, and a current of between 1,000 and 2,000 cycles per minute, there is a discrepancy between the metal deposited and that going into solution. A similar deficiency is not found to occur in the case of hydrogen, and the author attributes the deficiency in the case of copper and cadmium to the time required to form complex compounds of the cyanide type. Professor Nernst in the discussion pointed out that one cause of the difference observed was the lower migration coefficient of complex ions.

The third session of section X, on Thursday afternoon, June 4, was occupied chiefly with French papers. Professor Moissan, Professor Lebeau and M. Gin being the authors respectively of papers on "Alkali Metal Carbides," "Metallic Silicides" and "The Manufacture of Aluminum."

Professor Lebeau was accorded first place, and read his paper showing that the following series of compounds of silicon with various metals of the iron group had been produced in the electric furnace:

Silicon and iron.....	$SiFe_2$	SiFe	Si_2Fe
Silicon and cobalt.....	$SiCo_2$	SiCo	Si_2Co
Silicon and manganese...	$SiMn_2$	SiMn	Si_2Mn
Silicon and nickel.....	$SiNi_2$	SiNi	Si_2Ni
Silicon and chromium....	$SiCr_2$	Si_2Cr_3	Si_2Cr

Professor Moissan followed with his paper on the "Alkali Metal Carbides." After referring to the early work of Berthelot and others on this subject, he described the methods by which he had prepared the carbides of sodium and potassium, and more lately the carbides of rubidium and cesium, the most active of the metals of this group. To obtain the latter carbides, he embedded a thin ribbon of the metal in pure lamp-black, and then raised the metal to a high temperature by means of an electric current. Professor Moissan regards the alkali metal carbides as of some industrial importance, since on treatment with water they produce not only acetylene gas, but a by-product of considerable value. The discovery of a practical and economical method of producing sodium carbide is therefore to be desired, and research in this direction is called for.

The paper by M. Gin upon the "Manufacture of Aluminum," dealt merely with the calculated electromotive force required to decompose Al_2O_3, Al_2F_6 and Al_2S_3 respectively, and the author pointed out that the problem of cheapened production in the aluminum industry was one which the chemist rather than the electrical engineer would be called upon to solve.

The next paper read was in German, and was upon "Evidences of Metallic Action in Oxidation and Reduction Phenomena," the author being Professor Coehn, of Göttingen. Professor Coehn brought forward numerous instances in which the nature of the cathode influenced the results obtained in electrolysis, and asserted that these proved catalytic action to have occurred at the cathode surface. A very lively discussion followed the reading of this paper, and it was urged that the phenomena observed by Professor Coehn could all be explained by the "uber-spannung" caused by the formation of a thin layer of oxides and peroxides on the surface of the cathodes.

The remaining two papers read at this session of section X dealt with industrial applications of electricity, and were as follows:

5. "The Production of Steel in the Electric Furnace," by Dr. Goldschmidt, Essen.

6. "The Manufacture of Carbon Bisulphide in the Electric Furnace," by E. R. Taylor, Penn Yan.

These subjects have been recently dealt with by the present writer and Mr. E. R. Taylor in illustrated articles in the columns of the ELECTRICAL REVIEW, and the papers contained nothing very new on either subject. It is, however, interesting to note that Dr. Goldschmidt admitted, in the discussion which followed the reading of his paper, that the electric processes of steel manufacture could not compete with the older processes for the production of iron and steel from the raw materials of the manufacture, working under the most favorable conditions as regards supplies of coke and

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ore, and that it was chiefly in the production of special steel alloys from scrap iron that their competition would be felt. Very cheap water power is, however, an essential factor of their development, and practically Dr. Goldschmidt is in agreement with the writer as to the future of these processes.

FRIDAY, JUNE 5—AFTERNOON SESSION.

The following papers were read and discussed at the afternoon session of Friday, June 5:

1. "Electrochemical Units," by Professor Nernst, Göttingen.

2. "Report of the Commission Appointed by the 1900 (Paris) Congress on Physical Units," by Professor Marie, Paris.

These two papers were discussed together, and it was decided that the congress should be asked to recommend for international adoption this list of signs and formulæ.

3. "The Decomposition of Carbon Monoxide," by Dr. Schenck, Marburg.

4. "The Variations in the Electric Resistance of Soot and Other Bodies Under the Influence of Light," by M. Ancel, Paris.

5. "Theories of the Contact Process for Sulphuric Acid Manufacture," by Dr. Bodenstein, Leipzig, and Dr. Bodländer, Braunschweig.

6. "Chemical Reactions at the Highest Temperatures," by Professor Zengelis, Athens.

The author, by combustion of powdered aluminum in oxygen, has been able to exceed the temperature of the electric furnaces and has also obtained a new series of nitrogen products, by substituting nitrogen or nitrous oxide gas for oxygen. By burning aluminum in carbon monoxide, he has been able to prepare the carbide of this metal.

7. "Radioactive Bodies," by Professor Marckwald, Berlin.

A paper dealing with the electrolytic separation of an alloy of radium and tellurium from uranium residues. Deposited on copper plates, this alloy is of value for experimental demonstrations of the remarkable properties of radium.

Limit of space renders it necessary that a mere list of the remaining papers read before section X on Saturday, June 6, and on Monday, June 8, should be given.

SATURDAY, JUNE 6—MORNING SESSION.

1. "A Gravity Formula Applicable to Diffusion Phenomena," by E. Solvay, Brussels.

2. "Contribution to the Theory of Reduction Phenomena," by Professor Goldschmidt, Christiania.

3. "The Value of Electrolysis in the Preparation of Organic Compounds," by Professor Elbs, Giessen, and Dr. Büchner, Mannheim.

4. "The Technical Applications of Catalytic Action," by Professor Bodländer, Braunschweig.

5. "The Formation of Complex Compounds by the Sulpho-Cyanide Ion," by Dr. Grossmann, Münster.

AFTERNOON SESSION.

1. "The Applications of Electrical Endosmose and Its Relation to the Colloidal State," by Professor Bredig, Heidelberg, and Dr. Graf, Schwerin Hoehst.

2. Adjourned discussion upon the papers of Bodländer and Bodenstein on "The Contact Processes of Sulphuric Acid Manufacture."

3. "The Physical Chemistry of Wine," by Professor Magnanini, Modena.

4. "Hydrogenation by Catalytic Action," by Professor Sabatier, Toulouse.

MONDAY, JUNE 8—MORNING SESSION.

1. "Electroplating Apparatus and Plant for Depositing Nickel on Small Articles," by Dr. Sacker, Berlin.

2. "Quantitative Separation of Metals by Electrolytic Methods," by Dr. Danneel, Aachen.

3. "Concentration of Dilute Solutions by Freezing and the Production of Freezing Mixtures," by Dr. Monti, Turin.

4. "The Light Emission of the Ions," by Dr. Werner von Bolton, Berlin.

5. "Colloidal Substances." by O. S. Burns, Boston.

6. "Theory of Concentration Changes in Diaphragm Cells for Electrolysis of Alkali Chloride Solutions," by Professor Guye, Geneva.

Section XI of the congress was devoted to papers and reports bearing on the statistical, legal and social aspects of the chemical industries, and twelve papers were discussed by its members. None of these was of special interest to electrical engineers.

In concluding this account of the proceedings of the fifth International Congress for Applied Chemistry, the writer would draw attention to the leading part taken in the sectional proceedings by the professors of chemistry in the universities and high schools of the German Empire.

Though some disadvantages no doubt were attached to this preponderance of professors and "privat dozenten" upon the organizing committees for the various sections, and also in the discussions upon the papers read; the fact that this element was present at the congress in such large numbers shows the close connection between industry and science in Germany, and the lively interest taken by the leaders of science in practical and industrial questions. In section X one result of this over-preponderance of the academical element was the very large number of papers dealing with the theoretical phenomena of electrolysis, and the addresses relating to the practical application of electrolytic methods in the arts and industries were few in number and comparatively unimportant.

Of the fifty-one papers planned for reading before the members of section X only seventeen related (even distantly) to industrial subjects; and many of these were not read, owing to the time taken up by the papers dealing with the theory of electrolysis and by the discussions thereon.

At future meetings of section X of the international congress it may perhaps be possible to obtain a greater number of papers relating to "Applied Electrochemistry," and if the time is more fairly divided between these papers and those relating to theory, it will certainly conduce to the utility and benefit of the gathering.

Ball Bearings for Electric Motors.

Ball bearings are being used extensively in Germany for small and medium sized motors. Some interesting figures taken from actual consumption tests are given in the accompanying table, for which we are indebted to the *Electrician:*

	Motor Running at		
	No Load.	Half-Load.	Full-Load.
(1) Three-phase motor, ¼ h.p., 950 revs. per minute. Saving in energy over same motor with plain bearings.....	50%	19%	11%
(2) For a three-phase motor, 3 h.p. and 1,500 revs. per minute, the corresponding figures.....	45%	12%	6.5%
(3) For a three-phase motor, 30 h.p. and 750 revs. per minute, the corresponding figures are	30%	5%	2.5%

A one-half horse-power three-phase motor running at 1,500 revolutions per minute was tested, first without and then with counter-shaft, all bearings being of the ball type. The following efficiencies for half and for full load respectively were obtained: (1) Without counter-shaft, seventy-seven and seventy-eight per cent, respectively; (2) with counter-shaft, seventy-three and sixty-nine per cent, respectively.

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Annual Meeting of the Society for the Promotion of Engineering Education.

Joint Session Held with the American Institute of Electrical Engineers.

THE annual meeting of the Society for the Promotion of Engineering Education was held at Niagara Falls, July 1 to July 3, 1903. The first session was called to order at 10 A. M. Wednesday, by President Calvin M. Woodward, of St. Louis. The report of the treasurer, Arthur N. Talbot, was read, and it was announced that twenty new members had been elected to the society.

President Woodward then delivered his address. This was a discussion of the value of manual training for technical students, and a plea was made for more general instruction in these subjects in high schools.

Professor Charles F. Burgess reported for the Committee on Technical Books for Libraries. The report gave a list of technical subjects in branches of engineering and science, and included a list of some 350 books thought to be suitable. It was suggested that this list be revised yearly, the committee working together with the American Library Association.

The second session was called to order Wednesday evening by President Woodward, at 8 P. M. A paper by Mr. Arthur W. Ayer, of Philadelphia, was read by Professor Arthur N. Williston. This called attention to the growing importance of technical education, and offered some suggestions which the author thought would be an improvement. Particular stress was laid upon the value of business training.

In the discussion the value of business training was admitted, and it was stated that some work in this is being given in a number of technical schools, but it is impossible to carry it far. The question of what work should be left out to make room for this work was asked.

Professor J. P. Jackson, of State College, Pennsylvania, read a paper on "Methods of Study for Technical Students." The author advocated the group system, the students being encouraged to work together, and related his own success with this method. In the discussion some difference in opinion was shown as to the value of this method of study, it being generally thought that the strong man would profit most, and the weak man least, by group study.

THURSDAY, JULY 2.

The morning session was called to order by President Woodward at ten o'clock. The report of the secretary, Professor Clarence A. Waldo, of Lafayette, Ind., was read.

Professor F. C. Caldwell, of Columbus, Ohio, read a paper on "The Rating of Laboratory and Classroom Work in Schedules of Courses." This discussed the desirability of an understanding of the proper rating to be given to classroom and laboratory work.

A paper by Professor Arthur N. Williston, of Brooklyn, N. Y., was read by the author. This was entitled "Two Kinds of Specialization and Fundamental Principles, In Place and Out of Place." This paper discussed the trend in all lines of work toward specialization, and disproved the stand of the society against this. Special courses are useful where a group of persons desires training in certain lines of work.

In the discussion it was pointed out that in many cases lack of funds prohibits this, and that students frequently do not know what they wish to do.

In reply, Professor Williston said that the small schools could get over the difficulty of lack of funds by offering but one course and adhering to that.

Professor Hugo Diemer, of Lawrence, Kan., read a paper entitled "Education Preparatory to Factory Management." Owners of engineering works have expressed themselves as being in great need of technically educated young men who have the capacity and training to fit them for positions which are executive to a greater or less degree. There is here a branch of productive industry in which there are wide opportunities for life service, and it is the duty of the engineering school to give heed to these claims of the manufacturers.

In the discussion the question was asked, how time is to be secured for this instruction? Some speakers thought that this work did not belong properly to the technical schools.

Papers by Professor Walter H. Drane, Oxford, Miss., entitled "Education in the Southern States," and by Professor S. Henry Barraclough, of the University of Sydney, Australia, on "Progress in Technical Education in Australia," were read by title.

Professor A. H. Blanchard, of Providence, R. I., read a paper entitled "Engineering Jurisprudence an Essential in the Engineering Curriculum." The study on engineering jurisprudence by technical students is advantageous because of the knowledge required, for the insight gained into business relations and methods, due to a cultivation of respect for strict legal clauses in specifications, and on account of the development of reasoning power and independent thought. The course should extend throughout the senior year, one hour per week.

In the discussion the advisability of giving instruction in this work was recognized, but some speakers expressed the opinion that sufficient time was not allowed for the course.

The Thursday evening session was called to order at eight o'clock by the president. The election of the following officers for the ensuing year was announced: President, J. Frank Allen, Boston, Mass. Vice-presidents, Charles L. Crandall, Ithaca, N. Y.; James C. Nagle, of College Station, Tex. Secretary, Clarence A. Waldo, La Fayette, Ind. Treasurer, Arthur N. Talbot, Urbana, Ill.

A communication was read from Professor J. L. Van Ornum, of St. Louis, Mo., upon recent tests on cement.

Professor Walter M. Riggs, of Clemson College, S. C., read a paper entitled "The Equipment of an Electrical Engineering Laboratory." This paper was illustrated by lantern slides, and described the equipment which had been found satisfactory at this institution.

Professor A. F. Ganz advocated a lecture course in laboratory methods before taking up laboratory work.

A paper by Professor J. A. L. Waddell, of Kansas City, Mo., on "The Advisability of Instructing Engineers on the History of Their Profession," was read by Secretary Waldo. The author deplored the ignorance of students and young engineers in the history of their profession, and stated that there was at present no satisfactory book on the subject. He proposed that the society appoint a committee to consider the advisability of the society undertaking the writing and publication of the history of civil engineering, using the latter term in its broad sense so as to cover all branches of engineering except the military. Some suggestions were made concerning the proposed work. It should cover all branches, and it would probably be advisable to have different topics written or compiled by different engineers. A number of communications on this paper was read. The greater part of these expressed warm approval of the undertaking; others did not think it advisable for the society to go into the matter. Not all agreed with the author on the ignorance of engineers in regard to their profession.

Resolutions were adopted thanking the American Institute of Electrical Engineers for its courteous invitation to meet in joint session the following day, July 3, and for its hospitable entertainment. The society then adjourned to meet in joint session with the American Institute of Electrical Engineers on Friday.

The proceedings of the Friday morning session will be found in the report of the convention of the American Institute of Electrical Engineers.

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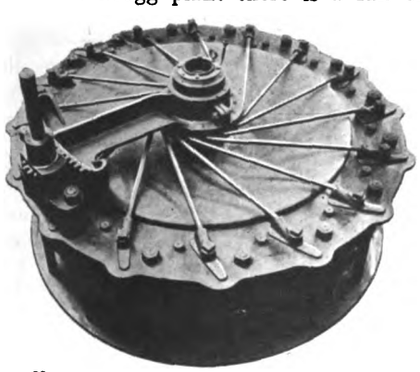
SWISS VERTICAL TURBINES.

BY FRANK C. PERKINS.

Among the hydroelectric plants abroad having a fall of less than ten metres and using vertical turbines, may be mentioned the Stadtisches Elektricitatswerk Aarau and those at Brugg, Wynau-Langenthal and Luterback-Solothurn.

The Aarau plant is of that construction utilizing vertically driven alternators directly-connected on the shaft of the turbine similar to the method used at Niagara Falls, but of course with much shorter shafting on account of the low head. The other plants, while employing vertical shaft turbines, use electrical generators with horizontal shafts and either transmit the power to the dynamos from the turbine shafts by bevel gearing, as at the Wynau-Langenthal installation, or utilize belt transmission from countershafts as at the Brugg and other plants. The horizontal turbine has many advantages over the vertical turbine, especially when generators of the horizontal shaft type are to be employed, on account of the great simplicity and the absence of troublesome gearing. Where it is desirable from special conditions met with to use vertical turbines, the vertical shaft generators are of great convenience in simplifying the installation.

At the Brugg plant there is a fall of



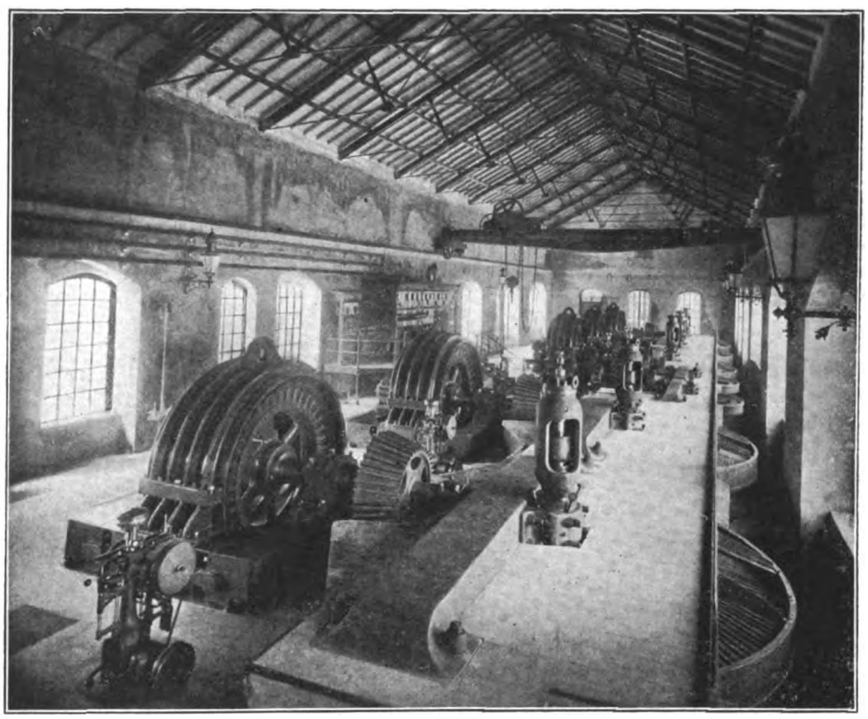
VERTICAL TURBINE AND WHEEL CASE.

2.38 metres and the discharge is 6,330 litres per second per turbine. There are two Rieter turbines installed at this plant, each having a capacity of 150 horse-power. They are of the slow-speed vertical type, operating at thirty-three revolutions per minute. They are employed in driving five direct-current generators by belt transmission and are controlled by special automatic governors designed by John Jacob Rieter & Company, of Winterthur, Switzerland. The electrical machines were built by the Elektricitats-Actiengesellschaft, formerly Schuckert & Company, of Nurnberg. A third turbine has been installed at this plant of the Francis type, which has a capacity of 260 horse-power, the effective head being increased to 3.12 metres and the speed to fifty-one revolutions per minute. This turbine passes 8,300 litres of water per second.

At the Luterbach-Solothurn plant, owned by the Aare-Emme-Kanal-Gesellschaft, there are in operation six Rieter turbines working under a head of only 1.8 metres. These vertical turbines drive by belt transmission six generators, built by Brown, Boveri & Company, of which five are alternating-current machines and one is of the direct-current type. The vertical turbines run at a speed of only thirty revolutions per minute and pass 8,660 litres of water per second, delivering a total of 696 horse-power or 116 horse-power each.

At the plant of Geizner, Mutter & Company, at Bludenz, Autriche, there are five vertical turbines of 300-horse-power capacity, working under a head of nine metres and discharging 3,240 litres of water per second. The vertical turbines at the Wynau-Langenthal plant are geared directly to the five alternating-current machines by bevel gearing. The two exciters and the five alternators were constructed by Siemens & Halske, of Berlin, Germany. The turbines driving the exciters run at a speed of ninety-six revolutions per minute, the head being four metres and the discharge per turbine 3,000 liters per second. These machines have a capacity of 120 horse-power each. The main turbines of the Rieter type develop 750 horse-power each or a total of 3,750 horse-power, the discharge being 18,800 litres of water per second per turbine and the speed 41.5 revolutions per minute.

There are two vertical turbines at the



THE VERTICAL TURBINES AT THE WYNAU-LANGENTHAL, SWITZERLAND, PLANT.

Aarau plant, directly connected to vertical alternators, built by Brown, Boveri & Company, of Baden, Switzerland. The Rieter turbines work under an effective head of four metres, and develop 400 horse-power each at a speed of forty-eight revolutions per minute. The water discharge for each turbine is 10,700 litres

VERTICAL TURBINE.

per second. The canal supplying the water for the power station at Aarau is 2,400 metres long, and carries at low water 23.3 cubic metres of water. Of the three turbines installed, the smallest one

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has a capacity of 200 horse-power and is utilized by the Cementfabrik Fleiner.

The vertical alternators are two-phase machines and supply a current of 2,000 volts pressure and a frequency of forty periods per second. The power transmission lines carry the current to Aarau, a distance of one kilometre, and both lighting and power service is supplied.

It is claimed by many prominent engineers that the efficiency of the vertical turbine may be made considerably higher than that of the horizontal turbine, although it would seem that the efficiency and power of both should be approximately the same. The advantages are many times in favor of the horizontal shaft turbines, on account of the case with which the turbine shaft may be extended, and pulleys be utilized for the transmission of the power at a higher or lower speed. The horizontal turbine may be designed for all heads—high, low and medium—and those constructed at Winterthur are of the Girard, Pelton, Francis, Rieter and American types.

Bath Electric Tramways, England.

The British Westinghouse Electric and Manufacturing Company, Limited, is now executing a contract for the Bath Electric Tramways, Limited, London, which well serves to indicate the position which the former company is now taking in general contracting work. The contract in question includes the building of the generating station and car sheds: also the supply, delivery, and erection of the entire equipment for the two buildings, in accordance with designs prepared in conjunction with the engineers of the Bath Electric Tramways Company.

The generating station equipment is to consist of three 200-kilowatt, Westinghouse generators, direct-connected to horizontal, tandem-compound engines, and one seventy-five kilowatt generator direct-connected to a compound steam engine. Two fifteen-kilowatt negative boosters are to be supplied, with a twelve-panel switchboard, of the Westinghouse tramway type, as well as such other auxiliary apparatus as is involved in a tramway generating station.

The boiler house is to be equipped with three 10,000-pound Babcock & Wilcox straight tube, water-tube boilers, and a Clay Cross economizer; surface condensers are to be used, and also a complete equipment of water-softening and grease-separating apparatus.

The car shed is to have a capacity of forty double-deck, fifty-six-passenger cars. On the second floor and across the front of the car sheds are to be located the offices of the company.

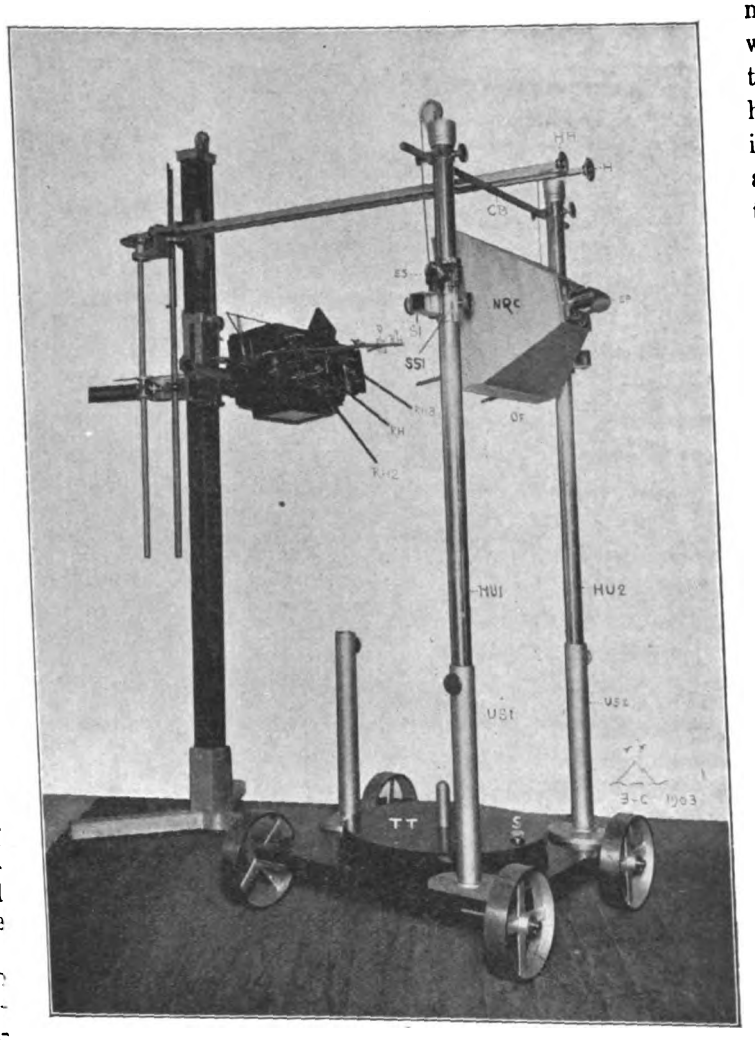
The rolling stock is to consist of forty cars, the bodies and trucks being of the Milnes make, and Westinghouse equipments. Most of the cars will, at the outset, be equipped with the Westinghouse magnetic brake, which should be found particularly useful on the Bath system, because of the large number of severe gradients.

NOTES ON X-LIGHT.

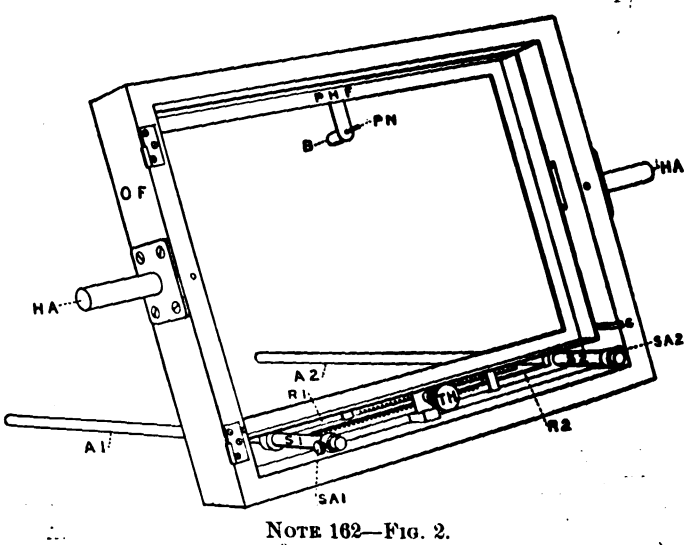
BY WILLIAM ROLLINS.

NOTE CLXII—A WAGON FOR X-LIGHT EXAMINATIONS.

I use the term wagon to emphasize the fact that the support for the patient is on wheels. In note cxv, March 9, 1901, I showed the importance of this plan in X-light examinations, stating why it was superior to the universally employed method of a fixed support. The plan here mentioned of mounting a patient on an axis that he may be turned in a horizontal plane and providing a graduated circle for indicating the amount of rotation is not claimed as original. It has been used by Williams for examining a patient in a sitting position in an office chair, elevating with a screw. For examining a patient's chest from the front, I prefer the standing position, as his knees and the arms of the chair make the sitting position inconvenient, therefore the X-light wagon here described is arranged not only for a sitting but also for a standing position. The wagon is furnished with a turn-table (TT, Fig. 1) which has the usual graduations, and is provided with a stop, S, which holds it in any position when a photograph is to be made. The base of the wagon and the turn-table are made of hard wood, cross-glued in three layers. There are four wheels, each thirty-six centimetres in diameter. The wheels may be deemed larger than necessary. The size was chosen to enable the movements of the wagon to be easily made by one hand during an examination, that the relative positions of the source of light and the patient might readily be changed without removing the eyes from the image on the screen. To the wagon base three upright metal sockets are attached. Two of these, US 1 and US 2, hold two metal tubes, HU 1 and HU 2, which support the frame, OF, holding the inner frame, PHF, Fig. 2, for the plate-holder and fluorescent screen. The frame, OF, can be turned about a horizontal axis to enable the fluorescent screen or photographic plate to be tilted from a vertical position when necessary to bring either closely against the patient. Usually in examining the chest from the front, the



NOTE 162—FIG. 1.



NOTE 162—FIG. 2.

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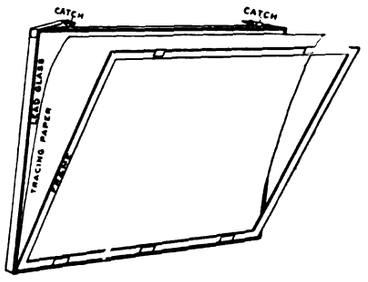
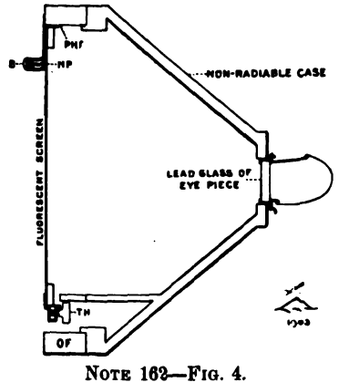
top of the fluorescent screen needs to be tilted back, as shown in Fig. 1. The frame can be swung to one side by sliding back the socket, SI, or removed by also sliding back a similar socket on the other



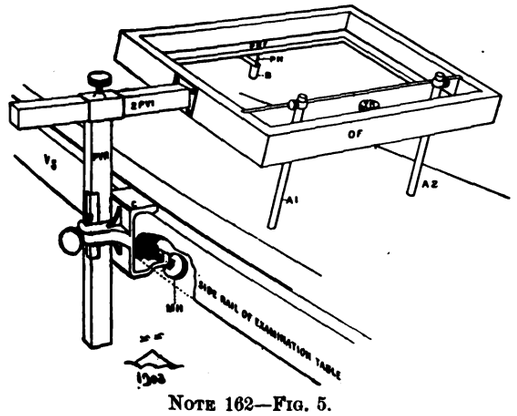
NOTE 162—FIG. 3.

side. The supports, SS 1 and a similar one on the other side, slide on the uprights to enable the frame to be adjusted to any height, where it will remain without clamping, as it is balanced by weights within the uprights. Clamping screws



NOTE 162—FIG. 4.

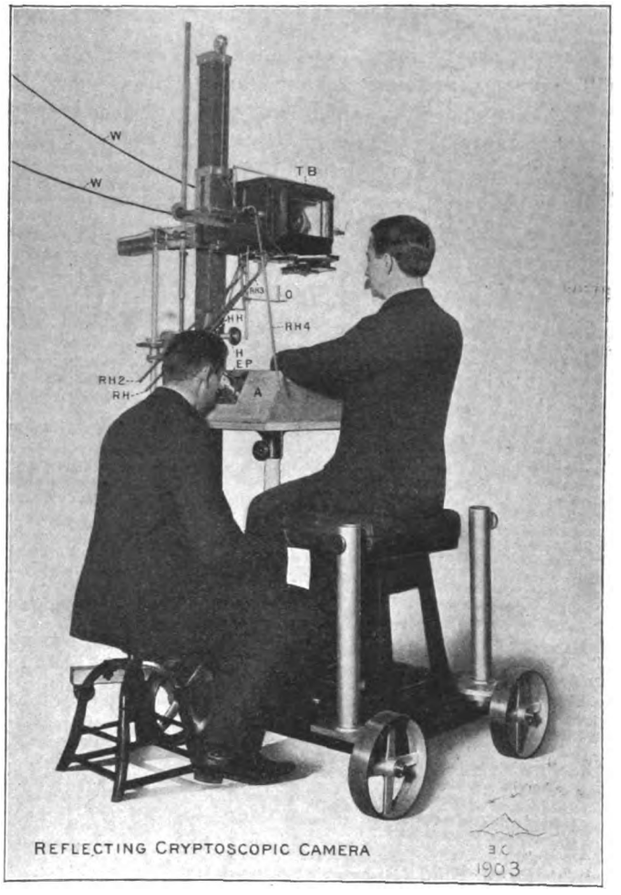
are provided for preventing movement during photographic exposures. A back support for the patient can be attached to the extra sockets, ES and a similar one on the other side. The frame, OF, is provided with a non-radiable pyra-



NOTE 162—FIG. 5.

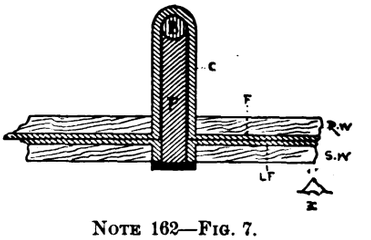
midal case, NRC, which has the same non-radiable eye-piece shown in earlier notes. This case can be turned back or entirely removed as it is attached to the frame, OF, by separable hinges. For examinations with the screen this case is convenient, as the room need not then be very dark. For photography it has the advantages mentioned in note clv. In making tracings of the organs the case, NRC, may be entirely removed, the room being dark, or an opening may be made in the side and provided with a sleeve for the insertion of the hand bearing the tracing pencil. If the screen is used without the case, it must be covered by a plate of heavy lead glass to prevent the X-light from injuring the eyes of the observer. This protection of the eyes is a point which is neglected. I frequently mention it, as my experiments on animals showed that the light could produce blindness. Over the glass is placed the tracing paper or cloth in the usual manner. I hold the glass and the tracing paper in a frame, shown in detail in Fig. 3. To compare one tracing with another, we have only to see that the image of my orienter occupies the same position on the screen in every case and that a tracing of its image on the screen is made on the paper when the shadows of the organs are sketched. To maintain a definite relation of the tracing paper to the patient I designed for Dr. Williams a frame, PHF, shown in detail in Fig. 2. It is of metal of proper size to receive either or both the fluorescent screen and plate-holder, or the fluorescent screen and the glass plate, either with or without the tracing cloth. There is a boss, B, of polished metal which fits into the sternal notch of the patient, a definite and easily distinguished point in the anatomy which is therefore satisfactory as a base station. The boss is hollow containing a spring-actuated needle, PN, which pricks a hole in the tracing paper, thereby indicating on the tracing the position of the base station, from which all measures of the tracing should be made when we wish to compare one with another.

To ensure that the tracing paper always occupies the same position in relation to the patient at every examination, it is also necessary to have some other reference points which may well



NOTE 162—FIG. 6.

form a triangle with the base station. The idea of using the nipples for reference points as is done in percussion may be definite enough for so inaccurate a method, but I discarded it when Williams showed by X-light that one could not determine accurately the outlines of an enlarged heart by percussion. I found the distance between the nipples in a woman of normal form varied several centimetres, according to the position of the



NOTE 162—FIG. 7.

body. In X-light examinations we expect the lines obtained by tracing to be capable of comparison within three millimetres. What was needed was some convenient method of indicating on the tracing paper the position of the medial

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line of the body, as this should be the line from which all transverse measures are taken, all vertical measures being referred to the pin prick showing the position of the sternal notch. But how was the medial line to be accurately determined? I used and recommended the method shown in Figs. 1 and 2. There are two arms, A 1 and A 2, attached to racks, R 1 and R 2, which are moved simultaneously in opposite directions equal amounts by turning the milled head, TH, which therefore serves to bring the arms in contact with the sides of the patient's chest. If now a medial line is printed on the sheets of tracing paper this line must indicate the medial line of the body when the tracing paper is in the frame, PHF, provided the boss, B, is in the sternal notch. If this procedure is followed, a tracing made at one time can be compared with those taken at other times.

The needle point already mentioned, which pricks the paper to record the position of the sternal notch, would prevent the insertion of the plate-holder into the frame if it was fixed, but it is forced back by the plate-holder into the boss, B, springing forward when the plate-holder is removed. If we do not wish to examine the image on the fluorescent screen while the photograph is being made, it is best to use the non-radiable plate-holders described in notes cxvi, March 9, 1901, and cxl, June 21, 1902. Under these circumstances the pyramidal hood, NRC, Fig. 1, can be turned back or removed, as the non-radiable back of the plate-holder protects the plate from the diffused and transformed light. If, on the contrary, we wish to see the organs while the exposure is being made, the back of the plate-holder should be of radiable material, the fluorescent screen being placed between it and the observer. Stray light being prevented from reaching the plate by the hood, NRC, which is closed over the plate-holder, the observer looking into the eye-piece, EP, to see the image on the screen.

Of course, I am aware that the projection of the images of the organs on a flat surface distorts them and that observers have recommended making the tracings on the skin and transferring the lines to the tracing paper, which is made to conform to the surface of the skin. This method is not practical with a woman of normal shape, as the breasts prevent it being accurate. As there is a necessary distortion if the source of light is stationary, the slight increase produced by the method recommended is not of serious importance; as for each patient the amount is fixed and therefore introduces no element of confusion. If we wish to avoid all distortion we must have the screen and tube move simultaneously, as has been done by Moritz. The future alone will determine which method is of most use. If we do not use the fluorescent screen in the non-radiable cone provided with a non-radiable transparent eye-piece, we should cover it with a sheet of heavy glass (which will also serve as a support for the tracing paper) to protect the observer's eyes from the X-light. The arrangement is shown in Fig. 3.

Whether the observer uses the direct vision cryptoscopic camera, NPC + OF, Fig. 18, or the glass-covered open fluorescent screen, he has within reach six handles (shown in the figure) which allow him, in connection with the rolling motion of the X-light wagon, to make the necessary adjustments in the position and quality of the X-light, and by means of the break shown in the illustrations to note cxxxix he can control the quantity. H raises or lowers the source of X-light. HH moves it toward or away from the patient. RH regulates the size of the area illuminated. RH 2 and RH 3 centre the opening of the diaphragm and the orienter with the central ray. RH 4 controls the quality of the light.

In addition to the use of an X-light wagon for examining the head, neck, shoulder or chest of a patient in a sitting or standing position, it is useful for photographing the hand, forearm, elbow and upper arm. For these purposes it is provided with one of my reflecting cryptoscopic cameras, similar to those illustrated in note clv. This camera can be placed at different heights above the floor of the wagon.

For photographing the hands for my method of anthropometrical signalment by X-light the turn-table, TT, Fig. 1, is removed. The person to be signalized is seated on a stool with the camera in front (Fig. 6), the hands' palms down resting on the fibre top. The light is then adjusted until the image of the central tube of the oreinter is seen on the screen within the camera between the thumbs, opposite the first joints. In taking the forearm, wrist, elbow or upper arm the patient should be at the side of the camera which is brought to the proper level. Directions for the use of a camera of this type are given in note clv. The cross-bar, CB, Fig. 1, which holds the uprights parallel, also serves as a support for the patient's hands, thus bringing his arm out of the field when examining the chest from the side, which is necessary in studying the heart, as Williams' triangle, thus brought to view, is of an important diagnostic point.

The frame, OF, with all it contains can be removed from the X-light wagon and attached to the examination table shown in earlier notes. The mechanism for this purpose is a modification of that illustrated in note cxxxix for supporting a plate-holder with a non-radiable back. I show it in Fig. 5. VS is a piece of the side rail of examination table. The milled head, MH, presses the rail into the corner of the clamp, C, holding it securely, yet permitting of immediate removal when desired. A similar milled head also clamps the vertical arm, PVR, and this in turn carries another arm, 2 PVR, holding the frame, OF, which can be turned about a horizontal axis to allow the screen or plate-holder to rest against the patient's chest. Thus tracings or photographs can be made with the patient in a horizontal position, the patent being relieved of all unnecessary weight, as this is supported by the rail of the examination table. Full details of the various positions in which this type of mechanism permits a plate-holder to be held were given in the note mentioned.

The Telephone Line Between London and Belgium.

Mr. George W. Roosevelt, United States Consul at Brussels, writes as follows, under date of June 10, 1903: The new telephone line between Belgium and London was opened to the public June 7. The exact length of the finished line, which connects St. Margaret's Bay, England, with La Panne, Belgium, is 87,000 metres (54.058 miles) and the cost of laying was 750,000 francs ($144,750). By this service, Antwerp and Charleroi will be conected with twelve English cities and towns, Brussels with sixteen, and Ghent, Malines and Termonde with eleven. Liege, Verviers, Bruges and Ostend will have communication only through Brussels. Localities in the United Kingdom to be shortly included in the service are Birmingham, Brighton, Bristol, Cambridge, Cardiff, Derby, Ipswich, Sheffield, Southampton, Leicester, Lowestoft, Newport, Norwich, Nottingham and Yarmouth.

The cable is of British make and is composed of four wires, permitting the establishment of two distinct circuits. The thickness of the cable is five and one-quarter inches and the wires are insulated by three coats of chemical composition and by gutta-percha, and are wound on a cable made of tarred flax. The whole is covered by two layers of specially prepared cotton, separated by a copper band. On top of this again a layer of flax acts as a protector, and finally the whole is enclosed in galvanized-iron wires, prepared in a special way and encased in two layers of flax tightly wound in opposite directions.

The tariff for using the telephone is ten francs ($1.93) for three minutes' conversation.

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A RATIONAL TRAIN RESISTANCE FORMULA.[1]

BY JOHN BALCH BLOOD.

1. In the early days of train resistance formulæ, when speeds were not high, the frictional resistance of track and journals was a considerable factor in the total resistance. Again, the head resistance was charged up to the locomotive, without a formula, and train resistance meant the pull on the engine drawbar.

These facts, together with the fact that the criteria of industrial competition were loosely drawn, made a simple formula the desideratum, and we see as a result formulæ of many varieties containing a single variable.

These served their purpose at the time, but time and advancing knowledge showed their inadequacy both as to absolute results and functionally. The immediate needs were supplied by sets of formulæ with different coefficients and variables, each good only for a certain range.

The original single-term formulæ were of two kinds, as follows:

$$R = A + BM \qquad (1)$$

$$R = A + CM^2 \qquad (2)$$

Where R = train resistance in lbs. per ton,
M = speed of train,
A, B and C = coefficients.

2. The development from these formulæ showed a desire for a rational formula, the elements of which would represent distinct parts of the resistance recognizable and measurable. Experiments and the gradually increasing train speeds began to indicate the different elements of resistance, although the function and absolute value of each was not obtained.

The higher normal train speeds brought out the fact that a factor of the resistance was the air friction, and that it certainly varied as a function of the speed greater than unity, and in all probability as the square.

3. In 1885, the Eastern Railway, of France, made some very extensive experiments and gave as its results a set of formulæ of a rational type, using different coefficients for different ranges of speed. Its formula was of the type

$$P = (A + BM)\,T + CQM^2 \qquad (3)$$

Where P = total pull or horizontal effort,
M = speed,
T = weight of train,
Q = cross-section of train,
A, B and C = coefficients.

This reduces for comparison with other formulæ to

$$R = A + BM + \frac{CQM^2}{T} \qquad (4)$$

It will be noted that for trains with a speed of twelve to thirty-two kilometres per hour, the engineers left off the last term having the speed-factor as the square, leaving a formula of the form (1).

This formula (4) is interesting from a rational standpoint. First, it has two terms with variables; one as the first power of the velocity, and one as the second power of the velocity. Second, the second power-factor has a component, the cross-section of the train. This would show that this factor was to give the air resistance, and would show that they appreciated that there was another part of the resistance that was not constant, and yet it did not vary as the square.

4. Their set of formulæ, instead of a single formula, showed that their variables were not functionally correct, and must be modified by variation of the coefficients.

The set of formulæ as given by them is as follows:

(*a*) For freight trains speeds twelve to thirty-two kilometres per hour.

$$W = (1.65 + 0.05\,v)\,Q.$$

(*b*) For passenger trains speeds thirty-two to fifty kilometres per hour.

$$W = (1.8 + 0.08\,v)\,Q + 0.009\,Av^2.$$

(*c*) For passenger trains speeds fifty to sixty-five kilometres per hour.

$$W = (1.8 + 0.08\,v)\,Q + 0.006\,Av^2.$$

(*d*) For express trains speeds seventy to eighty kilometres per hour.

$$W = (1.8 + 0.14\,v)\,Q + 0.004\,Av^2.$$

Where W = resistance of train in kilogrammes,
Q = weight of train in tonnes of 1,000 kilogrammes,
V = speed in kilometres per hour,
A = cross-section of trains (5 qm.).

These formulæ were very accurately constructed from careful and exhaustive experiments, and the variation in the coefficients will serve to indicate the functional inadequacy of the variables.

There are four points to be observed in the variation of these coefficients. First, that the factor independent of the speed was apparently constant at all speeds. The deviation from this in case of freight trains could probably be accounted for by the construction of the car or the relative weight of load per axle. Second, it will be seen that the coefficient of the first power-factor is increased as the speed increases. Third, that the coefficient of the second power term is decreased with increased velocity. And fourth, that the second power term is eliminated from the low-speed formula.

5. From these observations we would draw the following conclusions: that there is a portion of the train resistance that is independent of the velocity; that the air friction-factor has little or no influence below thirty-two kilometres. These seem to be clear.

The increasing of the coefficient of the first power term and the decreasing of the coefficient of the second power term indicate an empirical attempt to adjust the coefficient to take care of improper functional value of the variables.

We find a single variable formula with first power-factor gives too small results for high speeds if it is correct for low speeds. We find, also, that a single variable formula with a second power-factor gives too high results at high speeds if it is correct at low speeds. This would seem reasonable, as it is apparent that there are at least three forms of friction—plain sliding friction, which is independent of the speed; rolling friction, which varies directly as the speed; and fluid friction, which, in case of air, would vary theoretically as the second power of the speed.

6. It seems, then, perfectly reasonable that a rational formula should have these three terms. Experience shows that while a formula having three terms of zero, first and second power variables, respectively, will give accurate results for a wider range than either of the single variable formulæ, it in common with the second power single variable formula gives too large results at high speeds, if it is correct at the lower speeds.

This is apparently what the engineers of the Eastern Railway, of France, found, and they tried to counteract this by reducing the effect of the second power at higher speeds by reducing the coefficient, and by increasing the effect of the first power term at higher speeds by increasing its coefficient. It would seem that the increase of the relative moment of the first power term at high speeds was palliative only, rather than that the rolling friction did increase in greater ratio than the first power.

The conclusion to draw from the above is, that the third term of the equation should have an exponent greater than one and less than two.

7. In March, 1899, I presented in the

[1] A paper presented at the Saratoga meeting (June, 1903) of the American Society of Mechanical Engineers, and forming part of vol. xxiv of the *Transactions*. For further references on this subject see *Transactions* as follows: No. 924, vol. xxiii, p. 269, "Cost of Running Trains at High Speed."

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Street Railway Journal a rational formula with a third term having an exponent of 1.8; giving reasons somewhat as above to substantiate its reliability. The formula expressed in the same terms as above was:

$$R = 4 + 0.15\,M + 0.3\,\frac{M^{1.8}}{T} \qquad (5)$$

Mr. W. J. Davis gives a formula which gives very accurate results below forty or fifty miles, but it is generally acknowledged that it gives too high results at higher speeds. The formula is:

$$R = 6 + 0.13\,M + 0.25\,\frac{M^2}{T}$$
$$[1 + 0.1\,(N - 1)] \qquad (6)$$

Mr. Davis gives different coefficients for different sizes of cars, but does not vary them for the speed. The large cars would naturally be used at the higher speeds, so that the coefficients, if adjusted to the higher part of the curve for the larger cars, would give a series of curves with better total results, but would not be any more functionally correct than the French formulæ.

8. There is a point in rational formulæ which is very important; namely, that the terms for head and stern resistance have in the denominator a factor proportional to the length or weight of the train. This appears in many formulæ, and is reasonable when it is considered that the head and stern resistance would be independent of the length of the train, and, therefore, when expressed in pounds per ton, would be inversely proportional to the weight or length. In most formulæ the weight is used rather than the length. This would give as a prinicple that the head and stern resistance, which varies as a power of the speed between one and two, should have a weight-factor in the denominator.

It has been found by experiment that the air resistance on the sides of the cars varies as power of the speed higher than the first. It is evident that this factor of total resistance should be proportional to the length or weight of the train, and therefore in our form of formula would have no weight-factor in the denominator.

The head and stern resistance can be divided if it is desired. It is found in actual practice that the head resistance is much larger than the stern resistance. Professor Goss's experiments on models show that this head resistance is 6.5 times the stern resistance, and that the head and stern resistance together are about 6.2 times the side resistance of one car.

From collateral evidence it would seem that the coefficient of the variable in the side resistance term should be considerably lower than that of the head resistance term. The air, in case of the side resistance, is not compressed, but is sheared off, and the fluid particles are dragged aside rather than piled up on each other.

On the basis of the above, the rational formula would be:

$$R = A + BM + CM^n + D\,\frac{M^p}{T} + E\,\frac{M^p}{T} \qquad (7)$$

Where R = resistance in pounds per ton,
M = speed in miles per hour,
T = weight of train in tons,
n = exponent of side friction term,
p = exponent of head and stern friction terms,
A = coefficient for sliding friction,
B = coefficient for rolling friction,
C = coefficient for side air resistance,
D = coefficient for head air resistance,
E = coefficient for stern air resistance.

Now, we have not yet enough data for determining the proper exponents, nor to seperate the exponents into the two forms. Again, as there are always two ends to a string, the head and stern resistance will always come together.

Until we find sufficient evidence to give us the two exponential factors, we will be better served to combine all three exponential factors into one. Again, for general work this would be simpler and sufficiently accurate. We would then have:

$$R = A + BM + \left(C + \frac{D}{T}\right)M^n \qquad (8)$$

9. This is essentially the formula given by me in 1899, the only difference being in the coefficient of the exponential term separating out a factor representing the side resistance, which is proportional to the train weight.

Where R = resistance in pounds per ton,
M = speed in miles per hour,
T = weight of train in tons,
n = exponent = 1.8,
A = coefficient of sliding friction,
B = coefficient of rolling friction,
C = coefficient of side resistance,
D = coefficient of head and stern resistances.

The values of these various coefficients are as follows:

A = 3 for heavy freight trains.
A = 4 average passenger trains.
A = 5 heavy large electric cars.
A = 6 medium electric cars.
A = 7 light electric cars.

B = 0.15 for light track construction.
B = 0.12 for heavy track construction.

C = 0.0016 for ordinarily constructed cars.
C = 0.0014 for cars with vestibules.

D = 0.25 for small cross-section cars.
D = 0.30 for medium section electric cars.
D = 0.35 for large electric or suburban trains.
D = for largest express trains.

As our experimental data are increased, it will be possible to correlate these coefficients more intimately with the elements of friction they represent.

The foregoing has shown the gradual development of the train resistance formula from a rational standpoint. It, however, has been viewed all along from the start from an empirical standpoint.

10. When it was found that a formula with a single variable term was insufficient, there were those who refused to add another term to the formula, contending that such term did not give an absolute formula, and only extended its range if results were at all in advance. Again, the range of increased alleged accuracy was within the range of variation in the value of the coefficients, so that altogether the extra complication was not worth the result. These advocated an empirical formula taking such range for each separate set of coefficients as experience would warrant.

There were others, I believe, who were led to abandon the rational formula on account of intellectual cowardice. They found that a single variation formula was hopelessly inadequate with either the first power or the second power. After having passed to the three-term formula with first and second power variables, they saw that with the increase of speed and shortening of trains, too high results would be obtained at high speeds. They balked at following the natural and logical course of reducing the exponent of the second power term, arguing, perhaps, that complication of the fractional exponent was not warranted; also, perhaps, being led by the fact that the theoretical air resistance is known to vary as the second power.

11. Let us consider the uses of a train resistance formula. Originally, it served more as a guide than an engineering hypothesis. As skill in design and application increased, more and more attention was paid to the fitting of machines

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to the work they had to do. Moreover, with steam railroads and long trains, extreme accuracy was not essential, as one or more cars could be added or taken off as conditions required.

With the advent of short suburban trains with three to five cars, short distances between stations and a demand for increased schedule speed, it became very necessary to fit the motive power with a nicety to its work. In case of a three-car train, if the locomotive was too small, the taking off of a single car would reduce the train weight thirty-three per cent, and then the locomotive would be too large, besides necessitating a change in the time tables.

This need was still further emphasized by the high speeds of such trains as the Empire State Express, of the New York Central & Hudson River Railroad, and also by the high-speed interurban electric cars. In case of these electric cars, the motive power of each car being on its own axles, there is no possibility of adjustment if it is not suited to its work.

It will be seen, then, that the use of train resistance formulæ has changed from that of a general guide to that of a fundamental engineering criterion. Extreme accuracy is now a desideratum, functional as well as absolute.

Again, the complication of the number of terms and the fractional exponent is not the drawback that it would appear, as the use of such formulæ now takes the intermediary of charts or curves, eliminating all complication of calculation. Moreover, the general use of the slide-rule makes a fractional power practically as easy of calculation as the integral factor.

Those who argued for the empirical formula pretty generally stuck to the single variable formula, and varied the coefficients to suit the case. There were those who, finding the two variable formulæ inadequate, apparently went on an empirical excursion to find some form which would give accurate results for a wider range than given by existing formulæ. The formula of Mr. John Lundie is of this class, and as stated by him is:

$$R = 4 + 5\left(0.2 + \frac{14}{35 + T}\right),$$

which, reduced for comparison with rational formula, becomes

$$R = 4 + 0.20\,M + \frac{14M}{35 + T} \quad (9)$$

The third term of this equation can not be explained rationally. The depreciated reciprocal weight-factor has no rational analogy in practice. This formula has all the complications of a three-term formula, without the advantage of rational formula.

12. Mr. J. A. F. Aspinall, the general manager of the Lancashire & Yorkshire Railway, has gone into the matter of train resistance in an exhaustive manner, and presented in November, 1901, at a meeting of the British Institution of Civil Engineers a paper on the subject. He gave as a results of his study and experiments for a five-car train:

$$R = 2.5 + \frac{V^2}{57.8} \quad (10)$$

Where R = resistance in pounds per ton of 2,240 pounds drawn,
V = velocity of train in miles per hour.

He found that for a greater number of cars that the length entered as a factor and gave

$$R = 2.5 + \frac{V^2}{50.8 + 0.0278\,L} \quad (11)$$

Where L = length of train in feet.

It will be noticed that the independent coefficient is small. It can generally be taken as a fact that when the independent factor is less than three the formula is empirical, and that the independent coefficient is reduced to compensate some other error introduced. In all formulæ this independent factor represents the resistance just before coming to rest, and is the minimum obtainable resistance. This is seldom less than four pounds, and only in exceptional cases goes below 3.5 pounds.

Mr. Aspinall has the courage to go to a fractional exponent. He, however, combines all variables into one term, thereby cutting loose from a rational formula. He has also a depreciated reciprocal length-factor, which is comparable with Mr. Lundie's depreciated reciprocal weight-factor. Mr. Lundie has a third term with the first power variable alone, which Mr. Aspinall has not.

Although I am a believer in a rational formula, I was pleased to see Mr. Aspinall's fromula, as he is the first man to give, other than myself, a fractional exponent of the variable.

Mr. C. O. Mailloux recommends an empirical formula, and one of the form

$$R = A + BM^n \quad (12)$$

Now, mathematically, this equation can be made to very closely represent any curve with a constantly increasing function and, therefore, can be made to represent any given test curve, probably, within the limits of accuracy. If a curve be plotted representing a given set of readings, and a curve of form of equation (12) be plotted to represent such curve, if the highest points of the two curves coincide, it will be found that the empirical curve cuts the real curve at two points, and that the values of the resistance as calculated from the empirical curve beyond the upper limit are higher than the true values. It is very important in extending curves to have all points determined as accurately as possible, for a slight variation in direction is magnified by the amount of extension. That this empirical curve would give high results on the extension is obvious when it is considered that a factor varying as the first power of the velocity is eliminated and its place taken by an augmented coefficient of the higher power-factor. At low values of the speed, the difference between the true value of the first power variable and its substituted higher power-factor would probably be within the limits of accuracy of observation, but this is not so at high values, and would always lead to high results. This empirical train resistance formula is good to represent a given series of results for mathematical or functional comparison. It, however, is of little, or, perhaps better stated, inferior value for predicted results of extension beyond the highest value of observation. It is very important for extending the curve that the first power-factor be present and accurately determined as to its coefficient.

13. Another important point which the empirical formulæ entirely leave out is the relative value of the different portions of the resistance. In a rational formula it will be seen that the side air resistance comes within the limits of accuracy at about thirty miles per hour, and the head and stern resistance become negligible for a six-car train at about the same speed; but for a single-car train, they do not become negligible till you get down toward twenty miles per hour. It would seem this is a very important function of a train resistance formula. It would seem, in conclusion, that all arguments favor the rational form rather than the empirical form, and that the highest exponential variable should have a fractional exponent between one and two.

Condensing engines require from twenty to thirty times the amount of the boiler feed water, for condensing purposes. An approximation, for estimating purposes, is one and one-quarter gallons condensing water per minute per indicated horsepower. It is usually estimated that a condenser will decrease the fuel consumption by from twenty to twenty-five per cent.

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A FORM OF MAGNETIC DETECTOR FOR HERTZIAN WAVES, ADAPTED FOR QUANTITATIVE WORK.[1]

BY J. A. FLEMING.

The normal power of electrical oscillations to demagnetize iron or steel was first applied in the construction of a detector of Hertzian waves by Mr. E. Rutherford. The power possessed by electrical oscillations to annul the magnetic hysteresis of iron was discovered by Mr. G. Marconi, and applied by him in the construction of a sensitive Hertzian wave detector for use in wireless telegraphy. As is well known, very slight differences in the nature of the spark or the spark balls in a Hertzian oscillating system cause immense differences in the radiating power; but there has been no instrument which could indicate and measure exactly the intensity of the radiation. Although the coherer is quite sensitive, it is of little value for quantitative measurements. On the other hand, the magnetic detector is not only superior to the coherer in sensitiveness, when properly constructed, but is capable of being used as a measuring instrument. In the form in which it was constructed by Rutherford, an extremely fine bundle of iron or steel wires was magnetized by means of a magnet, or by being placed in the interior of a solenoid; then demagnetized by an electrical oscillation passing through another coil surrounding it. The amount of demagnetization was detected by a magnetometer.

After trying various forms, the author found the following to be the most satisfactory: A pasteboard tube about three-quarters of an inch in diameter and five or six inches long was surrounded with six coils of No. 40 silk-covered copper wire, each containing about 6,000 turns. These coils are joined in series, and have a resistance of about 6,000 ohms. In the interior of the tube are placed eight small bundles of iron wire about six inches in length, each bundle being composed of eight wires of No. 26 S. W. G., previously well paraffined or painted with shellac. Each bundle of wires is wound over uniformly with the magnetizing coil formed of No. 36 silk-covered copper wire in one layer; and over this, but separated from it by one or two layers of gutta-percha tissue, is wound a single layer of No. 26 wire, forming a demagnetizing coil. This last coil is, in turn, covered over with one or two layers of gutta-percha.

The magnetizing coils are connected in series with one another, so that when a current passes through the whole of them it magnetizes all the bundles in the same sense. The outer or demagnetizing coils are joined in parallel. In addition to this coil there is a rotating commutator, consisting of a number of hard fibre discs, secured on a steel shaft driven by an electric motor at about 500 turns a minute. There are four of these discs, and each has let into its periphery a strip of brass, occupying a certain angle of the circumference. The brass sector of the first disc occupies ninety-five degrees of the circumference. The brass sectors of the second and third discs occupy 135 degrees of the circumferences, and that of the last disc, 140 degrees. Brass brushes make contact with these discs, and serve to interrupt or make electrical circuits as they revolve. The function of the first disc is to make and break the circuit of the magnetizing coils placed around the bundles of iron wire, thus applying a magnetizing current during a portion of one period of rotation of the disc, leaving them magnetized during the remaining portion. The function of discs two and three is to short-circuit the terminals of the secondary coil of the bobbin during the time that the magnetizing current is being applied by the first disc. A sensitive movable-coil galvanometer is employed in connection with the secondary coil, one terminal of the galvanometer being permanently connected to one terminal of the secondary coil, and the other terminal connected through the intermittent contact made by the fourth disc. This disc is set so that during the time the secondary coil is short-circuited, and while the battery current is being applied to magnetize the wires, the galvanometer circuit is opened.

During one complete revolution the operation goes on as follows: First, the magnetizing current of a battery of secondary cells is applied to magnetize the iron bundles, and during the time that this magnetizing current is being applied, the terminals of the fine-wire secondary coil are short-circuited, and the galvanometer is disconnected. Shortly after the magnetizing current is interrupted, the secondary bobbin is un-short-circuited, and an instant afterward the galvanometer circuit is completed and remains completed during the remainder of one revolution. If, during the period when the galvanometer is connected to the secondary coil, an electrical oscillation is passed through the demagnetizing coils, an electromotive force is induced in the secondary bobbin by the demagnetization of the iron, and causes a deflection of the galvanometer. Since the rotation of the commutator is rapid, these impulses produce a continuous deflection of the galvanometer which is proportional to the demagnetizing force being applied to the iron. The instrument can be employed as a telegraphic receiving instrument, or it can be used to verify the law according to which variation falls off with distance. Its chief use would be for comparing together the wave-making power of different radiators. For this purpose the oscillation coils must be connected to two long connecting wires, or one end may be connected to the earth and the other to a vertical aerial.

It is thought that this instrument will be of great value in the design of radiators and transmitters for Hertzian-wave wireless telegraphy. The instrument may be made as large as desirable, but it is necessary that the iron wires be quite small, and that they be assembled in small bundles. It is also necessary to short-circuit the fine-wire secondary coil, as described above, during the time of magnetization of the core.

[1] An abstract of a paper read at a recent meeting of the British Royal Society.

Wireless Telegraphy in Guadeloupe.

Consul L. H. Aymé, of Guadeloupe, under date of June 10, 1903, says: The wireless-telegraph system in operation between this island and Martinique has been thrown open for the use of the public. Messages are transmitted from this city and other points to the station at Gosier by telephone. The tariff of rates is practically that of the French Cable Company, the lines of which have been broken for some sixteen months. The service is satisfactory, an average of sixty messages each way being transmitted daily. There are, of course, occasional interruptions, due to weather conditions, but these are not frequent.

Uses of the Telephone.

In the course of a recent lecture on telephony, Mr. F. C. Raphael stated that at the present time there were more than a quarter of a million subscribers and about 1,100 exchanges in Great Britain. He explained how subscribers could utilize their telephones for a number of purposes, of which the majority of subscribers were ignorant; as, for instance, telephoning telegrams, express letters, and even ordinary letters to post offices. In the latter case, thirty words can be telephoned to a post office for transmission as an ordinary letter for an extra charge of one penny in addition to the ordinary charge for postage; and telephoned express letters are delivered at the ordinary express fee (threepence per mile) from the post office without extra charge.

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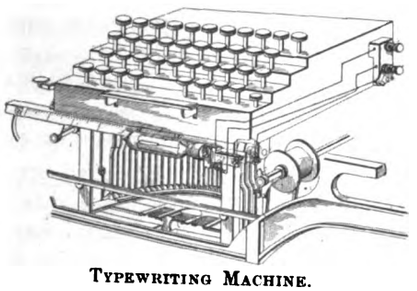
Electrical Patents.

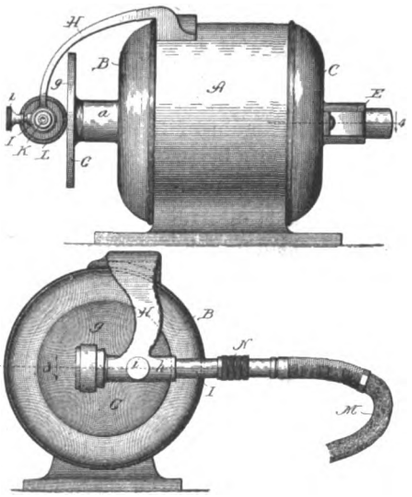
Hiram J. Halle, of Cleveland, Ohio, the president of the Fisher Book Typewriter Company, of Cleveland, Ohio, has just obtained a patent on an electrical lighting attachment for typewriters that is both novel and useful. While the attachment is being employed with success and is particularly adapted for use on the Fisher typewriter, the invention is



TYPEWRITING MACHINE.

not limited in scope to this particular machine. The object is to provide an illuminating device, designed to illuminate the work sheet for the purpose of facilitating the inspection of the work. It frequently happens, particularly in large establishments, that typewriting machines are located at points where it is impossible to secure sufficient light and this is particularly true of typewriters, wherein the machine is located over the paper to be written upon, thus cutting off from the work a considerable portion of the light. As is well known, the Fisher typewriter includes in its organization what is known as a "traveling carriage," carrying the type bars and movable over a flat platen arranged beneath the same and supporting the flat sheets or pages to be written upon. The printing mechanism includes a segmental supporting ring in which the type bars are journaled, and as these type bars strike downwardly toward the axis of the type ring, the printing point is in full view of the operator. During the printing operation, however, the line being written upon is obscured by the ribbon, which extends under the type ring from the opposite sides of the carriage. Means are employed for shifting this ribbon away from the line, so that such line will be exposed when it is desired to inspect the same. The means include a rock shaft, having connections with the ribbon spools and ribbon guides, this rock shaft carrying a suitable key located in convenient relation to the operator. Thus, when the key is depressed, the ribbon will be shifted rearwardly. A small electric lamp of the incandescent type is secured to the frame of the machine above the printing point and is so arranged that the light therefrom will fall upon the line being printed, though it is cut off by the frame from the eyes of the operator. This lamp is in a suitable electric circuit, which also includes a switch comprising a pair of contact devices, one of which is attached to the rock shaft of the ribbon shift, the other being fastened to the lamp. The arrangement of these contact devices is such that as long as the ribbon is over the line being printed the lamp circuit will be broken, for the light will not be needed, but when it is desired to inspect the work, the depression of the key, as already stated, will cause the ribbon to move rearwardly away from the line. This movement will rock the shaft and bring the contacts into engagement, thereby closing the circuit and lighting the lamp. As soon as the ribbon is permitted to move back to its operative position, the lamp is extinguished. If, however, the operator desires a continuous light, a separate switch is employed having suitable connections with the lamp and the source of electrical energy, so that a circuit may be made which when closed by the switch will keep the lamp constantly illuminated.

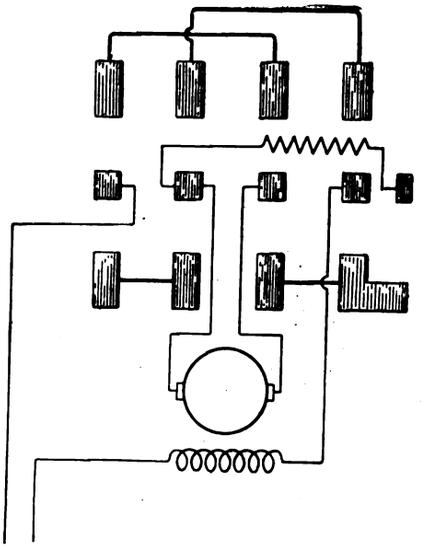
A simple friction gear for electric motors has been devised by Mr. Julius B. Wantz, of Chicago, Ill., and the patent obtained thereon is controlled by the Victor Electric Company of the same place. The mechanism can be employed for driv-



FRICTION GEAR FOR ELECTRIC MOTORS.

ing any light machine or tool wherein the speed and power transmitted may be readily and quickly varied without changing that of the motor itself. The armature shaft of the motor is provided with a yielding thrust bearing at its inner or rear end, comprising a ball bearing against the end of the shaft and a spring bearing against the ball. The outer end carries a friction disc journaled upon the motor casing or frame, and extending at right angles to the face of the disc is a longitudinally adjustable shaft carrying a friction wheel that engages the disc, the bearing or gripping pressure between the same being effected by the yielding thrust bearing.

A controller for electric hoists devised by Philip J. Darlington, of Glen Ridge, N. J., has been purchased by the Sprague Electric Company, of New Jersey. The invention is designed to provide for the controlling of electric hoisting motors, such as are used on traveling cranes or on



CONTROLLER FOR ELECTRIC HOISTS.

stationary hoists. When used on traveling cranes, the crane consists of a bridge mounted on wheels on elevated supporting-rails and carrying a traveling truck or trolley on which the hoisting motor is mounted. The bridge may be substituted by a boom, in which case suitable provision should be made for bracing and supporting it, or the hoisting motor may be mounted on a stationary support without any traveling bridge or trolley. The hoisting motor is series-wound and is adapted to rotate forward and backward, as desired, for hoisting and lowering the load. When used for hoisting, it will generally suffice to have a controller with only one forward position; but in lowering the load it is very desirable that the controller should be arranged so that with heavy loads the descent shall not be too rapid and that the motor shall not be caused by the load to run away. The inventor has devised for this purpose an efficient controller in which there are four positions—an off or open-circuit position to bring the motor to rest, a hoisting position, and two lowering positions, one of which provides for fast running, while the other provides for slow running by shunting the armature of the motor with a resistance in the shunt. In lowering a heavy load the operator moves the controller to the fourth position, either immediately or after it has been for a time in the third position, and in this way the motor is caused to run slowly and too rapid lowering is prevented. He also combines the controller with a brake, which when the controller is in off-position is automatically applied to the motor and stops it.

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Reviews of Current Engineering and Scientific Literature.

On Hertzian Waves in Wireless Telegraphy.

When oscillations are produced in a simple antenna using a spark-gap connected in the circuit, the antenna vibrates in quarter waves, but the length of the wave produced depends upon the electrical constants of the conductors. It then becomes necessary to select a conductor which will give the maximum vibratory effect. A method of doing this is described here by M. G. Ferrié. To determine the wavelength of the oscillations produced, a horizontal wire is connected to the antenna at a point between the oscillator and the earth. In this wire a hot wire ammeter is connected. The indications of this instrument will be proportional to the amplitude of the oscillations. Bv varying the length of the horizontal wire, the amplitude of the oscillations will vary between maxima and minima. The maximum vibrations will occur when the wire is in tune with the oscillations. In this way the experimenter can determine the fundamental note, as well as the harmonics. A table is given showing some actual results of an experiment of this character.—*Translated and abstracted from l'Electricien (Paris), June 27.*

The Real Inventor of the Mercury Coherer.

This short article by M. Emil Guarini gives a review of the facts connected with the invention of the mercury coherer. This coherer was used by Mr. Marconi for his first transatlantic experiments in September, 1901, and the statement was made at that time that it was the invention of Lieutenant Solari, of the Royal Italian Navy. This, however, was denied by the latter. Following this, an article appeared in *l'Elettricita* (Milan) stating that the coherer had been invented by Signor Castelli, of the Royal Italian Navy. It now appears that the true inventor is Professor Tommasina, a distinguished savant of Geneva, well known for his interesting experiments and researches in connection with wireless telegraphy. The latter, in a note to the *Comptes Rendus* (Paris), of May 1, 1899, on the production of electrolytic chains and deposits, said: "In my researches relating to coherers with single contact, after having obtained very sensitive ones by means of a drop of mercury placed in a glass tube between two brass electrodes of cylindrical shape . . . " Again, in an article appearing in the archives of a Geneva society, dated May 3, 1900, Professor Tommasina mentions, among different decohering coherers, a coherer consisting of a drop of mercury between two carbon electrodes. This article was abstracted in *l'Elettricita* (Milan) in its issue of July 7, 1900, just at the time the Italian Navy was making experiments with the Marconi system. It seems highly probable that those engaged in this work noticed the article, and tried the coherer described there.—*Abstracted from the Electrician (London), June 19.*

A Proposed Transmission for Pumping Purposes.

In this article, Mr. Lewis A. Hicks considers the development of the Kings River to furnish power for irrigation of the lines between Fresno and Hanford in California. The site selected for the power-house is at the junction of the south and middle forks of the Kings River at an altitude of 1,980 feet. The diversion planned is from the middle fork through 14,000 feet of continuous tunnel, delivering a maximum flow of 182 feet at the penstock, which is 680 feet above the water-wheels. The watershed tributary to this diversion contains an area of 325 square miles. The minimum flow occurs in September and during the rest of the year is never less than 100 cubic feet per second. The power available here has been shown to be ample to furnish a maximum of 328,500 acre-feet required annually by the pumping plants. Ordinarily the water is very clear, but provision has been made for trapping the sand brought through the tunnel. Details of the penstock and the tracks which give a movable flashboard, will make it possible to flush a settling chamber without interfering with the continuous flow of the conduit. From the settling chambers three pipe lines, thirty inches in diameter with full load velocities of seven feet per second and an effective head of 660 feet, deliver the water to Pelton wheels. Each pipe feeds one generating unit, but a thirty-inch by-pass connecting the three pipes makes it possible to feed two units in any one of the three pipe lines. The generators proposed are of the three-phase, sixty-cycle, revolving field type, with a normal capacity of 1,350 kilowatts at 2,200 volts at a speed of 200 revolutions per minute. This voltage is raised to 30,000 by static transformers and the lines follow the wagon roads as far as possible. To handle the large amount of water delivered by the wells fifty-horse-power induction motors are proposed, operating at 2,000 volts. One transformer station is to be installed for four pumping plants. The substations will contain 200 kilowatts of self-cooling oil-insulated transformers. The station building has a double wall to provide ample ventilation. The pump motors are to be mounted on a vertical shaft driving a centrifugal pump, the latter is designed to carry the weight of the motor when in operation. The motor is started empty and the pump is primed by closing the gate valve on the discharge pipe and exhausting the air from the suction pipes and pumps with a mechanical primer operated with a taper friction from the motor-shaft. The estimate for the cost of this development is, for the hydraulic works, $289,499; for buildings, bridges, etc., $85,888; electrical equipment, $92,705; transmission lines and substations, $343,950; 100 pumping stations, $425,985. Allowing five per cent for contingencies, the total cost will be $1,278,629. The estimated cost of operation is $157,611. This would make the cost per acre-foot per annum about fifty cents. This figure is considerably less than that given for a number of other irrigating systems.—*Abstracted from the Journal of Electricity, Power and Gas (San Francisco), June.*

The New Electricity Works of the Manchester Corporation.

This is a description of the largest electric power distribution undertaking in Great Britain. The schemes of the Manchester Corporation include the Stuart street generating station, with an output of 9,000 kilowatts and ten substations; a second station at the same place, with an output of 7,500 kilowatts, with nineteen substations; and, in addition to this, the corporation has completed the new works at Bloom street, with a normal output of 7,200 kilowatts, as well as a station on Dickinson street, with an output of 10,350 kilowatts. The total output of the three works existing at this moment is 26,550 kilowatts. When the sets now under construction are completed, the total output will be more than 34,000 kilowatts, about forty per cent more than the Glasgow works, which ap-

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pears to be the second in size in Great Britain. The load consists of about 400,000 lamps; 1,000 motors, aggregating about 4,000 horse-power; and 130 miles of tramways, operating 400 motor cars. The Stuart street station, which is here described, generates three-phase alternating current at 6,500 volts, fifty cycles. This is transmitted to substations through underground cables. At the substations the energy is converted, by means of motor-generators, to direct current at 550 volts for traction, and 205 and 410 volts for light and power. The boiler house contains twenty-four Babcock & Wilcox boilers, each capable of evaporating 12,000 pounds of water per hour at a pressure of 200 pounds per square inch. The normal working pressure is 170 pounds. There are six main generating sets, each consisting of a 2,500 indicated horse-power, vertical cross-compound engine, direct-connected to a 1,500-kilowatt generator. Full details are given of the boilers, engines, generators, piping, electrical wiring and accessory apparatus.—*Abstracted from the Electrical Review (London), June 26.*

Electric Lighting of Railway Systems.

This is an article by M. M Soebrier, describing the electric lighting systems employed by the Compagnie des Chemins de fer de l'Ouest. This company is operating a number of stations in the neighborhood of Paris. One of these lights the Saint Lazare station. This is an old plant furnishing current at seventy volts, but on account of the low pressure the system has not been extended, and will soon be replaced by the Moulineux station which is now being erected. The Montparnasse depot is supplied from the Vaugirard station with continuous current at 110 volts. The machines are of the old Gramme type, driven by eighty-horse-power engines. A storage battery equipment of 4,300 ampere-hours runs the lights at times of light load. The service at this depot includes arc and incandescent lights, elevators, electric pumps and other apparatus. The new Moulineux station will supply current for lighting and for power for the railways of the western part of Paris. It is located on the Seine, between the Paris end of the Lazare line and the Champs-de-Mars. The buildings are divided into two sections, one for boiler and the other the generator room. There are nine generating groups in the engine room, each with a normal output of 800 kilowatts, but able to develop 950 kilowatts for thirty minutes, or 1,000 kilowatts for five minutes. Six of the generators are driven by triple-expansion Corliss engines, and the other three by cross-compound Corliss engines. All the generators are revolving field multipolar Westinghouse machines. There are three groups of 125-kilowatt exciters. Power is generated at twenty-five cycles, 5,000 volts, which is transmitted to three substations for the railway lines, and to many others for lighting. The low frequency was selected on account of the railways to be operated, and this introduced a number of problems when used for lighting. Another difficulty was introduced by the many points to be lighted, each requiring but a few lights. In the principal depots arc lamps were necessary, and here motor-generator sets were installed to furnish them with direct current. When but a few lights are required incandescent lamps are used, operated in series from the 500-volt railway circuit. At one of the freight depots a tentative arrangement of arc lamps on the twenty-five-cycle alternating circuit is being tried. These lamps are placed ten metres above the floor, and at this height the flickering is less objectionable. At the substation at Batignolles 5,000-volt induction motors are direct-coupled to 500-volt direct-current machines. Current is distributed for lighting by the three-wire system at 220 volts across the circuits, two 110-volt lamps being connected in series on these circuits. The arc lamps are mounted four or five in series. A balance between the two circuits is maintained by an equalizing group and a storage battery with a capacity of 600 ampere-hours.—*Translated and abstracted from the Revue Technique (Paris), June 10.*

Electrical Traction on the North-Eastern Railway, England.

Additional information has been given out concerning the proposed equipment of the North-Eastern Railway, England, in the neighborhood of Newcastle-on-Tyne. Newcastle is situated eight miles from the mouth of the Tyne. The intervening districts on both banks of the river are densely populated, and contain an almost continuous succession of shipyards, engineering and other works. There is between Newcastle and the sea a large traffic the whole year round. This attains enormous proportions during the holiday seasons. The Quayside branch of this system is for freight traffic only, but this is being electrically equipped on account of the severe grades and the many tunnels. The freight trains of this system, except those of the branch just mentioned, will be drawn by steam. Passenger traffic will be handled electrically. Trains will be operated by continuous current obtained from a single conductor rail, with the return circuit through the running rails. Power will be generated at 5,000 volts, three-phase, forty cycles, and transmitted to substations, where, by means of stationary transformers and rotary converters, it will be transformed into continuous current at 600 volts. The collector rail will be of specially high conductivity steel, Vignole's section, eighty pounds per yard, and carried on insulators composed of reconstructed granite. Current will be supplied to this rail from five substations, located at Pandondene, Wall's End, Collarcoats, Benton and Kenton. Fourteen 800-kilowatt rotary converters will be distributed among the substations, that at Pandondene having the largest capacity, and containing four rotaries. Each converter has been specially designed to operate without serious sparking at an overload of 100 per cent for ten minutes, and an overload of 200 per cent momentarily. The rotaries are started by a small induction motor fed by a special transformer. The unit train will be composed of two motor cars with a trailer between, and, if necessary, will be increased by adding other units. The trains are controlled by the Thomson-Houston multiple unit system. The railroad company will purchase electrical energy from the Newcastle-on-Tyne Electric Supply Company, which is erecting a station at Carville. This new station is to consist of steam turbo-generators of the Parsons type, each of 3,500 kilowatts, with an overload capacity of 5,000 kilowatts for two hours. As the space occupied by such a set, compared with that taken by the boilers necessary to supply the steam, is small, each turbine will have a separate range of boilers running at right angles to the engine room. Every two ranges of boilers will be combined in one centrally fired boiler house, and will be provided with independent flues, economizers, induced draft and an iron chimney. By this arrangement a short, simple pipe system can be secured, and the station can be extended in either direction. Turbine sets will be supplied with steam at a pressure of 200 pounds per square inch, superheated to 500 degrees Fahrenheit. The condensers will be placed directly under each turbine. Plans and elevations of the generating station and substations are given.—*Abstracted from the Electrician (London), May 29.*

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An Interesting Wireless Incident.

The whole question of the efficacy of the tuning apparatus which Mr. Marconi employs in his system of wireless telegraphy, has once more been brought prominently before the public by reason of a little *contretemps* which has happened in connection with a lecture given by Dr. J. A. Fleming at the Royal Institution. The object of the lecture was to demonstrate to the audience the wonderful feat of receiving a message into the heart of London, through such a multitude of obstructions, from Cornwall. To all outward appearances the demonstration was completely successful, but the lecturer himself was made painfully aware of the fact that some "enemy" was at work, inasmuch as a number of severely irrelevant interruptions were indicated on his tapes. Wishing to "draw the badger," Dr. Fleming wrote to the *Times* in harsh terms of such, as he called it, "scientific hooliganism," with the result that Mr. Maskelyne, who will be recognized as the author of an article some time back in one of the electrical papers here giving facsimiles of the messages sent from Cornwall to the Italian warship Carlo Alberto, acknowledged himself to be the perpetrator of the "outrage." He claims to have proved beyond all doubt that the Marconi system has not shown itself to be a success, as his experiments from the beginning have been with an ordinary untuned apparatus. On the other hand, the Marconi Company claims that its arrangements have never been specially made with a view to keeping out intruders, and really one can not but help wishing, in the interests of everybody, that some conclusive data were furnished us on the point. The ordinary man on the street, having followed up this controversy from the advent of Mr. Maskelyne, can not help being influenced by the fact that the daily news service to the *Times* from the other side of the Atlantic has been to all appearances dropped, then when Mr. Maskelyne's tapes of the Alberto messages were, in effect, claimed to be forgeries, his challenge to contest the matter was ignored. Now comes this latest instance of interference, with the methods of which, perhaps, every one will not be in agreement. The company appears satisfied that the attempt to wreck the demonstration was unsuccessful, but this is putting a false view of the facts before the public. Mr. Maskelyne did not attempt to, nor wish to, do any such thing. He apparently only desired to demonstrate that interference was possible. On the other hand, Mr. Marconi has a larger number of supporters in Great Britain than is indicated by the expressions of opinions in the newspapers, and these would welcome a final settlement of these problems—if this be at present possible—and consequently a confusion of his enemies. It is the continual refusal to do this and the number of somewhat evasive statements issued by his company which strengthen the hands of his "enemies."

London, June 27. A. W.

The Anglo-Belgian Telephone Cable.

Some particulars are here given of the London-Brussels telephone cable, which was opened June 8. The idea of this cable is by no means new, for experiments have been made from time to time since 1877 on the telephonic cable, but without success. More recently the feasibility of successful telephone cable between England and Belgium was demonstrated by means of the Anglo-French telephone cable, lengthened by overhead lines, so as to represent, as nearly as possible, the conditions under which an Anglo-Belgium cable would have to work. The Dover-Calais cable measures twenty-three nautical miles, while the Anglo-Belgium cable, beginning at St. Margaret's Bay, England, and terminating at La Panne, Belgium, has a length of 47.3 nautical miles. The overall diameter of the cable is fifty-five millimetres and contains four conductors, and was made by Henley's Telegraph Works Company, London. It weighs 7.275 kilogrammes per metre, and costs about $3,000 per mile. Each of the four conductors is of a left-hand strand of seven wires, the weight per kilometre of conductor being 39.7 kilogrammes. At a temperature of seventy-five degrees Fahrenheit, the resistance is less than four ohms per kilometre. The insulation of the wires consists of three layers of gutta-percha, with three layers of Chatterton compound. The weight of one conductor, including its insulation, is approximately 112.3 kilogrammes per kilometre. After being insulated the conductors were placed in water tanks, heated to seventy-five degrees Fahrenheit for twenty-four hours, then subjected for fifteen minutes to an alternating-current of 5,000 volts at 100 cycles per second. The cable was then tested for insulation and capacity with a 300-volt battery. The insulation resistance specified was 500 megohms and the capacity for the same length 0.275 microfarad. The four conductors are grouped round a tarred hemp core 7.5 millimetres in diameter, and the same material is used for filling up spaces between the conductors. Then follows a layer of cotton tape, prepared with ozokerite, next is the usual brass protection consisting of a brass tape one millimetre thick by thirty-eight millimetres broad. Over this is another layer of cotton tape, then a covering of the best tanned Russian hemp. This is followed by the metallic armor, consisting of sixteen galvanized iron wires, each 7.1 millimetres thick. These wires are heated with pure gas tar before application. The cable is wound with two reverse layers of hemp. It is laid in three sections and crosses the Anglo-Belgian telegraphic cable in deep water. After laying it was tested for resistance and capacity at 46.5 degrees Fahrenheit. The resistance of the four conductors varies from 331.2 to 331.5 ohms. The capacity of the wires varies from 12.617 to 12.575 microfarads. The total length of the London-Brussels telephone circuit is 394.3 kilometres, 150 being overhead lines in Belgium, and 156 overhead lines in England. The overhead lines are all of hard-drawn copper, weighing about 800 pounds per mile.—*Electrician (London), June 12.*

New Substation for Union Railway Company, New York.

The Union Railway Company, of New York city, is building three new substations in the vicinity of New York city; one at West Farms, one at Mount Vernon and the other at Yonkers, all of which are to be equipped with Westinghouse apparatus exclusively. They will be operated by the large power station at Kingsbridge, which is owned by the Interurban Street Railway Company, having been built by Westinghouse, Church Kerr & Company, of New York, and the Westinghouse Electric and Manufacturing Company, of Pittsburg, Pa. The substation at West Farms will contain nine 375-kilowatt, oil-insulated static transformers, divided into three groups, supplying current to three 600-kilowatt rotary converters. The switchboard consists of high-tension, alternating-current, receiving panels with electrically operated oil circuit-breakers, low-tension, alternating-current rotary panels and load panel, with direct-current rotary panels and load panel; also about twenty direct-current feeder panels.

The other two substations, now in course of construction, will have similar equipments, excepting that the capacity in each case will be three 500-kilowatt units instead of three 1,000-kilowatt units. The entire equipment for each substation is being furnished by the Westinghouse Electric and Manufacturing Company.

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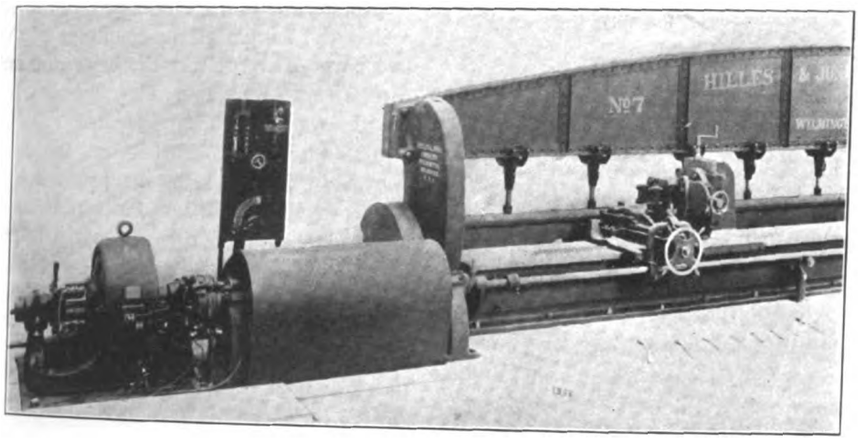
INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Motor-Driven Plate Planer.

The attached illustration shows a thirty-two-foot, heavy plate planer built by Messrs. Hilles & Jones, of Wilmington, Del., and recently installed in the United States Navy Yard at Charlestown, Mass. Direct-connected to the main driving screw of the planer, through gearing and magnetic clutches, is a fifty-horse-power, Westinghouse, multipolar motor of 220 volts and running at slow speed, which furnishes ample power to enable the machine to plane two-inch armor-plate, taking a heavy chip. A thorough test proved the machine to be a powerful tool in every respect.



MOTOR-DRIVEN PLATE PLANER.

The saddle of the planer is designed to carry two tools, one cutting in each direction, also a third tool for vertical feed, the saddle and tool holder being shifted automatically at any point desired.

Test Methods in Steam Turbine Construction.

At a recent meeting of the Electric Club, of Cleveland, a paper was read by Mr. Edwin Yawger, in which he described the testing of material and turbines as carried out by the Westinghouse Machine Company in developing the Parsons turbine. The author called attention to two classes of testing. One he designated as scientific, and the other empirical. The first class of testing is that made on machines and material with the intention of obtaining information useful for design and construction. The second class is a test to which the machine is submitted when it is put out into actual service, and the results of this test indicate the reliability of the machine. A noteworthy test of this kind was made by the company when it installed a 1,600-kilowatt plant in the works of the Westinghouse Air Brake Company, and operated this for four years.

At the testing laboratory organized by the company tests of material are carried out chemically, mechanically and microscopically. Mechnical tests are made on sample specimens of all the large forgings and on the material for all the smaller forgings, from time to time. In the chemical laboratory tests are made of all the materials used in turbine construction, and microscopic examinations are made of samples of the materials used. This latter test frequently shows a marked difference between two specimens which have the same chemical composition.

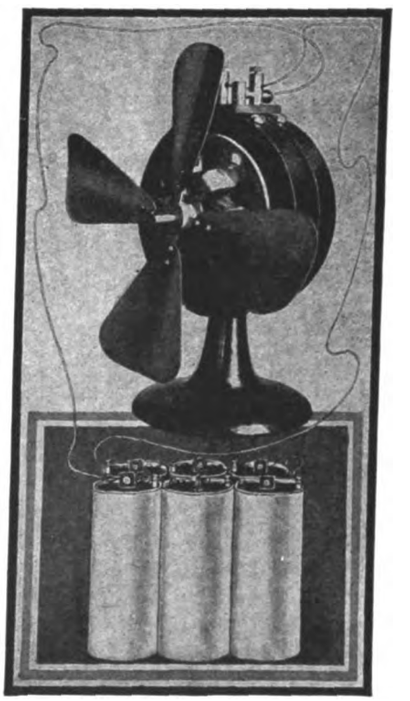
In order to test the turbines a laboratory has been arranged which provides space for four 5,500-kilowatt machines at one time. There is a large superheater by which the steam can be superheated 200 degrees. Two condensers and the accompanying pumps maintain a vacuum of twenty-eight inches. When the turbine is connected to a generator it is most conviently tested by measuring and absorbing the output of the generator. For this purpose a water rheostat containing 165 square feet of electrodes and a water capacity of 1,200 gallons has been provided. When a brake test of the turbine is desired it is coupled to a water dynamometer. This consists of a short cylindrical chamber in which revolve one or more discs. Water is admitted to the chamber near the axis, and escapes through one or more of a series of outlets placed at various distances from the axis. The power absorbed is varied by varying the depth of the water in this chamber.

Tests of various sizes of Parsons turbine were shown, and attention was called to the uniform efficiency of this type of prime mover under widely varying loads.

In the discussion, in which Messrs. Benjamin, Hoag, Sperry, Ballard and Langley took part, it was brought out that the efficiency of the turbine increases with an increasing load until the limit of the machine is reached. It then slows down. Steam is admitted to the turbine in puffs, and regulation is effected by increasing the duration of these puffs. The operating valve is driven from a worm-gear at a speed from one-twentieth to one-tenth that of the turbine. The weight of these turbines for an equivalent output is about one-third that of an ordinary compound engine. The efficiency of the larger units is better than that of the smaller ones, but the difference is not so marked as is the case with reciprocating engines. The advantage gained from condensing is much greater with a turbine than with a reciprocating engine.

Dry Battery Fan Motor.

The Ewing-Merkel Electric Company, 1106 Pine street, St. Louis, Mo., has placed on the market a new seven and one-quarter-inch dry battery fan motor. This is well shown in the accompanying illustration. The motor is equipped with six dry cells and will run for 200 hours without renewing. As may be seen from the illustration, the fan motor closely follows the design of the larger apparatus.



DRY BATTERY FAN MOTOR.

While being built substantially and constructed in a most thorough manner, the price is exceedingly low. The dry cells are of the ordinary type, and if at any time new cells are required, these may be secured at almost any supply house.

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An Electric Express Annunciator.

Mr. J. H. Rusby, of Nutley, N. J., is placing on the market an express annunciator, an illustration of which is shown in the accompanying engraving. The operation of this annunciator is decidedly simple, and consists essentially of a fulcrumed lever, one end of which meshes with a semi-circular gear segment. This lever is placed between two opposing electromagnets. The electromagnets are connected in the circuit of an on-and-off push-button, the manipulation of either attracting the lever to the charging electromagnet. The action of the lever in moving toward the charging electromagnet is to throw the painted signal either up or down, through an arc of ninety degrees. These annunciators are made in any desired length, the width always being the same, but the length varying with

ELECTRIC EXPRESS ANNUNCIATOR.

the number of signs affixed in the cabinet.

The device is designed for use in warehouses and commercial establishments which will find it necessary or convenient to manipulate their express-calling signs on the sidewalk from the shipping clerk's desk within the building.

A Thermo-Call Button.

The accompanying illustrations give a good idea of a new device which the American Thermo-Call Company, 12 Pearl street, Boston, Mass., is placing on the market. This thermo-call is adapted for use in private dwellings, hotels, factories, steamboats, warehouses, etc.

The device combines the ordinary push-button now in general use with an automatic fire-alarm. As may be seen from the illustration, the thermo-call consists of the ordinary push-button apparatus, to which is added a thermostatic coil and an adjusting screw. Both the ends of the thermostatic coil and the adjusting screw are platinum-tipped, ensuring a long life and a perfect contact whenever occasion makes this essential. The thermostatic coil is made of a peculiar alloy, and is so adjusted that it will give an alarm over a wide range of temperature, varying from zero to 400 degrees. The combination push-button and thermostat is placed in every room, and may be installed in the same circuit as the ordinary push-button and annunciator service now

COMBINATION CALL BUTTON AND THERMOSTAT.

existing in hotels and dwellings. The push-button service may be utilized to test the circuits every day, indicating on the annunciator wherever any trouble may be found. If the temperature of the surrounding atmosphere should, at any time, reach that for which the thermostat coil is set to indicate, the alarm is promptly given by the circuit closing automatically. This is in no way a fusible device, the contact being made mechanically, and when the apparatus cools down to the normal the circuit is automatically broken. Where the thermostats are located on the ceiling or in places where a push-button is not desired, a small cap is fitted over the apparatus, making the thermostat positively dust and moisture-proof.

The manufacturer claims to have brought this device to a high state of perfection, as a delicately sensitive instrument for indicating a dangerous temperature; and numerous tests have demon-

THERMOSTAT FIRE-ALARM.

strated the fact that the most incipient fire will be discovered in time to bring it entirely under control without suffering any loss.

Mechanical and Electrical Equipment of a Cotton Mill.

The mechanical and electrical equipment of the cotton mills of the Davis Mill Company, at Fall River, Mass., is in many ways up to date, including a fan-and-heater system of heating and ventilation, induced draft in place of a chimney and electrical motor-drive throughout. To provide flexibility in the boiler plant and ensure against shutdown, the induced-draft plant has been installed in duplicate. Two seven-foot blast-wheels, running in three-quarter, steel-plate housings, are driven by centre-crank, horizontal engines. The fan-wheels are overhung in the housings and are furnished with special wide, water-cooled bearings. The engines themselves are provided with extended shafts upon which a pulley is mounted between each fan bearing the respective engines. These pulleys are in reality the flanges of the couplings of the two parts of the shafts, the belts running directly on the flanges. They are used for driving the economizer scrapers.

The air connection between the fans contains a flat swinging damper, which is so arranged that either fan can be shut off and the other run separately if desired. The outlet connections are likewise provided with dampers and the operating attachments are so placed that both can be changed at once by hand. The engines receive steam at eighty pounds and are furnished with a balanced valve which can be used in connection with a damper regulator.

The heating plant of the Davis mills is a duplicate of that installed at the Arkwright mills some years ago. It consists of a large exhaust-wheel drawing air through a steam-pipe heater. The fan-wheel is provided with one tight and two loose pulleys and the engine has an extra wide, flat-face flywheel for shifting the belt. A second belt connects the fan pulleys with the line-shafting of the mill. This arrangement makes it possible in the summer time to run the fan from the line shaft, thus taking advantage of the economy of the large mill engine, while in the winter, when the exhaust of the fan engine can be utilized in the heater, or at night when the large engine is not running, the fan is driven by the fan engine.

The heater is built up of one-inch pipe, erected on cast-iron sections which rest at one end on ball bearings to allow for expansion and contraction. It is so arranged that the exhaust steam from the engine can be used entirely in one group of sections, making it possible to condense all the exhaust before it is necessary to use any direct steam, which is added at a reduced pressure when necessary. The outfit also includes a Kendall receiving-tank, with a water gauge and a safety valve, and a duplex Worthington steam pump. The heating apparatus

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will heat the mill to seventy degrees Fahrenheit when the temperature outdoors is zero.

The electrical equipment consists of two belted direct-current generators, one of fifty kilowatts and one of seventy-five kilowatts, operating at 125 volts, no load, and compound-wound. These generators supply current for lighting and for a twenty-seven horse-power motor and one of forty-three horse-power. The oiling devices of the motors are so arranged that they can be hung from the ceiling. The above apparatus has been furnished by the B. F. Sturtevant Company, of Boston, which also designed and constructed the heating and ventilating and mechanical draft plants.

Stone Pipe for Underground Conduits.

The American Stone Conduit Company, Chicago, Ill., is the manufacturer of an underground conduit that is increasing greatly in popularity with electrical and contracting engineers. American stone conduit is made in single duct, six-foot lengths, four and one-half inches in diameter, with a three and one-eighth inch bore. Crushed lime-stone and the best quality of Portland cement are used in its production. In the process of manufacture the conduit is subjected to an interior pressure of thirty-five pounds per square inch, giving great strength to its walls, and a highly polished inner surface. Displacement taking place from the interior gives a smoothness which is of great advantage.

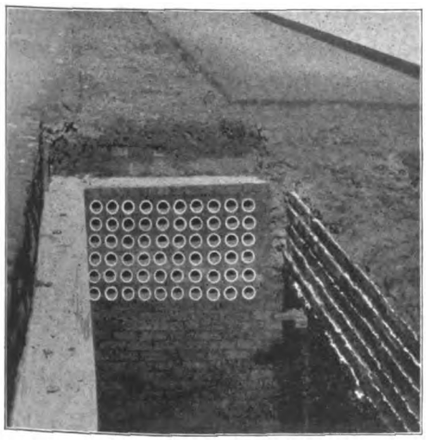

FIG. 1.—TERMINATION OF A 60-DUCT SUBWAY.

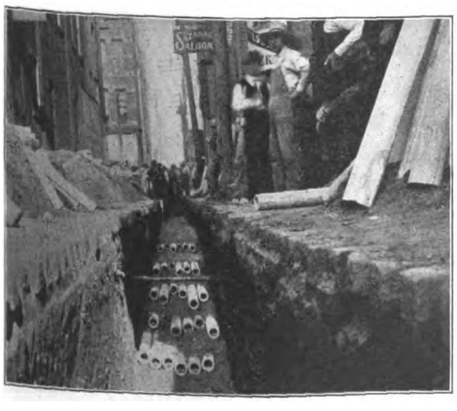

FIG. 2.—A SUBWAY SYSTEM IN CINCINNATI, OHIO.

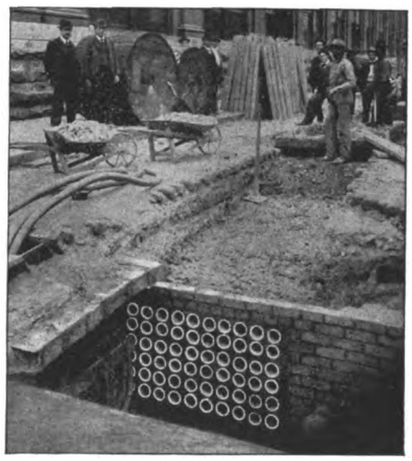

FIG. 3.—SUBWAY SYSTEM IN CINCINNATI, OHIO.

Several of the accompanying illustrations show portions of a 400,000-duct-foot underground conduit system constructed with American stone conduit in Cincinnati, Ohio. The termination of a sixty-duct system at the manhole is shown in Fig. 1. Figs. 2 and 3 are other illustrations of this installation. Fig. 4 details the method of construction, and Fig. 5, the method of making joints. The process of laying this conduit system is very simple. Under ordinary conditions the bottom of the trench is concreted to a depth of from two to three inches. The conduit is then laid on this surface, with one-half inch of Portland cement concrete firmly packed or tamped between the ducts as laid in the subway. By the use of the mandrel which is supplied by the company, a joint is formed that is practically self-aligning and perfect. If more than one horizontal row of ducts is to be laid in the same trench, the top of the first row is covered with one-half inch of concrete, and the work is continued in the same manner until the required number of ducts has been laid. The space between the sides of the trench and the outer ducts is filled in with from two to three inches of concrete, and the system is completed with a top layer of the same amount of concrete.

The rubber mandrel, which is shown in Fig. 5, fits the bore of the conduit snugly, is placed directly at the joint of the conduit, and while in that position concrete or grout is packed firmly around the joint and along the conduit to the next joint. The mandrel is then brought forward and the work continued in the same manner.

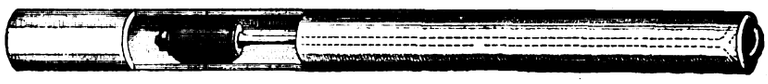

FIG. 4.—PATENTED RUBBER MANDREL.

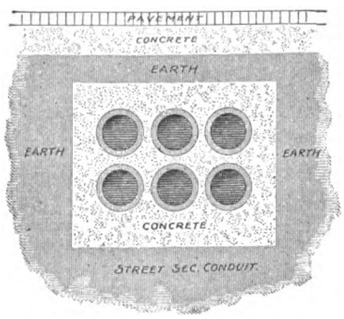

FIG. 5.—STONE CONDUIT CONSTRUCTION.

Journal of the Western Society of Engineers.

The June issue of the *Journal* of the Western Society of Engineers contains several interesting articles. Among these may be mentioned one by T. L. Condron, on "Specifications for Material and Workmanship for Steel Structures." Mr. Richard McCulloch contributes a few notes on European tramways, in which he describes some of the features of the English, French and German street railways. A paper by Mr. W. B. Jackson, on "Hydraulic Developments as Related to Electric Installations," discusses points which must be considered in developing water power.

The "Michigan Technic."

The "Michigan Technic" is published annually by the Engineering Society of the University of Michigan. Volume xvi, for 1903, contains a number of articles of interest to electrical engineers. Professor G. S. Williams writes on "Some Phases of Hydraulics;" Professor G. W. Patterson, Jr., on "Illumination;" Dr. K. E. Guthe, on "The Electron Theory;" Mr. S. P. Grace, upon "Telephone Engineering;" Mr. C. T. Johnson, upon "Some Responsibilities of the Civil Engineer;" Mr. B. F. Bailey, upon "The High-Frequency Transformer;" and Mr. J. R. Bibbins, on "The Present Status of the Steam Turbine."

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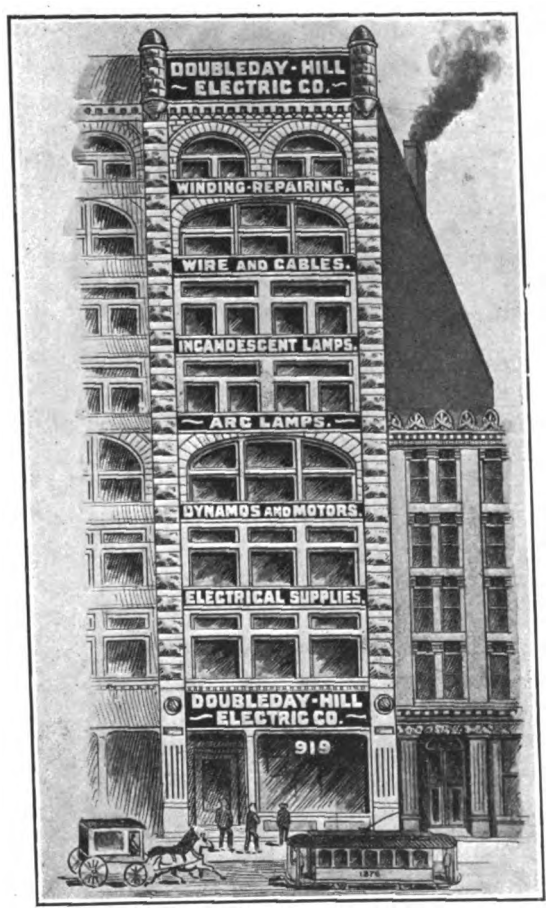
The Doubleday-Hill Electric Company.

The Doubleday-Hill Electric Company has recently moved into a new eight-story building at 919 Broad street, Pittsburg, Pa. A good view of this building is shown in the accompanying illustration.

Starting in a very small way at 609 Smithfield street six years ago, the company has enjoyed a remarkable growth. The original quarters having proved too small, the company removed to 525 Wood street three years ago, where it occupied a four-story building. Shortly after the first of the year the company removed to its present quarters. This is one of the



NEW HEADQUARTERS OF THE DOUBLEDAY-HILL ELECTRIC COMPANY.

largest buildings in the country devoted to electrical supplies and equipments.

The company carries a large line of supplies of every description, and special attention is given to the prompt despatching of every order. This company is the exclusive distributor for Triumph dynamos and motors, Adams-Bagnall arc lamps, Nernst lamps, Packard incandescent lamps, Emerson fans and many smaller specialties. A winding and repair department is operated by the company, in which it manufactures and repairs electrical apparatus of various kinds. An electrical pin and bracket factory is also operated at Ninevah, Pa.

Guy Anchors for Pole Line Construction.

The accompanying illustrations show the details of a novel form of anchor for

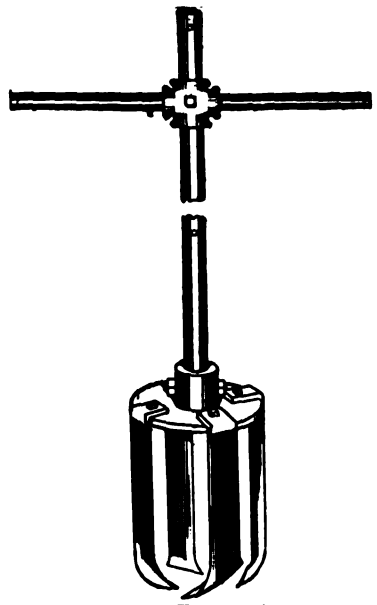


FIG. 1.—EARTH AUGER.

pole line construction, and an auger for boring the holes. Fig. 1 shows a com-

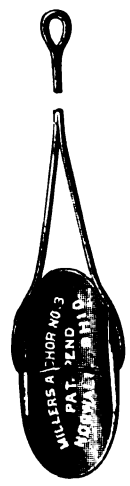


FIG. 2.—GUY ANCHOR.

bination auger which has an eight-foot stem, one inch in diameter. This auger

FIG. 3.—GUY ANCHOR.

is fitted with two boring heads, the smaller one for a special form of anchor, and the large head having adjustable blades. All augers have adjustable handles, and as the auger goes down the handle can be moved up to the stem.

To install this anchor a hole is bored from five to nine feet deep, at the same angle that the guy is to make to the pole. Figs. 2 and 3 give a good idea of the form of the anchor, and Fig. 4 shows the anchor sunk into the earth.

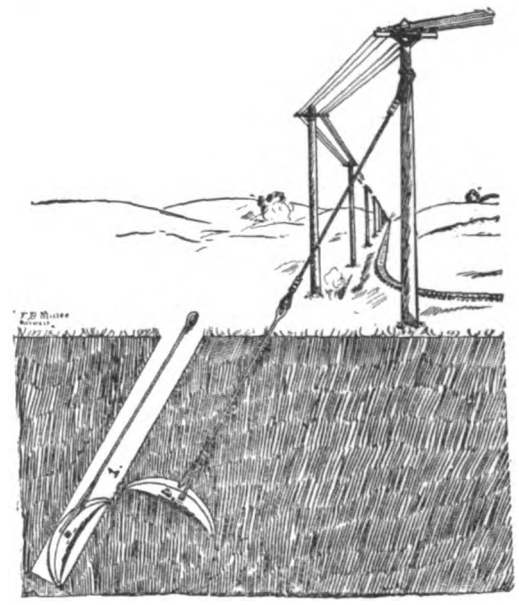


FIG. 4.—GUY ANCHOR IN EARTH.

After the holes have been bored the anchor is slid down to the bottom, and the dirt is then filled in and tamped in solid. After the earth has been tamped in solid the guy is drawn over a horse and pulled on to a standing pole at right angles to the strain. In this way the flange of the anchor is opened, taking a firm grip in the earth, and the danger of pulling the pole over under the strain is obviated.

The Kull System of Train Lighting.

A recent article by Paul Dupuy gives a somewhat detailed discussion of the Kull system of train lighting. Each car has mounted on it a small shunt dynamo driven from the axle and a set of small accumulators. The system is regulated by means of a speed governor, which alters the resistance in the field current of the dynamo as the speed of the car changes, and in this way maintains a fairly constant potential. This governor is mounted directly on the axle of the dynamo. In addition to this apparatus, there are automatic switches, one of which connects the dynamo to the battery and lamps, whenever the potential reaches normal, and the other introduces into the dynamo circuit a lamp resistance. The speed of the dynamo may vary from 650 revolutions per minute to 2,320, the latter figure corresponding with a train speed of 100 kilometres per hour. The voltage of this system is thirty-six. Each car is entirely independent, and can be connected to any type of train, local or express.—*Revue Practique de l'Electricite* (Paris), June 20.

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CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

CHICAGO ELEVATED REORGANIZATION PLAN—It has been officially announced that the Lake Street Elevated Securities Company has received sufficient deposits of stock to warrant it in proceeding with its reorganization plan. This plan provides for an assessment on the stock, the retirement of the present five per cent bond issue with a four per cent issue, and the giving of stock in the new company for whatever assessment is made on the present stock issue of $1,000,000.

CLEVELAND RAILWAY MERGER RATIFIED—The stockholders of the Cleveland Electric Railway Company have unanimously approved the plan to absorb the Cleveland City Railway. The resolutions adopted in connection with this provide for an increase of capital from $13,000,000 to $23,400,000, the new stock to be given to the stockholders of the Cleveland City Railway in exchange for their stock. The directors of the new company were also elected, and the members chosen include all of the present members of the directorates of the combining companies. These are H. E. Andrews, C. F. Emery, G. A. Garretson, M. A. Hanna, R. A. Harmon, C. Morris, George G. Mulhern, C. A. Otis, Jr., C. L. Pack, James Parmelee, L. W. Prior, R. R. Rhodes, W. H. Sanders, J. J. Stanley and J. H. Wade.

LOUISVILLE INTERURBAN CONSOLIDATION—The consolidation of the traction and interurban companies of Louisville, Ky., has practically been completed. The company, which will have a capital stock of $14,500,000, has filed papers of incorporation in the Hudson County clerk's office, New Jersey. The incorporators are K. K. McLaren, Louis B. Dailey and Joseph M. Mitchell. The consolidated company will operate under the name of the Louisville Traction Company. The company is formed to purchase or otherwise acquire or construct, control or lease, maintain and operate by electricity or other power, steam, electric and street railways for the transportation of passengers, mail, express and merchandise; and pole lines, wires, viaducts and underground subways or conduits for the transmission or distribution of electricity or other mechanical power.

NEW CONNECTICUT POWER COMPANY—The Eastern Connecticut Electric Power Company, which was recently incorporated with corporate headquarters in Hartford, and which proposes to develop a large power plant in the eastern section of the state, has accepted its charter and perfected its organization. The company is authorized to issue capital stock up to a maximum amount of $900,000. It will develop water powers on the Quinnebaugh River, in the towns of Plainfield and Canterbury. The concern proposes to sell electric power to street railways, electric light companies and manufacturing establishments in Windham and New London counties. The franchise authorizes it to distribute electric power not only in eastern Connecticut, but in Massachusetts. The water privileges which the corporation proposes to develop are said to have a capacity to supply a minimum of 1,800 horse-power, and a maximum of 2,200 horse-power.

GROWTH OF ELECTRIC ROADS—The Census Bureau has issued a report on the street and electric railways of the United States, showing by statistical computations the increase of electricity as a motive power. The report shows that there are in existence in the United States 817 operating street and electric railway companies, and 170 companies leased to and operated by other companies, making a total of 987 companies, controlling 22,576.99 miles of single track. The par value of the capital stock and funded debt outstanding amounted to $2,308,282,099. The average net capital liabilities per mile of single track were $96,287. The increase in the length of track is confined entirely to the roads operated by electric power. The single-track mileage increased from 8,123.02 miles in 1890 to 22,576.99 miles in 1902, or 177.94 per cent. and the number of fare passengers carried from 2,023,010,202 to 4,809,554,438, or 137.74 per cent. The total reported cost of construction increased $1,778,276,788, or 456.7 per cent, since 1890. In New York there are in operation ninety-six companies, with gross earnings from operation in 1902 of $59,315,606, and operating expenses of $33,667,724, or 56.78 per cent of the earnings.

MISSOURI ELECTRIC INSTALLATIONS IN MERGER SCHEME—With the passing of the Missouri Edison Electric Company into the hands of the North American Company, of New York, and other interests which recently purchased it, a plan is reported for the consolidation of all the electric power companies with the street railways of St. Louis into one corporation with a capital of $141,000,000. For the reorganized Missouri Edison Company, William F. Nolker, a director in the Mississippi Valley Trust Company, was elected president, and Mr. August Gehner, also a director in that institution, was made vice-president. The new directors are Charles H. Huttig, H. C. Stifel, C. Marquard Foster, E. H. Benoist, Philip Stock, Henry S. Ames, William D. Orthwein, and Messrs. Gehner and Nolker. The reorganization is a temporary one, it being the intention of the new owners of the property to consolidate with the Union Electric Light and Power Company. The Union Electric Light and Power Company has in course of erection a $6,000,000 plant, located at the foot of Biddle street. This plant will have a capacity of 25,000 kilowatts, and the company has a contract with the World's Fair Company to furnish it with light and power during the exposition period.

ELECTRIC LIGHTING.

ST. LOUIS, MO.—The Interstate Transit Company, of East St. Louis, has secured a fifty-year franchise for an electric light and power plant on the East Side.

ST. LOUIS, MO.—The Taylorville gas and electric companies, of Taylorville, Ill., have been consolidated and sold to A. H. Bickmore & Company, of New York city. The consideration was $85,000.

SAN FRANCISCO, CAL.—The Independent Gas Company and the Independent Electric Company have been sold by Claus Spreckles to the San Francisco Gas and Electric Light Company for $6,000,000.

OROVILLE, CAL.—It is stated that the Nimshew power plant, on Butte Creek, will be put in operation in about two months. This plant will generate about 20,000 horse-power. The same company owns a power-house at Centerville, about six miles below the Nimshew plant, where something like 8,000 horse-power is being generated.

NATCHEZ, MISS.—It is said that the Natchez Street Railway and Power Company is being reorganized under the name of the Vicksburg Light and Traction Company. Mr. S. S. Bullis, president of the Natchez company, has been elected president of the reorganized company. The sum of $129,000 has been set aside for possible changes.

BALTIMORE, MD.—Articles of consolidation and merger made between the Norfolk Industrial Company and the Montgomery Power Company have been filed in the clerk's office at Rockville. The two companies have been incorporated under the laws of Maryland, under the name of the Potomac Power Company. The capital stock is $110,000.

YAZOO CITY, MISS.—Final arrangements have been made whereby the municipality of Yazoo City becomes the owner of its own electric lights, waterworks and sewerage. The plant of the Yazoo Improvement Company has been purchased at a cost of $28,500, and the company has passed out of existence. The city will erect new buildings for the plants at a cost of $37,000.

CHICAGO, ILL.—The North Shore Electric Company has executed a mortgage for $350,000 to the Equitable Trust Company, maturing on October 1, 1912, and bearing five per cent interest. It is for the purpose of refunding its existing indebtedness and developing the road's business. It covers the property of the company in Highland Park, the electric lighting station in Waukegan, and all other property of the company.

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ELECTRIC RAILWAYS.

ITHACA, N. Y.—The controlling interest in the Ithaca Street Railway property has been sold by E. G. Wyckoff to George F. Archer and others, of Camden, N. J. The consideration was over $500,000.

ROCKFORD, ILL.—The first survey of the Rockford-Madison electric line, which will pass through Green County, Wis., has been completed, and the right of way is being purchased. The actual measurement from Rockford to Madison by the new line is seventy and three-fifth miles.

EXETER, N. H.—The Epping, Brentwood & Kingston Street Railway Company, chartered at the last session of the legislature with an authorized capital of $200,000, has been organized with the following directors: Russell H. Fellows, of Brentwood; Levi W. Bartlett and L. Waldo Collins, of Kingston; D. Frank Fellows, of Brentwood; John Scammon, of Exeter; J. A. Edgerly, W. S. Goodridge and others.

CHARLESTON, W. VA.—The Kanawha County Court has granted a fifty-year franchise to the Kanawha Water and Light Company to build a line of electric road over the public highways in the county. It is the intention of the company to build and operate an interurban line up and down the Kanawha River for a distance of about fifty miles, connecting Charleston with the numerous mining towns along the Kanawha.

INDIANAPOLIS, IND.—The Indianapolis & Eastern Traction Company has completed its line between this city and Richmond, and work has begun on the road east of Richmond. It will be completed to Dayton by the fall, and it is stated that arrangements have been made for operating through cars between Cincinnati and Indianapolis on the completion of the Dayton-Richmond extension, cars running to Cincinnati over the Cincinnati, Hamilton & Dayton from Dayton.

SCHENECTADY, N. Y.—The Schenectady division of the Fonda, Johnstown & Gloversville Railroad was opened on June 30. A special car, with the officers of the company and their guests on board, left Schenectady about 9 A. M., reaching Amsterdam about ten o'clock. The distance is sixteen and one-half miles. The first survey for this road was made on July 1, 1901, and the work of construction was begun in October of the same year. The powerhouse of the company is located at Tribes Hill.

MILWAUKEE, WIS.—Articles of incorporation of the Withee & Maplehurst Electric Railway and Light Company have been filed at Madison by W. K. McElroy, F. C. Eschweiler and E. H. Naber. The new company, which will have a capital of $50,000, is formed for the purpose of constructing, purchasing or leasing street railways, power and lighting plants. Its main object will be the construction of an interurban line between Withee and Maplehurst, in the northern part of Clark County, to be used for passenger traffic only.

DUBUQUE, IOWA—Two more electric lines will be constructed from Dubuque west in the next year by the Dubuque & Western Railroad, it is stated. One of the roads will run through the northern part of the county, and the other through the southern part. Both will start at Dubuque, but the ultimate destinations have not been determined upon. The officers of the company are as follows: Peter Kiene, Dubuque, president; Jesse C. Bennett, New York, vice-president; Everett M. Mabie, New York, secretary; Charles H. Eighmey, Dubuque, treasurer.

LOUISVILLE, KY.—The incorporation papers of the Louisville & Cincinnati Interurban Railway Company, with a capital of $50,000, have been filed. The company, which is composed of Louisville, New Albany and Jeffersonville men, proposes to build a line direct from Jeffersonville to a point near Cincinnati now reached by the Cincinnati & Aurora Company, connecting there with this line for Cincinnati, and at Jeffersonville with the proposed interurban across the Big Four bridge, thus completing a line between Louisville and Cincinnati. The directors of the company are George B. Lewman, president of the First National Bank, of Louisville; John F. McCulloch, New Albany; John C. Zulauf, Jeffersonville, and Louis Hartman, of New Albany. It is estimated that it will cost about $3,000,000 to get the line in operation, and there is said to be ample capital back of the undertaking.

TELEPHONE AND TELEGRAPH.

HEVER, ARK.—A telephone line is to be erected between Guidon and Melbourne.

OTTUMWA, IOWA—The Iowa Telephone Company will erect a building in this city, to cost $20,000.

WAYNESBURG, PA.—The South Penn Telephone Company has been organized here with a capital of $200,000.

ROSEAU, MINN.—The village council has granted a franchise to C. A. Pearson to put in a local telephone system.

DES MOINES, IOWA—The Robinson & Wilson Telephone Company has been incorporated with a capital of $60,000.

DES MOINES, IOWA—The American Telephone and Telegraph Company will extend its line to Minneapolis *via* Cedar Rapids.

MINNEAPOLIS, MINN.—The capital stock of the Dell Rapids Telephone Company has been increased from $2,000 to $25,000.

NORWICH, CT.—The Gagon Selective Telephone Company has been organized with M. McGilliciddy and M. F. Brown as officers.

MACON, MISS.—The entire system of the Macon Telephone Company has been bought by T. J. Evans and J. W. and T. B. Haulett.

SALISBURY, MD.—The Diamond State Telephone Company has completed the reconstruction of its line between Salisbury, Berlin and Ocean City.

PADUCAH, KY.—Work is being pushed by the East Tennessee Telephone Company upon its long-distance line between Paducah and Paris, Tenn.

CINCINNATI, OHIO—A new branch telephone exchange, to cost $400,000, will shortly be built in this city by the City & Suburban Telegraph Association.

ATLANTIC CITY, N. J.—Improvements which are ultimately to cost close to $100,000 are about to be begun to the system and plant of the Atlantic Coast Telephone Company.

EL RENO, OKLA.—The Consolidated Telephone Company has completed the purchase of the Western Oklahoma Telephone Company's property, the purchase price being $20,000.

INDIANAPOLIS, IND.—The Posey Home Telephone Company has been incorporated with a capital of $30,000, by Allen Gray, Evansville; W. M. Ford, New Harmony, and Braddock McGregor, Mt. Vernon.

CRESTON, IOWA—The stockholders of the Creston Mutual Telephone Company have voted to increase the capital stock of the company from $80,000 to $100,000, and to expend $12,000 in improvements.

PITTSBURG, PA.—The capital stock of the Pittsburg & Allegheny Telephone Company will be increased from $1,500,000 to $5,000,000, and a change in the controlling interests of the corporation will ensue.

BINGHAMTON, N. Y.—A new telephone company has been organized in Windsor, called the Lester Telephone Company. The officers are H. A. Williams, A. Judd and A. Andrews. The line will run from Lester to Windsor.

NEW YORK, N. Y.—The Northeastern Telephone and Telegraph Company, of Newark, has been incorporated by Union N. Bethell, William T. Bouchelle, Walter Brown, John H. Cahill and Howard Thurber. The capital of the company is $100,000.

BIRMINGHAM, ALA.—The Western Union Telegraph Company announces that it has begun the construction of a line along the route to be covered by the Mendenhall and Columbia branch of the Gulf & Ship Island Railroad, now in course of construction. The line will be sixty miles long.

JERSEY CITY, N. J.—The East Jersey Telephone and Telegraph Company has filed a certificate of agreement to the consolidation with the North Jersey Telephone and Telegraph Company and the Northeastern Telephone and Telegraph Company. The capital of the consolidated corporation is $100,000, and the directors are U. N. Bethell, W. T. Bouchelle, W. Brown, J. H. Cahill and H. F. Thurber.

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ELECTRICAL SECURITIES.

The persistent raids which the bear interests have made on the stock market for the past ten months have resulted in a condition of affairs which has seldom been approached. It is natural that a pessimistic view of the immediate speculative outlook should be taken, in the face of genuine efforts of a number of financiers to raise the level of prices. Notwithstanding the fact that there has been a number of large dividends paid, and the closing of the half-yearly business will show a balance account in almost every industry which is entirely favorable, the reinvestment and new investment outlook is said to be decidedly adverse. This condition is no doubt by reason of the apparently strong hold which the bear interests have, and the possibility of forcing values still lower.

ELECTRICAL SECURITIES FOR THE WEEK ENDING JULY 11.

New York:	*Closing.*
Brooklyn Rapid Transit	54⅝
Consolidated Gas	188½
General Electric	173
Kings County Electric	200
Manhattan Elevated	134½
Metropolitan Street Railway	119⅛
New York & New Jersey Telephone	155
Westinghouse Manufacturing Company	190

Boston:	*Closing.*
American Telephone and Telegraph	129¼
Edison Electric Illuminating	245
Massachusetts Electric	90
New England Telephone	130
Western Telephone & Telegraph preferred	90

An additional $5,018,700 of the capital stock of the American Telephone and Telegraph Company has been listed on the New York Stock Exchange, making the total amount listed to date $109,700,100.

The Board of Gas and Electric Light Commissioners has approved of the issue by the Edison Illuminating Company of 20,000 shares of additional capital stock at the par value of $100 each. the proceeds to be applied to the following purposes: The proceeds of 10,000 shares to the payment of obligations now existing or which may hereafter be incurred; the proceeds of 10,000 shares to the purchase of the electric lighting plants located in Milton, Dedham, Canton, Natick, Framingham, Woburn, Somersville, Chelsea, Newton and Needham.

Philadelphia:	*Closing.*
Electric Company of America	8¾
Electric Storage Battery common	60
Electric Storage Battery preferred	60
Philadelphia Electric	6
Union Traction	44⅞
United Gas Improvement	86¼

At a meeting of the board of directors of the Electric Company of America, the president reported that the full returns for five months show that in the net earnings there was a gain of more than 19 per cent over the same period of the previous year. The board passed a resolution unanimously advising that the par value of the stock be increased from $10 to $50 a share. A special meeting to vote on this question will be held in the fall.

Chicago:	*Closing.*
Chicago Telephone	115
Chicago Edison Light	146
Metropolitan Elevated preferred	66
National Carbon common	23
National Carbon preferred	93
Union Traction common	3½
Union Traction preferred	30

LEGAL NOTE.

A SPECIAL CASE OF THE RIGHT OF EMINENT DOMAIN—The flooding of land by a dam for manufacturing purposes is held in Avery *vs.* the Vermont Electric Company (Vermont) 59 L. R. A. 817, to be a taking within the meaning of the constitutional provision regulating the taking of land by right of eminent domain. An extensive note to this case collates all the other authorities on liability for damming back the water of the stream.

PERSONAL MENTION.

DR. SAMUEL SHELDON, professor of physics and electrical engineering at the Polytechnic Institute, Brooklyn, N. Y., is summering at Middlebury, Vt.

MR. H. DURANT CHEEVER, of the Okonite Company, Limited, returned on the Cedric this week after a ten weeks' sojourn in European capitals. Mrs. Cheever accompanied him, and both returned with best of health.

MR. VINTON H. SEARS, president and manager of the New England Automatic Telephone Company, and Miss Francis L. Olive, daughter of Mr. and Mrs. George W. Olive, of North Cambridge, Mass., were married on June 30 at the home of the bride's parents.

MR. EDWARD B. ELLICOTT, the well-known city electrician of Chicago, has been awarded the Octave Chanute medal for the best paper on an electrical engineering subject read before the Western Society of Engineers during the year 1902. This paper was entitled "The Transmission of Fire Alarms."

MR. R. S. KELSCH, of Montreal, formerly of Chicago, has resigned as general superintendent and engineer of the Lachine Rapids Hydraulic and Land Company, and has opened an office as consulting engineer in Montreal, at 44 Street Railway Chambers. Mr. Kelsch has been appointed consulting engineer of the Montreal Light, Heat and Power Company, and is building a lighting plant in Nova Scotia.

MR. EDWARD R. KNOWLES, New York city, has been retained as consulting engineer for the heat, light and power installation to be made in the Publishers and Printers' Building, to be erected at West Thirty-seventh and West Thirty-eighth streets, New York city. This installation will be one of the largest of its kind in New York city, and the enterprise will be well handled, as Mr. Knowles brings to this work a large experience in matters of this kind.

STATE ELECTRICAL CONTRACTORS.

The two state associations of electrical contractors of New York and Pennsylvania held separate meetings at Buffalo on Tuesday of this week. The Pennsylvania association met at nine o'clock in the Iroquois Hotel. The New York association met at ten o'clock in the Board of Trade Building. Owing to the illness of President S. Davis, of the New York association, the vice-president, Marshall Barnes, presided. The meeting of the New York association was devoted to routine business as no change in officers was in order and matters of vital interest were held for discussion at the meeting of the National Association at Detroit the following days.

President Mathieu presided over the Pennsylvania meeting, and after discussing the several phases of the labor question, etc., adjourned.

The impression obtaining as the result of these two state meetings is that the serious labor questions of the last months are likely to reach an early settlement, and it is the feeling that the National Association will accomplish much good in this direction.

Among those on the special cars *via* the New York Central system and those who had gone earlier to Buffalo were James Dole, president Dole Manufacturing Company, New York; James F. Burns, Schenectady; Major Robert Edwards, Western Electric Company; E. S. Keefer, Western Electric Company; C. E. Corregan, Osburn Flexible Conduit Company; A. S. De Veau, De Veau Telephone Manufacturing Company; F. S. Blackhall, of Blackhall & Baldwin; George S. Searing, Hart & Hegeman Manufacturing Company; Charles L. Eidlitz, president the National Electrical Contractors' Association; H. B. Kirkland, R. B. Corey and Thomas Bibber, of the American Circular Loom Company, and the following from the Philadelphia association were on the New York train: Frederick W. Myers, Edwin R. Keller, Walter McIntyre, T. Carpenter Smith, Gilbert S. Smith, H. A. Loeb. G. W. Swan and Frank Harrington, of John A. Roebling's Sons Company, Trenton, N. J., and George F. Porter, Atlantic Insulated Wire and Cable Company, of New York, and W. H. Browne, of the Stanley Instrument Company, of Great Barrington, Mass., were also in the party. Both the New York state and Pennsylvania state delegates and visitors left by steamer Tuesday evening for the meeting of the National Association at Detroit.

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INDUSTRIAL ITEMS.

THE H. O. S. ENGINEERING COMPANY announces a change of address from 277 Broadway to 88 Warren street, New York city. The new office will be connected with a large stockroom where the company will carry a complete stock of knife switches and panelboards for prompt deliveries.

THE B. F. GOODRICH COMPANY, Akron, Ohio, is the well-known manufacturer of a strong line of tires for automobiles and other vehicles. This company has recently published a magnificent art souvenir entitled "Ruth," showing in colors a life-sized drawing of a beautiful woman.

THE MUSSO DUPLEX TYPEWRITING WIRELESS TELEGRAPH COMPANY, Wallace Building, New York city, has been incorporated under the laws of the state of Maine. The officers are Guiseppe Musso, president; James M. McCormack, vice-president, and Robert E. Sylvester, secretary and treasurer.

MESSRS. WICKES BROTHERS, Saginaw, Mich., machinery manufacturers, issue regularly a monthly stock list of new and second-hand boilers, engines and machinery. The list is carefully classified, and the company states that a number of good bargains can always be obtained by looking up this list.

THE ELECTRIC APPLIANCE COMPANY, Chicago, Ill., is meeting with great success in introducing the new "Zenith" Packard lamp. This lamp is made in two sizes, twenty-five and fifty-five candle-power, the latter in two efficiencies, 1.9 and 2.18. The lamp is ornamental, and produces a fine quality of light.

THE MARSHALL-SANDERS COMPANY, Boston, Mass., reports a very large increase in the use of its well-known line of sockets. The company credits this increase entirely to the effect of automatic methods. This company has perfected a complete line of automatic machines for producing a high grade of sockets.

THE A. L. DYKE AUTOMOBILE SUPPLY COMPANY, 1402 Pine street, St. Louis, has removed to 2108 Olive street. This gives the company larger quarters on one of the most prominent streets in St. Louis. The change of address has been found necessary owing to the increasing and rapidly growing business.

MR. C. HUDSON MACHEN, sales engineer representing the Cutter Company, of Philadelphia, announces that he is prepared to submit blue-prints and give any information required relative to "I. T. E." circuit-breakers and Keystone measuring instruments. Mr. Machen's office is at 120 Liberty street, New York city.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, Pa., announces the change in address of its New York Exide depot, which was formerly located at 148 West Eighteenth street. This depot will hereafter be operated by the New York Transportation Company, at Forty-ninth street and Eighth avenue.

THE SUMTER TELEPHONE MANUFACTURING COMPANY, Sumter, S. C., is now building a large addition to its works, which will more than double the present capacity. This addition will give about 20,000 feet more space, and will be ready for occupancy in about sixty days. The great increase in business has necessitated the additional working room.

THE BUFFALO & DETROIT STEAMBOAT COMPANY announces the opening of the new lake route between Detroit and Buffalo. The new steamers, Eastern States and Western States, are running daily between the two points, making connection with all morning trains. Mr. A. A. Schantz, G. P. T. manager, Detroit, Mich., will be pleased to send descriptive literature on request.

THE BENBOW COMPANY, 215 Rothschild Building, Philadelphia, is placing on the market the Benbow adjustable swinging telephone bracket. This is a convenient and up-to-date device. The company states that this apparatus will be sent on trial, and the claim is made that it will give positive satisfaction. The telephone brackets are made of oxidized copper, nickel-plated.

THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, Chicago, Ill., and Rochester, N. Y., has recently closed contracts for switchboards for the following companies: Adena Telephone Company, Adena, Ohio; Vigilant Telephone Company, Dillonville, Ohio; Morrow County Telephone Company, Mount Gilead, Ohio, and also a large number of telephones to the last-named company.

THE COLUMBUS STEEL ROLLING SHUTTER COMPANY, Columbus, Ohio, has appointed the Pittsburg Cornice and Skylight Company, Pittsburg, Pa., as its exclusive agent for eastern Ohio, western Pennsylvania and West Virginia. This agent has already sent in orders for steel rolling shutters for the new Joseph Horne Building and the Bailey-Farrell Manufacturing Company's building, both in Pittsburg.

THE GARVIN MACHINE COMPANY, New York city, announces that its stock of machine tools was never as complete as at the present time, and that the showrooms were never in better shape to afford a very complete inspection of a fine line of machinery. Recent consignments from two large eastern concerns have put the second-hand tool department in fine shape for inspection, and the company will be pleased to send its descriptive lists to any one needing quick shipments of first-class machine tools.

THE NERNST LAMP COMPANY, Pittsburg, Pa., announces a recent test of the Nernst lamp, which was made at the instance of F. O. O'Neill, jeweler, of Kingston avenue, Philadelphia. This showed an average consumption per hour of eighty-eight watts, which is stated to be about half which was required for incandescent lamps giving the same amount of light. The Nernst lamp possesses desirable features in the illumination of jewelry or other stores requiring a brilliant light showing true color values. Twenty Nernst lamps have been installed in this store.

THE CONSOLIDATED RAILWAY, ELECTRIC LIGHTING AND EQUIPMENT COMPANY, 100 Broadway, New York city, states that Consolidated "Axle Light" equipments for electric car lighting are steadily coming into general use on the best and fastest trains of leading railway lines, including the Pullman cars on all of the trains. With the private Pullman cars and business cars of railway officials, the "Axle Light" equipments are very popular. These equipments are beginning to be used quite extensively on railway systems of Great Britain and Europe.

THE H. W. JOHNS-MANVILLE COMPANY, 100 William street, New York city, is in receipt of a testimonial letter from Mr. Barney E. Oldfield, of Toledo, Ohio, who recently made a distance of five miles in five minutes, four and three-fifths seconds, in his racing automobile, as follows: "In breaking the world's automobile record for one mile and five miles to-day (Indianapolis, Ind., June 20, 1903), my racing machine was packed with the Johns-Manville Company's 'Molilene' packing. This packing successfully withstood the tremendous strain incident to this service, and I hereby recommend it to whom it may concern."

THE EUREKA ELECTRIC COMPANY, Genoa and Chicago, Ill., has recently supplied the Hoosier Telephone Company, of Salem, Ind., with a 300-line switchboard of its new Bell style ring-down type. This company is making a specialty of this style of board, and anticipates a large sale of them, since it is remarkably simple in construction and operation, and combines many desirable features. The company has completed its new factory at Genoa, Ill., which gives it three times its former capacity; and it claims that, from the present outlook, it will be necessary to enlarge the factory before a year elapses.

THE NEW YORK LIFE INSURANCE COMPANY, in its fifty-eighth annual report, makes a detailed statement of the condition of its affairs financially. The report shows the total assets of the company to be $322,840,900. The total cash income for the year was $79,108,401.34, and the total disbursements, $46,925,591.47. Since January 3, 1902, the company has filed its fifty-seventh annual report with the insurance departments of eighty-two separate and distinct governments throughout the civilized world. The total market value of all the bonds held by this company is $225,039,295. The gross income from properties is $906,707.41, and the total outgo on the properties is $430,023.81, leaving a net income of $476,683.60. The total value of mortgaged property is $49,417,965.

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Electrical Review

THE PIONEER ELECTRICAL WEEKLY OF AMERICA

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ELECTRICAL REVIEW

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TELEPHONE CALL (private branch exchange connecting all departments)—"21 Cortlandt."

REGISTERED CABLE ADDRESS—"Electview," New York.

A PROBLEM IN RAILWAY OPERATION SUCCESSFULLY SOLVED.

Every one remembers the old schoolboy puzzle of finding a method by which two trains going in opposite directions on a single-track road might pass by means of a switch which was shorter than either train. Probably few of us ever imagine that questions of this kind really come up in actual railway operation, but one did occur recently at a terminal station of one of the Brooklyn elevated railroads, and was very prettily solved in the presence of a platform full of impatient passengers.

At this station, after some waiting, three trains drew in, one after the other; and after shifting them about, apparently with the idea of changing their positions by means of a switchback no longer than any one of the trains, and which already contained a number of empty cars, the difficulty was got over in the following way: Two of the trains were first sent out empty, and the passengers crowded into the last one, which was held back to get on schedule time. There may have been some grumbling at this ingenious solution, but most of those who got aboard doubtless were grateful for being allowed to take the third train, and not being forced to wait for the sixth or ninth.

PROBLEMS IN THE EDUCATION OF ENGINEERS.

There has been of late a noteworthy awakening of interest in engineering education. For the past six months this subject has been undergoing a lively discussion in England and many and widely different views have been put forward and warmly defended both by instructors in the technical schools and engineers and manufacturers engaged in active business. In Germany as well, this most important problem has received attention and quite recently in this country a series of papers was read at the annual convention of the American Institute of Electrical Engineers, which touched upon certain phases of the problem and which should be of assistance to the technical schools not only in the suggestions offered but in awakening the interest and cooperation of the practising engineers.

Society for the Promotion of Engineering Education.

Some years ago the Society for the Promotion of Engineering Education was organized for the purpose of taking up and discussing problems relating to the education of engineers. This society meets annually and discusses reports prepared by special committees and papers prepared by members. This year the society held a joint session with the American Electrical Institute when the papers referred to above were presented, together with others from members of this society. While nearly all the members of this society are engaged in giving instruction in technical schools, most of them are themselves graduates of technical schools, and many of them are practising engineers, in addition to their work at some technical school. This society has done and is now doing work of the greatest value. Its members realize, as probably do few others, the difficulties met in laying out a satisfactory course of instruction in any branch of applied science.

The Question of Time.

One of the first to be met, and at the same time one of the most serious problems is the proper distribution of time to the various subjects required. Probably few engineers who have not at some time or other had to do with the planning of some branch of engineering instruction realize how rigidly the limits are set, and that it is impossible to introduce a new subject without dropping an old one to set free the required time. To illustrate this point: At nearly all of the technical schools a student is expected to spend from fifteen to twenty hours in the classroom every week. If outside preparation is required he is expected to give two hours' time to every hour in the classroom. In laboratory and shop work about three hours are assumed to be equivalent to one in the classroom. This gives the student from forty-five to fifty-four hours per week actual work. The instructor is supposed to allot to the various subjects which must be covered by the student a suitable proportion of this time. But it probably never happens that he gives to any one subject as much time as he thinks that subject really should have.

Four Crowded Years.

It must not be thought that the usual four years given to engineering courses can be devoted entirely to instruction in purely technical subjects. The student is taken from high school and about half this time is required in laying the foundation for his technical studies. Throughout the entire four years there is a constant demand upon the head of the department to allow more time, not only for the strictly technical subjects but for all the preparatory subjects.

The head of a department can not add to the work as he desires, because any new work can only be given at the expense of other courses; and it is a difficult mat-

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ter to decide on what part of the old course shall be omitted to make way for the new.

For a number of years past certain prominent technical instructors have held that an engineering course should be preceded by a general college course. This same idea was suggested at the recent meeting. While, in many ways, this would seem to offer the best solution, there is a very serious objection to it. Only recently certain gentlemen prominent in educational work stated that the four-year college course is too long, because the graduate does not get to work soon enough—that three years should be ample, and the student should be at work by the time he is eighteen, instead of not until he is twenty-one or twenty-two, as is now usually the case. To add two post-graduate years to a four-year college course would keep the young engineer that much longer away from active work, and for that reason be undesirable.

ELECTRIC TRUCKS.

The ease with which electric motors may be controlled has been an important factor in bringing about the use of this means of driving machinery, in many instances, irrespective of the actual cost of the power thus employed. These same advantages are appreciated by the builders of automobiles and power trucks, and as a result we find the electric truck growing in popularity where the conditions are such that there is no difficulty in keeping its battery charged.

Electric Driving of Four Wheels.

One of the advantages which has been made use of in building electric trucks is the ability to drive two wheels of the truck without the use of a differential gear. More recently this method of driving has been extended and there is to-day a large power truck being put out in which all four wheels are driven by independent motors.

But the use of electricity has not stopped when all the running wheels are driven, for these large trucks are now equipped with a small motor for steering. This steering motor, in addition to its use for this purpose, is also adapted to drive the windlass of the truck which is used for loading and unloading. Further, these large trucks are equipped with an automatic brake electrically controlled. These devices equip a truck as completely as a steamship. No manual work is required of the driver; all the latter is called upon to do is to direct the work of the truck.

A GROWING INDUSTRY.

A statistical report issued by the Census Bureau of the United States shows the extent of the growth of the electric railway industry. There were in 1902 in the United States 987 companies operating street and electric railways and controlling 22,577 miles of single track.

Increase in Mileage and Passengers.

The single-track mileage increased from 8,123 miles in 1890 to the figure given above in 1902, an increase of 177.94 per cent. The number of fare passengers carried increased from 2,023,010,202 in 1890 to 4,809,554,438 or 137.74 per cent. The report further states that the increase in the length of track is confined entirely to the roads operated by electric power.

What the Report Shows.

An interesting fact is shown by these figures. The increase in mileage was considerably more than the increase in passengers carried, and further, as the report shows, that the cost of construction increased 456.7 per cent. No doubt the great increase of cost of construction, as indicated by this figure, is due to the more substantial character of the work and the greater restrictions imposed upon urban roads, as well as the increase in the price of labor and material. But it is well to call attention to the fact that while the cost of construction increased over four and one-half times and the length of roads increased over one and three-quarters times, the increase in passengers carried was only a little more than one and one-third times. Either the early roads must have been quite profitable and the companies to-day are satisfied with a smaller profit, or a good number of these railways can hardly be considered profitable investments.

Too Much Road Building.

Electric railway construction is probably the most active of all the industrial applications of electricity, and for this reason also, as well as the conditions indicated by the census figures, it would seem wise to make haste slowly in planning and building new lines. While the greater number of these roads were necessary and while there is still a crying need in certain localities for better transportation facilities, many of the lines were merely speculations, built to be sold.

AN ATTRACTIVE SCHEME.

Some time since we took occasion to comment upon a scheme for an electro-magnetic railway which is being put forward in New York. Since then another glowing description has been published in a daily paper, from which we take the following new and interesting announcements.

Two Important Principles.

Since the train will be lifted from the rails by magnets suspended below the iron structure, and pulling upward, it is said that the expense of the iron structure will be only one-sixth of what would otherwise be required, the structure being relieved of the greater part of the weight. It has also been discovered by the inventor of this system that less power is required to magnetize his lifting magnets when they are in motion than when they are standing still, "because the first pole induces its pole and, sliding by, leaves it for the second pole coming up; therefore, as the magnet slides along, it has to induce but one pole, while if it remains stationary it needs enough charge to induce two poles at one time." The unimportant fact, that is to say, unimportant so far as this scheme is concerned, that a north pole will induce in the iron opposite it a south pole which would tend to repel the following south pole, is not worthy of consideration by the inventor of this system.

A Minor Improvement Suggested.

The description referred to above is illustrated by a number of photographs of the model of the car and drawings of the proposed train. While not endorsing this scheme at all, we venture to suggest that the locomotive shown in one of the drawings—which, by the way, is to be equipped with a ten-horse-power motor and to make a speed of three hundred miles an hour—would give better results if magnets were placed above the iron-work, so that they would pull down, instead of being placed below, as in this position they will lift the driving-wheels off the rail.

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Practical Telephone Engineering—II.

By William W. Handy.[1]

AFTER the general design of a telephone plant has been determined upon, including the location of the exchanges and the selection of the proper equipments for the same, the next problems presented to the engineer are the design of the cable and subway systems, the location of the pole lines and the distribution of subscribers' wiring.

In the following article we will take as an example the city illustrated in Fig. 4, showing the exchanges located at the points *a*, *b* and *c*, these locations having been selected as described in the previous article on this subject. The exchange districts to be supplied from the respective exchanges *a*, *b* and *c* are enclosed by the dotted lines as shown.

FIG. 4.—LAYING OUT A TELEPHONE SYSTEM FOR A CITY WITH 9,500 SUBSCRIBERS.

GENERAL DESIGN OF DISTRIBUTING SYSTEM.

The subway system, being the most costly part of the outside construction, should be very carefully laid out. In all large cities there is a certain district in which the laws of the city require that only underground subway construction can be used, but the installation of distributing poles in this district for the purpose of distributing subscribers' wires from the subway to the telephone is generally allowed. In some cities, however, this method is not permitted, and in such cases it is necessary to provide some other means of distributing to subscribers.

In place of the distributing poles it is common practice to install cable terminals either in the subway manholes in the streets or on the walls of buildings, and distribute the subscribers' wiring from these terminals along the rear walls of buildings to the telephone instruments. This is an expensive style of construction, and is generally avoided if possible, and in the present example we will assume that the distribution in the subway district is made from distributing poles, except in the congested business district where the cables from the subway may be brought directly into certain buildings to a terminal, and the subscribers' wires distributed from this terminal to the telephone instruments.

For the plant under consideration we will assume that the largest cables to be installed are 200-pair, the other sizes being 175, 150, 125, 100, 75, and 25-pair. Modern practice tends toward the use of still larger cables, as high as 350-pair, the object of using these large sizes being to decrease the cost of both the cable and subway systems. In order to lay out the cable system properly it is necessary to indicate in figures on a map of the city the number of prospective subscribers in each block, and then put in sufficient cables to not only distribute to these subscribers, but also to allow for a reasonable increase in their number. Sometimes it is advisable in certain districts to install cables having as much as fifty per cent greater capacity than required at the time the cables are installed, and in other districts it is not necessary to allow for such a large increase. Generally in the business district of a city a large cable capacity should be installed. To illustrate this, we will take for an example an office building or block with several office buildings in it, the number of subscribers being about 125. We could put in a 150-pair cable sufficiently large for the immediate requirements, but the number of subscribers is likely to increase in a year to, say, 175, and it would be necessary then to install a second cable of about seventy-five-pair capacity. These two cables, one having 125 pairs and the other seventy-five pairs, would cost more

[1] The first article of this series by Mr. Handy appeared in the ELECTRICAL REVIEW for June 20, No. 25, vol. xlii.—ED.]

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than one 200-pair cable, and it would therefore be best to install a 200-pair cable at first. For this and other reasons all the cables leaving the main exchange should be 200-pair, the size of any cable decreasing until the last distributing terminal connected to the cable is reached. The branch cables to the terminals should be multiplied with each other, that is, some of the pairs of wires connected to one terminal should also be connected to several other terminals in the immediate vicinity, as subscribers connected to a certain terminal may move, thus leaving a number of wires at the terminal out of use, which wires if they were multiplied to some other terminal could be used to 200. A twenty-five-pair branch containing pairs twenty-five to fifty runs to terminal *b*, and these pairs are also multiplied to terminal *c* by means of a fifty-pair branch containing pairs twenty-five to seventy-five. Thus pairs twenty-five to fifty are multiplied to three terminals, and may be used at either of them if not in use at the others. The other branch cables are as shown in the figure, and need no further explanation. There are a number of methods of multiple cable distribution, some of them quite complicated, but the above illustrates the matter quite clearly, and is a simple method and causes no complication either in the splicing or tracing out of circuits.

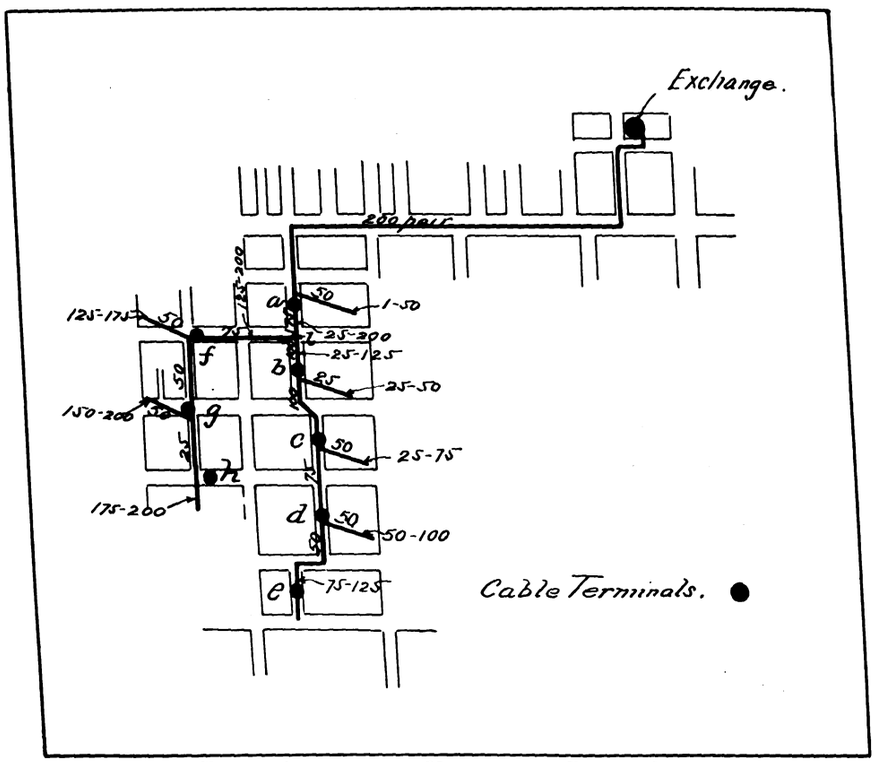

FIG. 5.—CONNECTING IN MULTIPLE THE BRANCH CABLES.

again. This plan has been found very economical, as it decreases the chances of having a large part of the cable system out of use, and often avoids the necessity of installing additional cables.

This system of connecting in multiple the branch cables is illustrated in Fig. 5. A 200-pair cable coming from the exchange has eight branch cables of the sizes shown, these branch cables supplying the terminals *a, b, c, d, e, f, g* and *h*. A fifty-pair branch containing pairs one to fifty is spliced to the 200-pair cable and carried to the terminal *a*, from this splice a 175-pair cable containing pairs 25 to 200 runs to the point *i*, and here the cable divides as shown into a 100-pair cable having pairs 25 to 125 and a seventy-five-pair cable having pairs 125

Referring to Fig. 4, there are 3,650 subscribers to be supplied from exchange *a*, and the subway and pole lines must be located so as to distribute to these subscribers in the most economical manner. We will assume that there are twenty-four 200-pair cables connected to exchange *a*, all of these cables entering the subway from the exchange, and most of them distributing to subscribers from terminals located in buildings and from distributing poles. A few of these cables, however, are to be carried through the subway to pole lines outside of the subway district, and are there to be connected to terminals and carried to the subscribers' telephones by separate wires. From exchange *b* there are, we will assume, twelve 200-pair cables distributing to the subscribers in this district. Most of the subscribers in district *b* are reached by pole lines, and the 200-pair should be split up into 100-pair or smaller where they are run on poles, as the larger cables make clumsy and rather costly construction due to their weight. From exchange *c* we will assume there are four 200-pair cables supplying subscribers in this district, most of these cables being supported on poles and they should therefore be divided up into smaller sizes.

In addition to the cables for distribution to subscribers, there should also be installed trunking cables approximately as follows: Between the two large exchanges *a* and *b* there should be a trunking cable capacity of about 200-pair, between exchanges *a* and *c*, a trunking cable capacity of about 100-pair, and between exchanges *b* and *c*, a trunking cable capacity of about fifty-pair.

The subway system and pole lines finally selected for this plant, we will assume, are as shown in Fig. 4. All that part of the city included in the subway district is supplied directly from the conduit lines, the cables either running to distributing poles located as near the manholes as possible and not over 200 feet from them, or to terminals located in buildings; the latter method being adopted for those streets in the congested business districts where there are a very large number of subscribers. From terminals located in buildings the wiring should be carried through the vaults of adjoining buildings to the subscribers located in the block where the terminals are placed. This makes a very satisfactory system of distribution, although, in some cases, the construction is expensive, and it often is necessary to furnish a free telephone for the privilege of distributing wires through the vaults of certain buildings to other adjoining buildings. It will be noticed from Fig. 4 that some of the subway lines are extended outside of the subway district; two of these lines are those connecting the exchanges *b* and *c* with the main exchange *a*, through which lines the trunking cables are carried. It is always advisable to have these trunking cables underground, as they are very important for the successful operation of the plant, and they should therefore be installed where they are not likely to be injured from external causes. There are also one or two other conduit lines extending beyond the subway district, and the reason for this is that the number of cables to be carried through them is quite large, these cables being too heavy to support

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satisfactorily on single-pole lines. From a first glance at Fig. 4, it looks as if a conduit should be run along the street marked Ave. A, instead of two lines, on the streets east and west of it as shown. We will assume that the reason for this is that Ave. A is paved with asphalt, and the other streets with a paving sufficiently less costly than asphalt to warrant installing two lines on these streets instead of one line on Ave. A. For reasons similar to the above and also due to present subsurface construction, it is often necessary to install the conduit lines on streets which are not very well located for distribution.

The pole lines, as shown, are laid out in as economical a manner as possible to reach the subscribers outside of the subway district. Very often in telephone plant construction the location of pole lines is one of the most difficult problems encountered, due generally to the great number of pole lines already installed on the streets. It is generally not advisable and often not permitted by cities to put up more than two pole lines on one street, and sometimes only one line is allowed. To overcome this, it is often necessary to either put in a conduit line or to run two pole lines in alleys or streets adjoining the one selected as best adapted to distribution.

In selecting the number of ducts for the conduit lines, ample provision must be made for increase of cable capacity, and also for the possibility of some of the ducts getting out of line or clogged up, and therefore unfit for use. For the plant under consideration we must install a conduit entering exchange *a*, having a capacity sufficient for twenty-four 200-pair cables. This line should have about fifty ducts or more, the other smaller and branch lines a capacity in at least the same proportion of ducts to cables, and in very small lines having only one or two cables the ducts should be not less than four in number. The connections to distributing poles and buildings should generally be of three-inch wrought-iron pipe, or some suitable form of tubing, and if there is any chance of more than one cable being installed there should be two pipes and often more.

In estimating on the above plant, we will assume the following:

EXCHANGE EQUIPMENT.

Three exchanges, one of 4,320 immediate and 6,000 ultimate capacity, one of 1,920 immediate and 2,880 ultimate capacity, and one of 720 immediate and 1,120 ultimate capacity, making a total immediate capacity of 6,960 lines and total ultimate capacity of 10,000 lines for 5,900 subscribers.

SUBWAY.

	Feet.
Lineal feet of trench	45,000
Duct feet of conduit	360,000
Lateral connections from subway	15,000

POLE LINES.

Number of poles required	5,000

DISTRIBUTING POLES.

Number required	300

UNDERGROUND AND AERIAL CABLES.

	Feet.
200-pair	90,000
175-pair	16,000
150-pair	20,000
125-pair	8,000
100-pair	13,000
75-pair	19,000
50-pair	29,000
25-pair	30,000

A Technical Institute for London.

A number of the large business houses of London have offered to London, through Lord Rosebery, the means for providing higher technical education. The idea is to supply London with a technical college, after the lines of the world renowned polytechnic at Charlottenburg. It is not for teaching the elements of this or that science; but after the foundation of a thorough education has been laid, the student can go there for the building up of the superstructure. The offer made by Lord Rosebery to the County Council is one of £300,000 ($1,500,000), one-third of this being subscribed by Messrs. Wernher, Beit & Company. The County Council is asked to contribute £20,000 ($100,000) a year for the maintenance of the institute. Lord Rosebery has agreed to act as the first chairman of the trustees, but definite plans for the organization have not yet been drawn up.

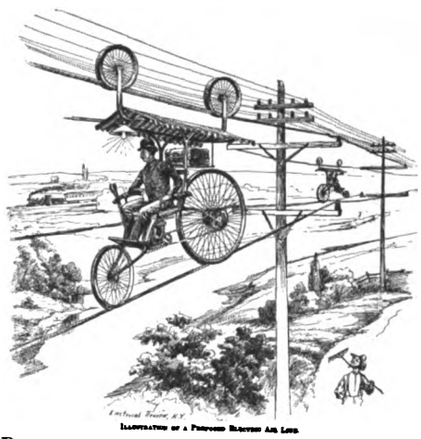
It has been suggested to organize this institute in connection with the Bessemer memorial scheme. At a meeting held to consider the plans for the latter undertaking, the following statement was made: "The establishment of completely equipped metallurgical teaching and research works should form the first object of the memorial for which the practical cooperation and financial aid of the industrial world are asked. The primary aim will be the thorough technical instruction of mining and metallurgical students. Metallurgical tests and research of all kinds for which facilities are not available in Birmingham or Sheffield will be carried out at this works on a practical scale by engineers and others. In this way advanced students will be afforded opportunities for the acquirement of practical knowledge and for original research which it would be difficult to obtain in any other way. The second object of the memorial will be a system of grants in the form of scholarships for post-graduate courses in specialized practical work in London and the great metallurgical centres."

Suspended Electric Railway.

TO THE EDITOR OF THE ELECTRICAL REVIEW:

In the tri-weekly New York *Tribune* of June 29 ult., is a picture of a "suspended railway in Germany," that in principle is exactly the same as the "electric air-line transportation," beautifully illustrated in the ELECTRICAL REVIEW of January 4, 1890.

You must be fully aware that this invention of mine has been encroached upon in a hundred different ways, both in this country and in foreign lands. But as it



REPRODUCED FROM THE ELECTRICAL REVIEW OF JANUARY 4, 1890.

was tendered in the cause of science, I can not be very serious with my complaints, still I must fall upon your excellent journal to maintain my priority.

G. P. HACHENBERG, M. D.

Austin, Tex., July 4, 1903.

[The accompanying illustration has been reproduced from the ELECTRICAL REVIEW of the above date. This drawing was made by R. F. Outcault from Dr. Hachenberg's explanation of his idea. The suspended railway recently opened in Germany differs, of course, from the doctor's scheme in a few essentials, but, as he says, the principle is the same. We are glad to support his priority, although we can not understand why the traveler burned his electric lamp in the daytime. This is probably the cause for the surprise of the farmer in the lower right-hand corner.—ED.]

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ELECTRICAL CONDITIONS IN INDIA.

BY ARTHUR C. HOBBLE.

During recent years British engineers have been active in promulgating civil and mechanical engineering projects throughout India. In one way this is evidenced by the number of miles of railroad which have been constructed and are at the present time in process of construction. Several universities and colleges in India afford instruction in all the branches of engineering with the exception of electrical engineering. This fact, in itself, is sufficient to demonstrate the lack of interest in electrical problems and causes the engineer who is lacking in knowledge of existing conditions in India to enquire why electrical engineering projects have not kept pace with other engineering enterprises?

There are general conditions which have in the past tended to discourage all engineering undertakings. These conditions have to a great extent been overcome, but not without much patience and perseverance on the part of those actively engaged in the execution of said undertakings.

Before any public enterprise (whether it be engineering or otherwise), involving a considerable sum of money, can be carried out plans must first be submitted to the home government for approval. It is extremely difficult for representatives of any foreign country other than England to engage in engineering or other enterprises in India without the payment of a heavy royalty.

Three-fourths of the population of India consist of the poorer, uneducated class of natives who have little or no ambition above their present state and who would interfere with, rather than promote, new methods and enterprises. The strict adherence of the natives to caste relations has caused no little annoyance in past, but to a great extent this difficulty has been overcome by convincing them of the fallacy of some of their ideas.

One of the most important factors to be considered under the general causes tending to discourage many engineering projects is the low wage rate. Some might unknowingly consider this an advantage, but it is well to remember that we have here to deal with unskilled labor. One white person can do as much work, and do it better, ordinarily, than several coolies. The common native laborer or coolie receives four or five annas (eight or ten cents) per day. In many cases power must be very cheap and machinery very efficient to compete with this factor. It is seldom that we find both of these conditions existing at the same time in any particular installation, but in such places as favor hydroelectric development of power both conditions may exist.

During the last few years many fan motors and "punkah pulling" motors have been imported from England and America, and there continues an increasing demand for the same. This seems at first strange in face of the fact that a native may be employed to pull a punkah all day for a trifling sum much less than the cost of power to operate the motors. The old Indian resident, however, smilingly tells us that "Swibo" goes to sleep during the night, or whenever he gets a chance, allowing his master to swelter while the electric motor runs keeping him cool as long as there is power to operate it. Here, then, we have a case in which the high efficiency of the motor more than offsets the low cost of man power.

There are specific conditions, however, tending to discourage electrical development. These conditions have been ameliorated somewhat, but only during the last three or four years, to any noticeable extent. As was stated in the beginning, there has been evident a lack of interest along electrical lines. Students have not had the opportunity of studying electrical engineering, because the colleges of India have offered no such course of training—and why?—simply because there has been no demand for electrical engineers on account of the slow development, or, we might say, non-development, of electrical projects. It is good to be able to state, however, that the University of Madras is contemplating the addition of such a course during the coming year.

It is only within recent years that long-distance power transmission at high voltages has been undertaken by leading nations. Hence it is not surprising that India has been slow to launch forth into this comparatively new departure of electrical engineering, even though the country possesses natural resources favoring such development. No doubt engineers have been aware of these resources favoring hydroelectric development, but more than mere capital and means for the utilization of such power was needing in the face of the discouraging conditions to be overcome.

In July, 1902, was completed the largest hydroelectric installation in the British Empire. The entire project, owned and controlled by the Mysore Government, is known as the "Cauvery Power Scheme." The General Electric Company, of America, was awarded the contract for the installation of the plant and assumed responsibility for the successful operation of the same until March 15, 1903, when it was turned over to the Mysore Government. The generating station is located at Sivasamudram, Mysore Province, where the Cauvery River affords a fall of some 400 feet. About 5,000 horse-power is transmitted at 30,000 volts over a distance of ninety-two miles to the Kolar gold fields, where it is utilized among the several mines for operating motor-driven air compressors, stone crushers, hoists and stamping mills. So successful has been the operation of this entire installation that the gold mines are demanding double the amount of power which the plant now affords. During the coming year this demand is to be complied with as the output of the generating station at Sivasamudram is to be almost doubled. It is unfortunate that the minimum flow of the Cauvery River during the extreme dry season of the year makes available only about 12,000 horse-power. The successful development of the Cauvery Power Scheme has awakened great interest throughout India and has opened the way for future developments along this line. In fact, several like projects are already being considered in other parts of the country. The engineers and all concerned in carrying out the Cauvery Power Scheme deserve much credit not only for the success which has attended their efforts in the face of discouragements, but because they have paved the way for greater developments in this line and have placed confidence in the place of scepticism.

The cost of distribution of electric light and power in the large cities has prohibited the installation of large central power stations in most cases, and small isolated plants are being installed for lighting many public buildings and private residences. A few of the large cities possess cotton mills which could no doubt employ electric drive with a saving in cost over present methods. However, there is another factor which must be considered especially when steam is the source of motive power. Though the coal mines of India can supply that product at approximately $7 per ton, it must be remembered that the coal of India possesses but about sixty per cent of the calorific value of coal imported from England. Considering this, together with the cost of transportation of machinery from England or America, it is not surprising that manufacturing concerns are slow in equipping their es-

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tablishments with the latest and most approved methods.

Owing to the great variation of rainfall in different sections of India, the power which any river may be capable of supplying during different seasons of the year, may vary from several thousand to several hundred thousand horse-power. A good example of this is the Cauvery River which furnishes the power for the generating station at Sivasamudram. During the extreme dry season of the year, about April or May, the river is capable of supplying in the neighborhood of 12,000 horse-power. During the rainy season, however, it may be capable of supplying 200,000 or 300,000 horse-power at times. The annual rainfall in India varies from about twenty-five inches in some sections to 200 inches in others. This great variation necessitates careful measurements and conservative calculations of available water power before considering seriously any hydroelectric project.

After a careful résumé of all conditions affecting electrical development in India, it may be safely stated, in conclusion, that the outlook is none but favorable for hydroelectric projects. The problem in most cases is not the lack of natural resources, but the lack of industries in the proper place to utilize the power. There is an increasing demand for small apparatus for isolated plants, and the invincible fan motor is finding its way in increasing numbers to India's tropical shores.

The German Government has erected a new lighthouse on the island of Heligoland, which will supplant the old petroleum lamp that has long directed the commerce at the mouth of the Elbe. It is claimed for this light that it is one of the most powerful in operation. The distinguishing feature is the return that has been made to the old form of parabolic reflector, with a powerful illuminant in the focus, in place of the Fresnel lenses and prisms. The mirror in this case is of glass, seventy-five centimetres in diameter, and silvered at the back. An arc light with a current of thirty-four amperes is the illuminant. The positive pole of the carbon is so near the focus that it is estimated that the beam is not more than two degrees in diameter, and its candle-power is quoted as 30,000,000. No protection against weather is provided in front of the light, and it is asserted that none is needed. Three similar mirrors and lamps are mounted in one plane round an axis, and the whole revolves four times in a minute, so that a flash is given every five seconds. A fourth mirror and lamp are provided in case of necessity, which will turn three times as rapidly, but it is not proposed to use this except in case of emergency. The duration of the flash is only one-tenth of a second.—*Nature.*

IMPROVEMENTS IN ELECTRIC TRACK WELDING.

BY GEORGE E. WALSH.

During the past year a number of improvements have been made in electrical track welding which, in view of the costly extension of railroad lines contemplated and the relaying of old tracks with new rails, is of the utmost importance. By the old method of track welding the number of breakages of rails was quite formidable in the course of a year; but with the modern improved electric welding system not one in a thousand of the joints shows breakage or loosening. The only weakness in the modern system was found at the bolt or bond-holes beyond the bars, and this has been remedied now by making the weld longer to cover the holes. The result of this has been that continuous rail joints are made which are as strong as the rail itself in any other part of its entire length.

The electrical machinery for modern rail welding is almost perfect in its equipment and operation, but the operator must be a skilled workman who in the last analysis must determine the success of the job. The track welder is mounted on a small trolley car of special type which carries with it a complete outfit of all things necessary for work. With this trolley car made to adjust itself to a track of any gauge, the work can proceed anywhere with equal facility. Either the welding of new rails or the repairing of old joints can be effected with promptness by one of these trolley car equipments.

The first step in the process is to remove all dust, grit, grease and rust from the joints by means of the sand blast. The trolley car carries a strong sand blast, which is operated by the motor. The blast is driven by an air compressor, which receives its power from a storage tank mounted on the car. The electric motor operates the compressor, and fills the storage tank. There is a good size sand bin and a mixer operated by electric power, and when in use the blast of air carries the fine sand against the surface of the rail joints under continuous pressure. The cleansing of the joints by the sand blast, whether they are new ones or old ones being repaired, must be carefully attended to, for in the early welding processes less attention was given to this part of the work, and the joints were always breaking. A hose and nozzle carry the blast of sand to the rails and quickly remove all foreign substances.

When the rails are cleaned they are brought up to a perfect level by measurement, so that the joint will prove continuous and perfect. The rails beforehand are supposed to be made perfectly level on the graded street. The welding machinery is carried forward of the car on a crane which enables the jaws to move far enough out to grip the rails firmly. The crane is wide enough to suspend double jaws so that the welding can proceed on the two rails at the same time. The operation of the crane, which controls the jaws of the welder, is worked from inside of the car by means of a shaft and friction clutches. The shaft of this crane is run continuously during the process of welding by a five-horse-power motor.

During the process of welding the transformer and faces of the rails must be kept cool, and a circulation of water kept up over them by means of a small rotary pump which is operated by the same motor. Ingenious devices have been made to cool this water as rapidly as possible after it has come in contact with the hot rails. It passes from the hot rails to an outer portion of the tank, which winds around to a false bottom through which air is forced by powerful blowers. This forced air tends to cool the water rapidly as it passes around the tank, and by the time it reaches the tank again it is almost as cool as in the first place. It can then be used over again, and passes through the old process of heating and cooling.

When the rails to be joined are gripped into the jaws of the transformer, the flat-rolled steel bars are put in position. These bars of steel have at either end slight projections which are to connect with the web of the rail. When the bars are in position across the joint, the jaws of the welder are swung into position and made to grip them firmly. This process is quickly done, for the bars of steel are fitted beforehand, and a workman can soon place them where needed. The current is then turned on, and it flows through the bars to the rail web.

The welding is done by an alternating-current transformer, with primary windings of two coils in parallel, of forty turns each. The jaws are held in position on either side by large levers, and a hydraulic jack connects these levers together about two-thirds of the way up. The necessary pressure is obtained in this way to draw the rails together and force the bars of steel firmly against the rails. This pressure can be regulated from a few tons to thirty-five tons and more.

It has been found that the welding of

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the joints is increased by alternating the pressure, and it is a prime necessity that this change in the power of the jaws shall be regulated easily. The pressure is alternated frequently by the operator until finally it is brought up to the welding point when the union is made complete. At this critical moment the current is cut off and the full welding pressure put on the rails. The pressure is held until the heat of the rails has been greatly reduced. This final pressure at the welding point requires careful manipulation, for if the operator does not understand the relative importance of great pressure and great heat applied at the critical moment the joint will not prove a good one. The strength of the weld has been found to be increased very materially by holding the pressure for an indefinite time. The ends of the joint require this heavy pressure after the weld more than the centre sides, and the jaws are made to bring the weight on the ends. When the bars of steel are in an expanded condition the ends should be welded, and consequently the improved method makes the centre weld first, and then without stopping to let it cool under pressure the ends are quickly welded. As a result of this method the greatest elongation of the bars is obtained, and as they cool off and shrink the joints are pulled closely together. The result is a tight and strong joint. Good workmen can, in fact, make a joint that shows no opening at all, and the rail appears, to all practical purposes, one continuous, unbroken length.

When the rails are thus joined in a tight weld they are as strong as the ordinary rail, and it requires a good deal of a strain to weaken the joints. The grinding off of the heads to make the surface perfectly smooth and continuous completes the process. A good many joints require very little grinding to complete the job when new welds are being put together for the first time, but in repair work this is quite otherwise. Then the two rails are not always equal in height and breadth. In welding old rails one is very apt to be higher than the other at the joint, and grinding is necessary to bring them down to the exact level. Inequalities in the surfaces of the rails at the joints make hard riding, and cause more trouble to the cars and springs than anything else. The grinder is generally made of an emery wheel mounted on a carriage and separate from the trolley car. It receives its power from the motor on the trolley, however, by means of a swing frame.

It requires from two to three minutes to complete a weld, or rather the current is turned on for that length of time to complete the most important stage of the process. In this time a voltage of about 500 and 225 amperes is consumed. The total current used in the operating plant is from 20,000 to 30,000 amperes, but the regulating apparatus maintains a constant voltage of about 300 regardless of everything else.

The advance in street rail welding has been so marked that it has become necessary to all well regulated roads. Modern passenger traffic demands rails with their joints welded so that there will be no jolting in crossing from one to another. Moreover, operating expenses have indicated that there is economy in welding rails in the end. The saving on the cars and rolling stock is so great when used on perfectly smooth, uniform rail surfaces that few companies would to-day consent to return to the old system of loosely joined rails, with here and there wide spaces between, and with the ever-present danger of accidents by pieces of the rails slivering off. Under the present system such accidents are mechanical impossibilities. The weld is so complete and firm that there is no possible chance of a splinter being started at any of the joints.

K. Mey has made some observations of the cathode and anode falls of potential near the surface of electrodes consisting of potassium or sodium. When the gas is nitrogen, the nitrides NH_3 and NNa_3 are produced and when it is hydrogen there is a probable formation of KH and NaH. The absorption of nitrogen takes place chiefly at the cathode. The formation of the compounds mentioned provides an excellent means of separating the rarer gases, such as helium and argon, from the commoner ones. It is best to employ a cathode made of sodium-potassium alloy for the purpose. In helium, the anode drop of such an alloy is high, and thus confirms Skinner's supposition, that metals of low cathode drop have a high anode drop. In helium also, the alkali metals show the smallest known cathode drops, being thirty volts for sodium, sixty-nine for potassium and 78.5 for the alloy. This may have some connection with the photoelectric power of the same metals. The series of metals arranged according to their cathode fall is the same in every gas, and is identical with the Volta series, or the series of densities, or the series of affinities for oxygen.

Sterilization of Water by Ozone.

In *La Review Technique*, Dr. E. Imbeaux describes several methods of applying ozone to the sterilization of water. A short account is given of the discovery of this substance and experiments upon its oxidizing and sterilizing properties. Early tests were made by Siemens, Froehlich and Tyndall. The latter exhibited his apparatus at Brussels in 1997, when the Belgian Government experimented with it. Marmier and Abraham have been developing an apparatus for making ozone since 1895. The present form consists of a closed chamber containing two cast-iron plates. These are placed parallel, and the opposing faces are covered by two glass plates. Air enters the chamber from one end and passes between the two glass plates and out through a pipe carried through the centre of one plate. The two iron plates are connected to the secondary of a transformer supplying 40,000 volts. In parallel with the plates, but not within the chamber, is a spark-gap which limits the applied voltage so as to prevent arcing between the plates. This gap also sets up oscillations in the circuit, which are said to be beneficial in producing ozone. The brush discharges take place around the glass plates, and thus act upon the air in its passage through the chamber. Another apparatus has been developed by Otto in France. He has found that the brush discharge is most effective when in producing ozone the potential approaches the sparking point, and his apparatus is designed to use high potentials, but to prevent continuous arcing, which would form nitric acid. The apparatus consists of an iron chamber, in which is a shaft fitted with iron discs. A portion of the rim of each of the discs is cut out, the breaks being arranged in a spiral when the discs are on the shaft. The wall of the chamber is cut away parallel to the shaft at one point to form a duct. When in operation one end of the high-potential circuit is connected to the shaft which revolves and the other to the chamber. The brush discharge takes place between them. If an arc jumps from any disc to the case it is broken as soon as the break in the disc comes opposite the duct in the chamber. Air is drawn in at one end of the chamber and passes out at the other. The Siemens & Halske apparatus consists of a closed chamber containing cylindrical concentric electrodes. This apparatus has already been described in the ELECTRICAL REVIEW of December 27, 1902. In all of these systems the water to be treated is passed down through a vertical tower, and in its passage is brought into contact with the ozonized air.

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A Three-Phase Power Transmission Plant Using High-Tension Motors.

By Frank C. Perkins.

THE use of high-tension alternating-current motors directly from the power transmission circuits is not a common practice, but a number of important plants have been installed which employ motors of large size in this way, the power being used in manufacturing plants and also in substations where the current is converted from alternating to continuous for use with storage battery, three-wire distribution.

One of the most interesting plants of this character is that in Allgeau, the current being generated at central power stations at d'Au and Thalerschachen, and supplying light and power to a number of villages between Wangen and Leutkirch, a distance of nearly fifty kilometres. The high-tension synchronous motors are used in various factories, and also in the substations, driving generators of the direct-current type, as motor-generator sets for charging storage battery plants which supply current for both light and small motors in the neighborhood of the substation. This transmission system was installed by the Machinenfabrik Oerlikon, of Oerlikon, near Zurich, Switzerland.

The necessary water power is obtained from the river Argen, the plant at d'Au being fifteen kilometres from Wangen and two and one-half kilometres from the power station at Thalerschachen, which is also supplied from the river Argen through an aqueduct and canal, with water under a head of seven metres, the penstocks having a capacity of 3,000 litres per second.

The interior of the generator and switchboard room at the Thalerschachen power-house is seen in Fig. 1, illustrating the method of power transmission from the turbines to the generators.

The power station at d'Au is supplied with water from the same source, under a head of 9.9 metres, the capacity being 3,400 litres per second.

The interior of the generator room of the d'Au power-house may be seen in Fig. 2.

The Thalerschachen central station has a floor space of eighty square metres and is supplied with a Jouval turbine constructed by the firm of Escher, Wyss & Company. This turbine has a capacity of 210 effective horse-power, 3,000 litres of water per second being used under an available head of seven metres. The turbine operates the high-pressure generators by means of belt transmission.

The Oerlikon three-phase generators installed in this power-house have each a capacity of 100 horse-power and are operated at a speed of 500 revolutions per minute. The three-phase current generated has a frequency of fifty periods per second, and has a potential of 5,000 volts. The armature of this machine consists of eighteen coils, twelve of which have 114½ turns, and the remaining coils 115 turns of copper wire, one and one-third millimetres in cross-section. These windings are arranged on the coils in five layers.

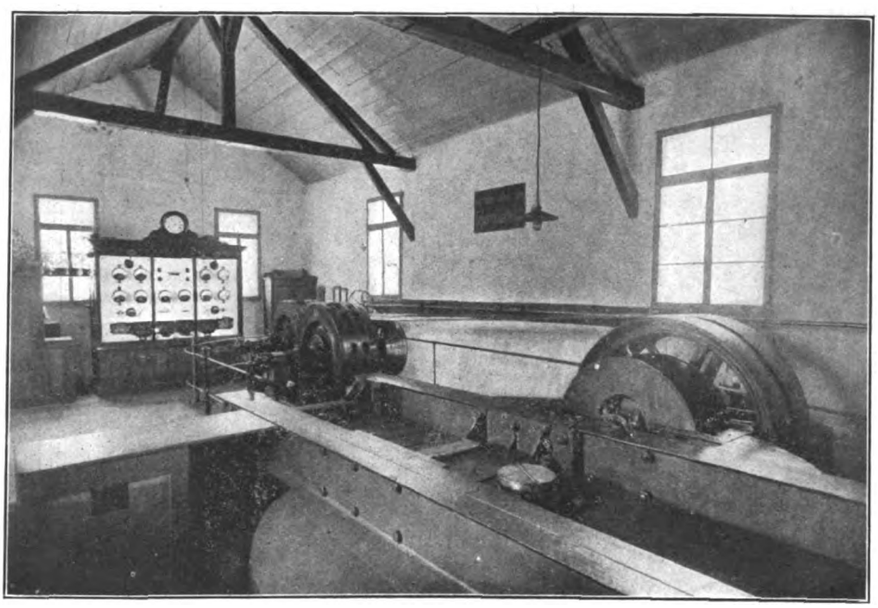

FIG. 1.—INTERIOR OF POWER-HOUSE AT THALERSCHACHEN.

It will be noticed that the exciting generators are bipolar machines, directly connected to the shafts of the alternators.

The switchboard noted in the accompanying figure in this power station is supplied with the usual voltmeters, ammeters, synchronizing lamps and transformers. In addition to the transformers for the measuring instruments a one-kilowatt converter is used for supplying lights to the power stations. The switchboard is exactly similar to that in the second power plant at d'Au.

The turbines in the d'Au station consist of two wheels of the Francis type constructed by the firm of J. M. Voith, of Heidenheim. The turbines are installed five metres above the tail-race so that one-half of the head is utilized by the draft tube. The turbines are regulated either by hand or automatic regulators. These turbines each has a capacity of 168 horse-power under a speed of 175 revolutions per minute. The flow of water is 1.7 cubic metres under an effective head of 9.9 metres.

The generators of this plant are also operated from the turbine by a belt transmission. The pulleys have a diameter of 800 millimetres and a width of 500 millimetres. These Oerlikon dynamos are of the three-phase type, supplying an alternating current of 5,000 volts, the frequency being fifty periods per second and the speed 500 revolutions per minute.

The revolving core has a diameter of 1,050 millimetres, the armature's internal diameter being 1,055 millimetres. The armature winding consists of two sets of eighteen coils, each having fifty-four turns of copper wire 2.4/2.9 millimetres in section. These windings are arranged in five layers. The field coil consists of 483 turns of copper wire 5.0/5.6 millimetres in section arranged in twenty-three layers of twenty-one turns each. The dynamos for exciting the field of these alternators are directly coupled to the generator shafts, as seen in the illustration, bipolar machines being used of somewhat different construction from those at the Thalerschachen power plant.

The high-tension power transmission lines from the central power station at d'Au consist of fifteen conductors each

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having a diameter of 3.5 millimetres and a total length of 48.3 kilometres. The total length of conductors used is 290 kilometres with a weight of 24,685 kilogrammes. The total number of poles used is 1,000, those between the power stations and Wangen being from fifty to sixty metres apart and those between d'Au and Isny and Leutkirch from forty to forty-five metres apart. The poles are twelve metres long and set 1.8 metres in the ground, the latter portion being impregnated with mercury sublimate. There are two transmission lines of six conductors from the power station at d'Au and Thalerschachen to Wangen, one of which operates a 100-horse-power high-tension 5,000-volt synchronous motor in the Cellulosefabrik and a forty-two-horse-power high-tension motor in the Papierfabrik at Wangen; and the other line supplies current to the high-tension motor of the motor-generator set in the transformer substation at Wangen, seen in the accompanying illustration, Fig. 3. A second transmission line of three conductors supplies current to the substation at Isny, and a third line is installed to the substation at Leutkirch. In the substation at Wangen, which is six metres long, 9.5 metres wide and three metres high, there are several rooms, including repair shop, switchboard, storage battery plant and motor-generator rooms.

It will be noted that the motor-generator room, seen in Fig. 3, is quite artistically decorated. The machine consists of a sixty-horse-power high-tension synchronous motor of the Oerlikon type directly coupled to two thirty-horse-power direct-current machines, all three machines being carefully insulated from each other by flexible insulated couplings and also from the foundation by porcelain supports.

The synchronous motor operates at 1,000 revolutions per minute, the frequency being fifty cycles per second and the potential 5,000 volts. The motor armature has nine coils embedded in eighteen slots or grooves. Each of these coils consists of 131 turns of copper conductor 1.6 by 2.2 millimetres in cross-section.

Both of the armature windings are connected in series. The exciting coil has 1,700 turns of copper conductor measuring 2.2 by 2.6 millimetres.

Both of the direct-current machines are of the shunt-wound type, supplying a current of 125 volts at the normal speed of 100 revolutions per minute. The armature core is 316 millimetres in diameter and 250 millimetres wide, and has eighty-one slots or grooves measuring 6 by 21 millimetres. Each groove has two conductors of two wires each in parallel 4 by 4.6 millimetres in cross-section. The commutator is insulated with mica of six millimetres thickness between each of the eighty-one commutator bars. The field magnet cores are 324 millimetres in diameter, and each of the four coils consists of 850 turns of copper conductor 2 by 2.4 millimetres. The switchboard noted in the background controls the motor-generator set as well as the storage battery plant which is located in the adjoining room. The battery installation consists of two sets of sixty-four cells each. The capacity of this accumulator outfit is 540 ampere-hours at a discharge rate of 180 amperes, supplying current to the lighting distribution circuits which are operated on the three-wire system.

The substation at Isny is 7.8 metres long, 6.6 metres wide and 3.3 metres

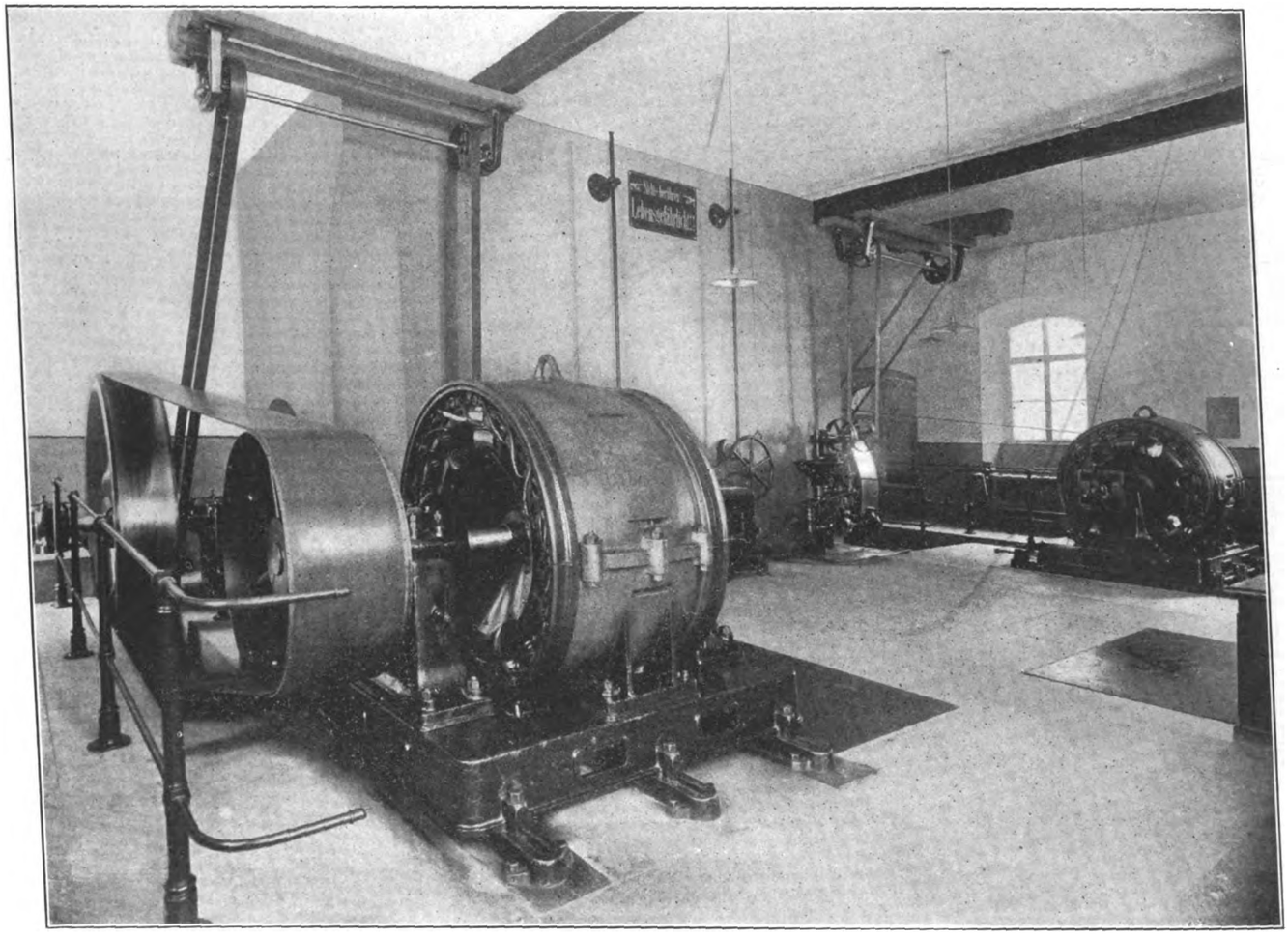

FIG. 2.—INTERIOR OF POWER-HOUSE AT D'AU.

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high, and is similarly equipped to that at Wangen just described. The storage battery plant at Isny consists of seventy cells of a capacity of 750 ampere-hours, the maximum discharge rate being 252 amperes.

The substation plant at Leutkirch is 8.7 metres long, 6.75 metres wide and 3.55 metres high, and is equipped with a motor-generator set similar to that at Wangen, and has the same number of cells and capacity of storage battery plant.

The construction of the high-tension motors used at the paper factory and the turns being used on each coil. The excitation coil has 780 turns of copper conductor 3.3 by 3.8 millimetres in section.

For lighting the various villages at a distance from the substation step-down transformers of the three-phase type are employed, ranging from two kilowatts to ten kilowatts in capacity. The lighting circuits near the substations are operated on the three-wire system from the storage battery plants. The private lighting includes several thousand lamps of five, ten and sixteen candle-power each, while the public lighting utilizes incandescent

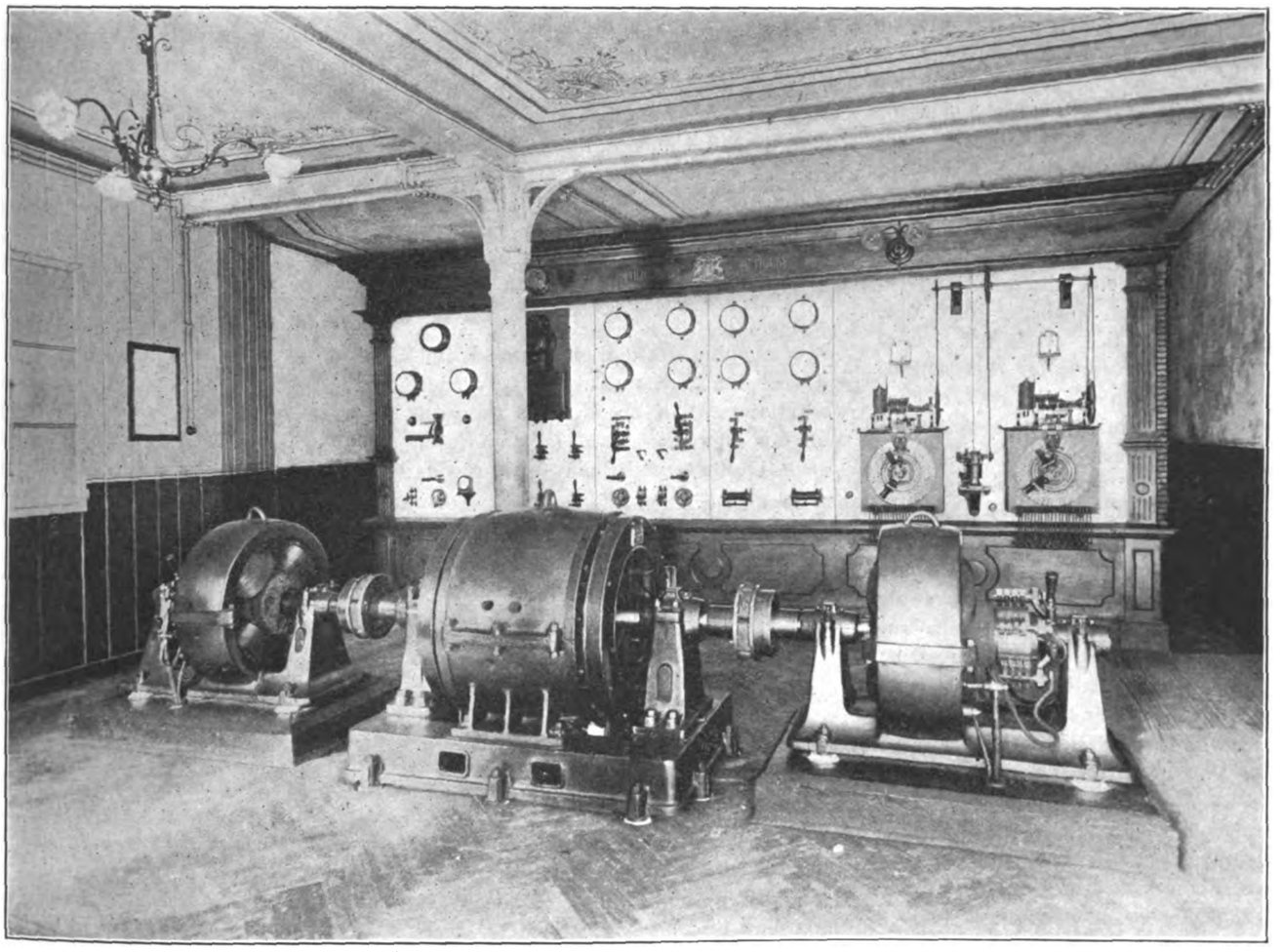

FIG. 3.—TRANSFORMER SUBSTATION AT WANGEN.

cellulose factory at Wangen may be of interest. The former has a capacity of forty-two horse-power and the latter 100 horse-power, and they receive their current from the three-phase 5,000-volt line from the power station at d'Au, about fifteen kilometres away. They are synchronous motors of the Oerlikon type, the forty-two-horse-power machine having a speed of 750 revolutions per minute. The armature winding of this motor consists of twelve coils of copper conductor; each of a cross-section 1.4/2 millimetres, 130 lamps of twenty-five candle-power and numerous arc lamps at Wangen, Isny and Leutkirch.

On the low-tension circuits there are fifty-two motors in operation ranging in size from one-eighth horse-power to fifty horse-power, and the cost for power varies from 300 marks per year for motors of one-eighth to three-fourths horse-power to 200 marks and 150 marks per horse-power per year for motors of one to ten horse-power and ten to fifty horse-power, respectively.

Shipments of Rubber from Para.

Under date of June 6, 1903, Consul K. K. Kennedy says: "The shipments of rubber from the Amazon Valley during the month of May just passed amounted to 2,070 tons, as against 2,083 tons for the same month in 1902. The total export of rubber for this season—July 1, 1902, to May 31, 1903—is 28,110 tons, as against 28,738 tons for the corresponding period of the previous season. It does not appear likely that the business of this closing month of the season will materially change the relative bearing of these figures. The crop shortage this year, as compared with the year of 1901-2, will therefore be only about two per cent, instead of five per cent as estimated January 1."

Whenever electricity is used in connection with cyaniding there is a larger expenditure of chemicals, and the base metals are dissolved to a much greater extent along with the gold and silver. However, when electric current is employed, a weaker cyanide solution may be employed, as its action is increased by the current.

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PROPER QUALIFICATIONS OF ELECTRICAL ENGINEERING SCHOOL GRADUATES FROM THE MANUFACTURER'S STANDPOINT.[1]

BY L. A. OSBORNE.

Any discussion having for its subject the educational needs of a student of engineering must necessarily be limited to the particular requirements to be met. It is therefore proper to state in the beginning that the writer has in mind the requirements of a particular industry and his views are therefore controlled by the environment with which he is most familiar.

It is probable that the majority of young men who enter upon a course of engineering in one of our technical schools rarely have expectations of devoting their energies to engineering pure and simple. My experience has shown that the average young engineer rather expects that his preliminary training and education will be of assistance to him in obtaining a foothold with the commercial side of industries which are based upon engineering practice. It is not obvious, in seeking for reasons for this attitude, whether our engineering courses are based upon the assumption that the industrial world requires business men with a technical training or whether the supposedly larger emoluments which come to men of affairs rather than to specialists and designers has its effect in diverting the energies of young men after they have departed from the influences which surround them in their academic career, but I believe that the latter is the determining factor. However that may be, my experience is that of all the technical graduates who obtain employment with the industry with which I am connected, not more than one in ten is fitted either by temperament or education to take up with success the work of pure engineering.

Temperament undoubtedly has a great deal to do with it, and the tendencies of modern industries to demand technical training of men in its commercial departments undoubtedly have the effect of inviting men to take the technical courses, where if there was not that incentive they would have devoted themselves to some other line of activity. There is therefore graduated every year a large body of men who are added to the engineering profession but who are not properly fitted to deal with engineering questions broadly.

On the other hand, the courses which these men have followed have generally not pretended or considered any other probability but that they are to become engineers pure and simple. There have consequently been turned out a body of men who are by inclination not prepared to follow the so-called drudgery of the profession. At the same time they have been given little instruction or special preparation for the lines of work into which they will obviously drift.

I can not but believe that the majority of men before they have completed a four years' course in college have given some indication to the faculty of their ultimate tendencies. It seems, therefore, as if it were desirable either to differentiate between these two classes of men, with the result that each would be better prepared for the work which they will ultimately be called upon to do in the world's activities, or better still to broaden out the courses in certain particulars to the end that the whole body of engineers will enter upon their work with a fuller comprehension of its duties and its opportunities.

I am quite aware that financial and physical limitations will always render the attainment of an ideal at the best only an approximation. I know from personal contact with many of our educators that they are fully awake to the growing demands of the profession, and that generally the most earnest efforts are being made to meet these ever-increasing requirements. My remarks should therefore be taken in the spirit in which they are given, that is, not in criticism of existing methods, but as an endeavor to point out conditions which might be considered as desirable to work toward.

In considering whether the training of the modern engineer is adapted to the demands which will be made upon him later on, we should bear in mind certain latter-day tendencies which have largely come about through engineering practice.

There was a time in the history of manufacturing when its activities were directed largely by men who had grown up from apprentices in the shops and who were primarily machinists and workmen. The work of modern engineering has resulted in the development of enormous industries which require skill, intelligence and knowledge and a high order of administrative ability, which was entirely unnecessary in the days of small shops and limited organizations. It has followed that the problems incident to this great industrial development have been more than the limited education and intelligence of the old-time shop superintendent could cope with.

The inventions and discoveries which have revised modern industrial practice have been made by comparatively few men. The activities which have been consequent upon these inventions and discoveries require an army of trained men to supervise and direct them. It is in this field that the average engineer can hope to find an outlet for his best talents. I am not now speaking of the few men who by temperament and by making the best use of the opportunities offered in the technical schools will ultimately develop into world-recognized engineers, but of that great body of men trained in engineering, who must look to the more general fields for a proper environment in which to exercise their abilities.

In this short paper it is not my intention to do more than to point out suggestive thoughts, hoping that the discussion, which is always more important than the paper itself, will bring forth the opinions of our members on this question, and will do much to aid us in defining our views upon the subject.

Considering the field of manufacturing it is my experience that not one in a hundred engineering graduates ever looks to that as holding forth anything attractive as a scene of his future labors. Manufacturing to-day in any industry is a proper field for an engineer. It is unnecessary for me to set forth the countless opportunities which any manufacturing concern, be it great or small, offers for the exercise of engineering judgment.

It is true that our technical schools devote a certain portion of their time to "shop work," and endeavor to give to the engineering student a certain facility in the manipulation of tools, both hand and machine; but it is very rare that the school makes any serious attempt to take up those larger questions of the adaptation of tools to special purposes or give instruction in general in the principles which underlie the tool organization of a shop. Consequently the student's interest is not stimulated and the majority of the technical school graduates leave college with but very hazy notions either of the function of tools, the principles of their design or the machine organization of a shop. In connection with manufacturing it is also certain that a more thorough knowledge of works organization as applied to the personnel would not only stimulate the interest of the student in this most attractive field, but would be of the greatest importance to

[1] A paper presented at the twentieth annual convention of the American Institute of Electrical Engineers, Niagara Falls, N. Y., July 3, 1903.

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his future employers, the industrial concerns throughout the land.

Almost without exception an engineering graduate enters a machine shop in utter ignorance of the principles which should underlie its organization and personnel. It is true that familiarity in these lines comes largely from experience, but it is also true that there are large fundamental facts underlying all successful examples of shop practice and shop organization, which should be of the utmost value to an engineering student.

Another very important function of the man whose work is the supervision of manufacturing processes is the subject of works accounting. Works accounting based upon general accounting practice is a closed book to the average student of engineering. I have been unable to find in the curriculum of any technical school that I have examined any course of study which remotely suggests that this would be desirable knowledge for an engineer. The matter of shop accounting is not a matter for the ordinary expert accountant to deal with. The man who knows the cost of his product—and upon this knowledge success absolutely depends—must adapt the fundamental laws of accounting to the particular cases with which he has to deal. There is no more important knowledge required of a works manager than an adequate knowledge of proper accounting methods. In criticism of this it might be said that ordinary accounting and bookkeeping is a thing which any intelligent man might readily acquire, but my opinion is that it would be much better for our engineering courses to recognize the important relation which this branch of knowledge has to modern engineering work and the advantage of including it in the curriculum would lie in bringing the importance of the subject prominently to the student's attention.

All engineers if they expect, as all do, to achieve prominence in their profession, must sooner or later come in contact with labor. There is no more vital subject facing the industrial world today than the relations between employers and labor. Every engineer may hope sooner or later to be an employer of labor. To enable the engineering student to understand the economic laws which govern the relations between employers and labor would add enormously to his value in a general way. The engineering student to-day has no insight into these questions except as he may gather his opinions through the newspapers or through such desultory reading as he may choose to do; the result is that the engineering student is not brought to an appreciation of the enormous influence which this question must have on our future industrial progress. A course which would bring to the student's attention the history of the relations between capital and labor and the economic laws relating thereto would be suggestive and call to his attention vividly its importance, and arouse in him a realization that this is a question which he some day might be called upon to treat intelligently.

On the commercial side, all engineers sooner or later must come in contact with the problems which introduce questions of business practice. The consulting engineer, the engineering salesman, and the designing engineer will, sooner or later, be called upon to enter, either directly or for his employers and clients, into contract relations. As it stands to-day the engineering student leaves college with the haziest notions of the principles underlying the law of contracts. Under the circumstances it would seem well if our engineering courses included a short course of law in its relation to contracts.

It may be said that all these things have nothing to do with engineering. This is partly true, but my plea is for engineers of broader horizons. Our technical schools to-day are admirably fitted to turn out men who are well grounded in the fundamentals of engineering. As a rule they are good mathematicians, electricians, chemists and physicists, and have all the technical knowledge necessary for pursuing the profession, but they are as a class woefully lacking in that they have no comprehension whatever of many of the subjects which are inseparably connected with the practice of the profession.

I believe that much of the manual training, which now occupies such a large proportion of the "actual hours' work" in the courses of most technical schools, could be replaced with profit by lectures on subjects related to those which have been mentioned in this paper.

No attempt has been made within this short paper to more than touch what has appealed to the writer as being the more important and most noticeable qualities lacking in the mental equipment of the average technical graduate with whom he comes in contact.

Peru Electrical Enterprises.

Of late years there has been a notable extension of electric force and electric lighting in Peru. Lima is now lighted throughout by electricity, and in many establishments the machinery is driven by electrical power. A number of the cities in the interior also enjoy the benefits of electric lighting.

Two syndicates have recently been formed in Lima for the construction of overhead trolley tramways. One is La Compañia Anónima Tranvia Eléctrico de Lima y Chorrillos. This company proposes to build an electric tramway from Lima to Chorrillos, passing through the small boroughs of Miraflores and Barranco, lying between Lima and Chorrillos. The distance is about fourteen kilometres (8.6 miles). The line will be double tracked and the cars will run at intervals of about ten minutes. The capital is £80,000 ($389,320), divided into shares of £1 ($4.86) each.

The other company is called Ferrocarril Eléctrico de Lima y Callao. This line is also to be double tracked and will connect Lima and Callao, a distance of about 13.7 kilometres (8.5 miles). This company also intends to construct tramways in the city of Callao. Its capital is £100,000 ($486,650), and it intends to compete with the existing railways for the carrying of freight as well as passengers between Callao and Lima. The passenger trains are intended to be run, like those of the other company, every ten minutes.

The government gives to these two syndicates a privilege for sixty-six years. The two companies are to be free of taxes, and are to import free of duty for the term of two years all material for their own use. At the end of sixty-six years, the tramways, rolling stock, and all material become the property of the government free of cost.

Both the electric tramway companies have made arrangements with American manufacturers for the supply of the plant and material to equip the lines, and it should soon begin to arrive, as the lines must be finished and in working order within two years from the date of contract with the government.

These facts were obtained from the interesting report to our government by the Hon. Joseph C. Cree, vice-consul at Callao, May 8, 1903.

Technology Quarterly.

The June issue of the *Technology Quarterly,* published by the Massachusetts Institute of Technology, contains the following articles: "The Figure of the Earth from Pendulum Observations," by Mr. G. L. Hosmer; "A Study of the Geology of the Charles River Estuary and Boston Harbor," by W. O. Crosby; the first section of a serial article upon "A System of Quantitative Analysis, Including Nearly All Metallic Elements," by A. A. Noyes; and "The Composition of Sewage in Relation to the Problem of Disposal," by Mr. George W. Fuller.

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WHY ENGINEERS SHOULD ADVERTISE.[1]

BY GEORGE H. GIBSON.

We hear much nowadays about the dignity, the honor and the glory of the engineering profession. At the same time the correspondence columns of the technical journals are filled with complaints concerning the meagre compensation usually received by engineers. These things do not harmonize. If the engineers, by virtue of their skill, ability and integrity, are indispensable in this industrial age, why are they not better paid? There are but two classes of people who can be held responsible for this state of affairs, *viz.*, the engineers themselves and their employers, the public. Some of the blame rests upon each, but most of it upon the engineers.

In the first place, most people, including many otherwise well informed, have a very hazy notion of what an engineer is and what he does. They perhaps think of him as somewhere between a highly skilled mechanic, or artisan, and a professional man consulted as an expert in cases of dire necessity. They rarely regard him as a man of affairs, capable of directing and conducting large enterprises. That this is the case is shown very clearly by the attitude of state and municipal governments toward engineers and their salaries. For instance, the wealthy state of New York advertises for engineering assistants in the office of the state engineer, offering the munificent salary of $5.00 per day for days actually worked, nothing for overtime. Bricklayers in many cities are paid $5.20 for eight hours labor and double pay for overtime. The "buyers" of department stores often receive more than $2,000 per year. Again, Kansas City, Mo., is making important and costly additions to its water supply system. In connection with this work three consulting engineers have been retained. In spite of the fact that the advice of these men may result in the loss or the saving to the city of thousands of dollars, the Kansas City *Journal* complains that one "has been added to the city pay-roll at a salary of $1,500 a year and annointed with title of "consulting engineer," and that the services of the others "cost the city $15 every time they blink an eye," that is, they are paid $15 per day when their services are required. No large city would think of employing legal talent at wages so small, and at the same time nearly every municipality is engaged in engineering undertakings upon which the profit or loss due to good or poor engineering judgment and skill may amount up into the thousands or even millions of dollars. Due to poor engineering, or the absence of any at all, hundreds of lives annually are lost from typhoid fever in some of our large cities, a loss which could be almost entirely prevented by the application of well-known engineering methods.

Now it is plain that the only way in which public opinion in regard to these matters can be reformed is by education, and it is equally plain upon whom rests the responsibility of doing the educating. The engineers must speak for themselves. They must educate the public in engineering matters. It is as much to the interest of engineers as of lawyers or bankers to take an interest and part in public affairs and to educate and direct public opinion. The engineer should advertise the engineering profession for the good of both the profession and the public. A beginning has been made in this by engineers like Kent, Thurston and others, who have sought to bring to public attention the great revolution in the industrial and social world being brought about by the activities of the engineer. Much is also to be expected from the efforts of those, notably Mr. C. F. Scott, now president of the American Institute of Electrical Engineers, who are endeavoring to draw the national engineering societies together into a united, harmonious and powerful body. Since the above was written, Mr. Carnegie's generous offer of $1,000,000 to erect a building in New York city for the national engineering societies has placed this movement upon a substantial footing.

The timeliness and importance of such movements are manifest when we consider that fifty years hence the engineer will probably hold a position of vast power and influence in the social organism. His work touches organization, financiering, management and, ultimately, statesmanship. He is forced to study political economy thoroughly and at first hand. He is destined to become and is becoming the leader of vast industrial organizations and, perhaps eventually, of the world itself. In the beginning the world was superstitious and ignorant and its rulers were priests; these were followed by soldiers who have disciplined it, and these again by lawyers, who have established the principles of civil rights. The great questions of the present and future are industrial and commercial. Science and invention should naturally, it would seem, place the source of wealth and power in the hands of the engineers, who should next hold the reins. This is not to be understood in any absolute or revolutionary sense, but it is to be noted that the professionally trained engineer is more and more becoming a man of affairs. His active life, exacting duties, accurate habits of thought, earnestness and integrity fit him to be the leader and adviser of men.

However, our exultation in the bright prospects of the engineering profession has perhaps caused us meanwhile to forget the individual engineer. As above pointed out, his pay is not always commensurate with his prospects and he can not live comfortably upon prospects in general and nothing in particular. His practice of "the art of directing the great sources of power in nature for the use and convenience of man" is not always supplemented by the art of being well paid for that practice. It would seem that there should be no great difficulty in selling at a good price services so profitable to the purchaser as those of the engineer, but it appears that he usually fails to do it.

Careful consideration of the subject seems to indicate that the limited financial success of many technical men arises more from lack of business perspective and enterprise than from anything else. First, they do not advertise enough. It is one of the first duties of every man to let the world know what he is good for. Honest advertising pays both parties concerned. If you can do a thing better than it is generally done, you should tell about it. It may help some one else, but it will probably help you most, besides, you don't need to give the whole secret away. In other words, engineers should write articles for the technical press based upon their work, study or observation. Such articles are valuable to refer to when applying for positions or soliciting work. They form the cheapest form of personal advertising, since they are usually productive of revenue. Most technical papers will gladly publish and pay for articles of any merit. Men are known for their ideas, and an idea properly disseminated has more advertising value than a vast amount of money. A man of real enterprise, however, will not stop with technical press, but at opportune time will discuss in the public press engineering and economic subjects of popular interest, such as the purification of public water supplies, public transportation, the fuel situation, gas and electric lighting, and many others of equal importance.

[1] Reprinted from "The Michigan Technic," 1903.

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Proceedings of the National Electrical Contractors' Convention, Detroit, Mich., July 14, 15, 16 and 17.

FIVE hundred names were registered at the third meeting of the National Electrical Contractors' Association, held in Detroit, July 14, 15, 16 and 17, and it is estimated that from 100 to 200 others interested in the progress of electrical matters were visitors at the meeting.

This session proved a surprise to many as it indicated clearly the strength and importance and the excellent character of the men identified with this branch of electrical work in the United States. For several years the electrical contractors in all parts of the country have been greatly harassed by the condition of the labor market, resulting in strike complications and in many cases long suspension of construction work. This and other questions of interest to contractors throughout the various parts of the country brought about a meeting of a number of electrical contractors four years ago, which resulted in the formation of the present organization.

Up to the present time all the sessions of this association have been held behind closed doors, and members only were allowed admittance. It has been, too, the attitude of the association to withhold information as to its proceedings from the press, not necessarily because the matter of the proceedings could not be printed with perfect propriety, but the points discussed were mainly of a non-technical nature pertaining to the adjustment of methods of buying from manufacturers, the attitude toward non-union labor, and subjects not of general interest to the public.

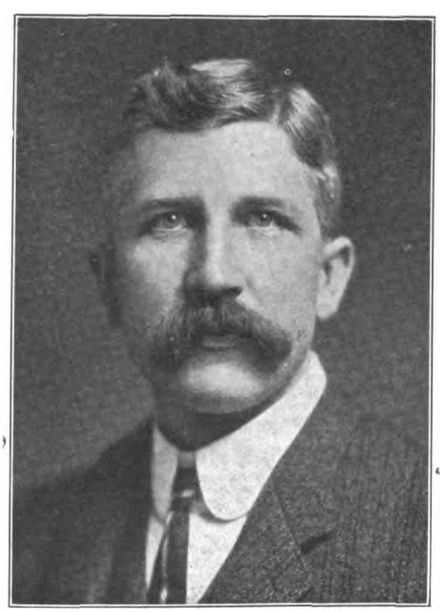
Much of the discussion and the proceedings in the several meetings had a direct bearing on the matter of dealing with manufacturers, of equipments used in construction work, such as conduit, lamps, sockets, porcelain products, wires, etc. This part of the proceedings is of especial interest to manufacturers.

As the result of the present session much has been done toward clearing the atmosphere, and it is believed that the strike difficulty will be minimized immediately and that in future this trouble will not continue as a serious embarrassment.

The first executive session was held at ten o'clock, Tuesday, July 14, with the president, Mr. Charles L. Eidlitz, in the chair. This was an open session and the delegates listened to an address of welcome by Mayor William C. Maybury, of Detroit. In a felicitous address the Mayor extended the freedom of the city to the visiting electric men, and in conclusion remarked that Detroit has the horror of being the home of Thomas A. Edison, during a portion of his boyhood. After this open session, business meetings were held daily.

Many of the contractors present left Detroit with the satisfaction that the gathering had been productive of great good and that the organization would hereafter be a strong factor in the electrical industry.

One of the prominent members remarked to a representative of the ELECTRICAL REVIEW, "The national labor board which has been appointed surely will work great good. The purposes of this board are the consideration of the difficulties with which we have been confronted and the attitude will be to deal with the question in a fair, broad and kindly spirit."



ERNEST MCCLEARY.
President-elect National Contractors' Association.

The purposes of the board also are to secure the names of all employers of labor in electrical construction work throughout the country to confer with them as to their difficulties and advise with them.

The officers elected for the ensuing year are: President, Ernest McCleary; first vice-president, W. I. Gray, Minneapolis, Minn.; second vice-president, Walter C. McIntire, Philadelphia, Pa.; third vice-president, F. P. Coghlin, Worcester, Mass.; treasurer, John R. Galloway, Washington, D. C.; secretary, W. H. Morton, Utica, N. Y.; sergeant-at-arms, J. C. Sterns, Buffalo, N. Y.

The next convention will be held in St. Louis at the World's Fair grounds in 1904, and it is the plan to hold the meeting in 1905 at Denver, Col.

During the present meeting a large number of new members have been added to the membership list, and the association is in excellent condition financially.

The new president, Mr. Ernest McCleary, is a member of the firm of McCleary-Colquitt Company, Limited, of Detroit. Mr. McCleary has served for the last year as director of the association for the state of Michigan, and has been most energetic in the organization. He has a thorough training as an electrical engineer, and also an excellent knowledge of the law, and the latter has been of inestimable value in all sessions of the directors of the association, inasmuch as the legal phase of the questions discussed has been an important element.

W. I. Gray, first vice-president, is from Minneapolis, Minn., he is a member of the firm of W. I. Gray & Company, engineers and contractors, and is especially accurate in electrical matters.

W. H. Morton, secretary, has filled this office for several years and as a tribute to his excellent work his reelection was confirmed. Mr. Morton is a member of the firm of Johnson & Morton, of Utica, N. Y.; he also manages the *National Electrical Contractor*, a publication issued in connection with the association.

On Friday afternoon the gathering was brought to a close by a steamer excursion to the St. Clair flats, where an elaborate banquet was served at the Oakland Hotel. Very many of the delegates and representatives of the manufacturing companies remained after the exhibition had closed to be present at this banquet, which was unusually attractive. Several bright toasts were heard.

A feature of the meeting which created much merriment was the manner in which the eastern delegation arriving on the steamer Western States, Tuesday morning, was received. This delegation had been at the New York State Electrical Contractors' meeting the day before at Buffalo. About 150 electrical men from all parts of the country, headed by Messrs. Gilpin, Bibber and Dale, accompanied by

(*Continued on page 122.*)

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NOTES ON X-LIGHT.

BY WILLIAM ROLLINS.

NOTE CLXIII—PULSATING CURRENTS FOR USE IN THE PRIMARY OF AN INDUCTION COIL.

The advocates of static machines for producing X-light claim that coils are unsuitable because the X-light can not be made steady on account of the break, which they state is a necessary part of an induction coil. I have shown that a break is not a necessary part of an induction coil. The current for the primary may be taken directly from an alternating-current dynamo. When a coil is excited in this way the double-focus tube may be used. Here I wish to correct the common error of ascribing the invention of the double-focus tube to other than Rœntgen. I therefore make the following quotation from his memoir dated March 9, 1896: "A discharge apparatus was prepared especially for experiments with alternating currents of the Tesla transformer; in which both electrodes were aluminum concave mirrors, whose axis were at right angles; at their common centre of curvature there was placed a platinum plate to receive the cathode rays." I especially call attention again to this passage as the double-focus tube has been patented in this country, and attempts made to prevent others than the owners of the patent from making these tubes. I also desire to make another quotation from the same memoir which shows that my statement that Rœntgen was the first to employ the Crookes or single-focus tube was correct, notwithstanding it has been ignored by even the most recent writers, who credit the application to others. This is the passage: "I have for weeks used with great success a discharge apparatus in which the cathode is a concave mirror of aluminum, and the anode a plate of platinum placed at the centre of curvature of the mirror and inclined to the axis of the mirror at an angle of forty-five degrees." Both these quotations are taken from a work by Professor Barker, entitled "Rœntgen Rays," in which the original memoirs are translated into English and are therefore readily verified. It will be observed that in both types of tube Rœntgen made the error of supposing with Crookes that the focus of the cathode stream was at the centre of curvature of the cathode. The fallacy of this was pointed out in notes ii and iii, and experiments mentioned which showed the focus was beyond. The matter is mentioned again because writers continue to state that the cathode stream particles move in straight lines, though my experiments have shown this to be incorrect as a generalization. Though an alternating current can be used in an induction coil without a break, thereby doing away with this source of irregularity in the X-light, it is customary when employing alternating currents in the usual way with a break to use a double-focus tube. I have shown by experiment why a double-focus tube is not desirable for X-light; the target is not an anode and therefore the impact of the cathode stream subatoms is less efficient in producing X-light for reasons already given in detail; and also the life of these tubes is shorter for the gases are more rapidly removed from the terminals. On these and other accounts I call attention to the possibility of operating an induction coil by a direct pulsating current, in which the waves succeed each other fifteen or twenty thousand times a minute, using this current in a properly shaped single-focus tube, and employing, as in the case of the alternating current under the same conditions, a large coil constructed on the plan described in notes cxii and cxxxvii, in which the sections of the secondary are interchangeable.

NOTE CLXIV—ON THE RECOMBINATION OF THE CATHODE STREAM PARTICLES.

In former notes I described experiments which proved that the kind of cathode stream we used to produce a practical amount of X-light was made of subatoms and not of the ultimate particles of either electricity or matter. Not of electricity, for no cathode stream was formed when by heat and heavy surges the gases had been sufficiently removed from the terminals and pumped out of the tube, though the terminals were connected with a powerful source of electricity which on the electron theory should have furnished an abundant cathode stream and much X-light. Not of the ultimate particles of matter, for they gave a familiar spectrum, and ultimate particles must give a new spectrum if we ever get to them. I also showed that these subatoms must recombine, as I could collect the gas formed by the recombination of the cathode stream particles by a special arrangement of the pump, and by introducing it into a spectrum tube could get a spectrum attributed to hydrogen, but since shown by Trowbridge to be that of water vapor. I refer to these old experiments again because they are too interesting in connection with the recent work of Rutherford on radioactive substances to be lost sight of.

NOTE CLXV—ON THE BEARING OF THE VARYING FOCUS OF THE CATHODE STREAM ON THE ELECTRON THEORY.

Those who hold the electron theory of the cathode stream claim it is composed of the natural units of electricity, each of which is like every other. I have already given reasons for not accepting this view of the kind of cathode stream used practically for the production of X-light, but there is another point which may possibly be interesting. In notes ii and iii it was stated that the focus of the cathode stream varied with the electric charge on the subatoms composing it. If the cathode stream was composed of electrons, that is, of particles of electricity free from "matter" and all having the same unvarying properties, the focus of the cathode stream should not vary in such a marked degree, for the greater or less repulsion between the subatoms due to the varying proportion of electric charge to mass (which I stated to be a cause of the variation in the distance of the focus from the cathode) could not exist owing to the sameness of the electrons. In this note I have purposely failed to consider the effect of the residual gases, for the relations claimed by the advocates of the electron theory of the cathode stream appear to make this legitimate.

NOTE CLXVI—ON THE TYRANNY OF OLD IDEAS AS ILLUSTRATED BY THE X-LIGHT TUBES USED IN THERAPEUTICS.

Within two months two valuable textbooks on X-light have been published in America. Each treats extensively of the use of X-light as a remedial agent. This shows the interest taken in this department of what I have called ether-therapeutics. I have examined both of these works, finding every tube illustrated for therapeutic work has a concave cathode. Now Rœntgen first applied the concave cathode of Crookes to an X-light tube for the purpose of reducing the impact area of the cathode stream in order to have the X-light arise from a small surface to ensure sharp definition. When X-light is used in therapeutics sharp definition is not important, therefore for some years I have rarely used an X-light tube with a concave cathode in the cavities of the body—the mouth, for example. When I have used a concave cathode it has been for the opposite reason, namely, to spread, not to contract, the cathode stream. A concave cathode is of no value in most types of tubes for use in body cavities. It is a serious disadvantage when used

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in the regular way to bring the cathode stream to a focus, for it is frequently desirable to have the impact of the cathode stream against the glass wall of the X-light tube which is quickly melted by a powerful current when not cooled, or cracked when cooled. It is manifest the risk is diminished when the impact area on the glass is made larger, for the energy of the cathode stream, which is degraded into heat waves, is more widely distributed; the glass, therefore, does not get so hot and may be cooled with less risk.

I have devised many forms of these flat cathode tubes for my work; in all applying the principle first used in 1896, in tubes designed for Dr. Williams—that of cooling the surface struck by the cathode stream. In earlier notes several forms of these cooled tubes were illustrated. The one in which an internal anode was cooled is now a common article of commerce and is attributed to T. D. H. in the catalogues of the tube makers. The second form in which an external anode was cooled is less frequently seen. I first applied it to a modification of Tesla's direct-acting X-light tube, which at that time greatly interested me on account of its symmetry. This method of cooling is of value in therapeutic work with tubes intended to be inserted into body cavities. For these purposes it is well to have the general form of the tube that of a cylinder of such diameter as will easily enter the cavity and to use a modification of a device first applied to X-light tubes by Edison (at least he used it as early as April, 1896), that of external electrodes. Edison found that a tube having internal electrodes if exhausted until no current could pass would become active if the ends were covered with tin-foil. The reason for this has not been given, but it is a very simple one. When the exterior of a part of the tube is covered by metal, the portion of the glass under it forms a terminal, and gas is driven from it, as I have shown it is for internal terminals. I have used cylindrical tubes with flat cathodes, in which the impact of the cathode stream was received on the glass wall of the tube, at the end opposite the cathode; the glass being covered at that place with thin aluminum-foil to act as an anode and yet permit the X-light to go forward without much absorption. In this tube the light not only goes forward, but spreads as spherical waves in all directions from every part of the glass struck by a cathode stream particle. When it is desired to limit the area illuminated or to send the beam in any given direction, the diaphragm which I illustrated in the *International Dental Journal* for July, 1896 (and in connection with direct-acting tubes, in the ELECTRICAL REVIEW for 1898), should be used in the form of a non-radiable tube enclosing the end of the X-light tube, which is inserted into the body cavity—the opening through which the light is to escape being closed by a radiable window, such as I have already illustrated in connection with a Tesla direct-acting tube—to allow the water to circulate without escaping. I have also lined the non-radiable sheath opposite the radiable window with a metal which reflects X-light. In other forms I have used a convex cathode to spread the cathode stream, that it might strike the walls of the tube over a considerable area and thus make the source of X-light a long cylinder, the whole of the part of the tube inserted into the body cavity, for example, if desired; for X-light arises wheresoever the cathode stream particles strike with great force. The same non-radiable sheath and zinc reflector are applicable to this form of tube, when it is desired to have a source of light which is directed to one side of the body cavity. In other cases I used a concave cathode to spread and not to concentrate the cathode stream, thus causing the light to arise from a large area, as with a convex cathode. I mention this chiefly to show that this is really the way the therapeutic tubes with concave cathodes of short curvature recently invented work; though such was not the intention of the inventors, as may be seen by examining the illustrations published of these tubes. When a cathode of short focus is placed in a long tube, the cathode stream is brought to a focus in the tube near the cathode, but far from the tube walls. Therefore the stream spreads again, there being nothing for it to strike and its impact is a diffused one over a large area of the inside of the tube, and from this large area the X-light arises and only a part of it from the end of the tube where it is supposed to arise. This should be kept in mind in designing such tubes. It does not seem worth while to burden this note with cuts of flat and convex target tubes, for these should be made for the cases in which they are to be employed. I have desired only to point out the principles to be followed. Physicians who wish to use such festive agents as ether waves and electrons in therapeutics need special training quite as much as surgeons and other specialists, and should have inventive and engineering faculties to enable them to design and construct their own apparatus, that progress may be rapid and their patients well served. Speaking of electrons reminds me that the subject of burns from X-light apparatus is not yet clear in the minds of some recent writers. I wish, therefore, to again state there are two sources of burns from such apparatus. In earlier notes it was proved that a burn could be produced from an X-light tube in which the resistance was so high that no X-light was being generated. This form of burn is due to electrons and can be made by radium. Perhaps I was the first to show that radium could be used in therapeutics when made into plasters and capsules. It is interesting to remember that radium gives both X-light and electrons. That burning can be produced with it, when a non-radiable substance (one of high atomic weight) is placed between the skin of the animal and the radium. In this case it is chiefly the electrons which do the mischief as they pass more readily through the substance than the X-light. I also published another experiment, in which the action of electrons shot from the X-light tube and other electric actions, except ether waves, were eliminated and yet blindness, burns, abortion and death were produced in animals by the X-light. This experiment has not received the attention it deserves as being the first in which electrons and other causes besides the short ether waves we know as X-light were ruled out. In all the earlier experiments there was a possibility that other causes besides X-light were acting, though some of these earlier experiments have been widely quoted.

The National Electric Light Association's Report of Municipal Lighting Statistics.

The confidential report of municipal lighting statistics, published by the National Electric Light Association, has been distributed to the members. This list is carefully prepared, and corrections are made from year to year, showing the population of towns and villages, the number of lamps contracted for, the price per lamp per year, the nominal candle-power of each lamp, the number of hours operated each year, the watts at lamp, the style of lamp—whether alternating-current or direct-current—the expiration of contract, the candle-power-hours for one cent, the price of steam coal, and the contract price of gas, either by common burner or Welsbach burner. This list has been so carefully prepared that, with all stations heard from, only one error of any importance was discovered. This list is secured only by members of the association.

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PROCEEDINGS OF NATIONAL ELECTRICAL CONTRACTORS' CONVENTION.

(Continued from page 119.)

an ambulance and dump-cart drawn by a diminutive Shetland pony, and other absurd paraphernalia, were at the pier on the arrival of the boat. Immediately the president, Mr. Charles L. Eidlitz, a man of more than ordinary dignity, appeared he was hustled into the small dog-cart and driven to his hotel, at the head of the procession. On his little dog-cart was a large placard, "Our Dear President." The staid citizens of Detroit were startled on hearing the dirge music that the brass band gave out as it preceded this procession through the streets at an early morning hour.

The work of the entertainment committee was unusually effective and courteous and it was remarked by a great many that the hospitable and kindly atmosphere of Detroit had marked the gathering as a most happy meeting. Mr. F. J. Minor, of Detroit, chairman of this committee, was especially diligent. The ELECTRICAL REVIEW wishes to acknowledge the courtesy of the complimentary office, with furnishings and equipments, which was tendered to it in the exhibition hall during the meeting.

During the days of the gathering Mr. Joseph E. Lockwood, president of the Michigan Electric Company, kept open house at the company's new building, 75 and 77 Bates street, and entertained visitors with a luncheon daily.

The exhibition at the Light Guard Armory of electrical construction equipments and the special products which are made by manufacturers, was unexpectedly elaborate and attractive. It is estimated that 2,000 people a day visited the exhibition. The interior of the building was beautifully festooned and especially well lighted for decorative effects.

The following is a list of the manufacturers who exhibited and were represented:

L. B. Allen & Company, Chicago, Ill. Represented by Stuart S. Crippen.

Holtzer-Cabot Electric Company, Boston, Mass. Represented by E. R. Harding, manager Chicago office, and T. G. Meinema.

United States Incandescent Lamp Company, St. Louis, Mo. Represented by H. G. Ferguson, president.

National X-Ray Reflector Company, Chicago, Ill. Represented by E. L. Haines, general manager.

Benjamin Electric Manufacturing Company, Chicago, Ill. Represented by R. B. Benjamin.

Gould Storage Battery Company, New York and Chicago. Represented by E. L. Draffen.

Osburn Flexible Conduit Company. Represented by C. E. Corrigan, vice-president, and Calvin B. Roulet.

S. B. Condit, Jr. & Company, Boston, Mass. Represented by Fred W. Nason.

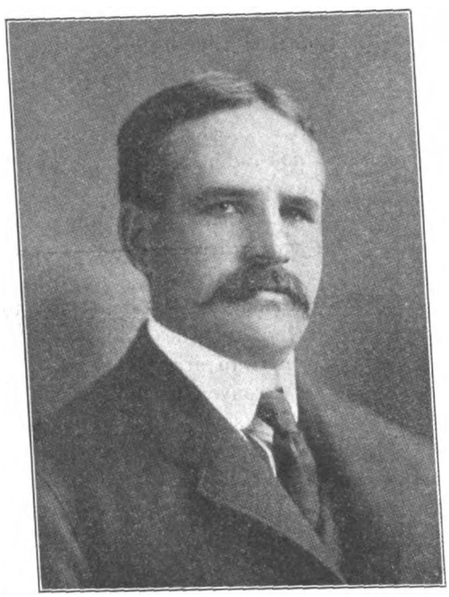
Fort Wayne Electric Works, Fort Wayne, Ind. Represented by A. L. Searles and Frank K. Ross, of the engineering department.

Anderson Porcelain Company, East Liverpool, Ohio. Represented by Howard H. Balliett.

The Fullman Company, Pittsburg, Pa. Represented by J. M. G. Fullman.

John Toler Sons & Company, Newark, N. J. Represented by Henry W. Cook.

The Dale Company, New York. Represented by O. J. Bryan and John Dale, president.



W. I. GRAY.
First Vice-President.

Marshall-Sanders Company, Boston, Mass. Represented by L. W. Kittman.

Maltby Lumber Company, Bay City, Mich. Represented by J. A. Maltby.

American Push-Button Telephone Company, New York. Represented by W. V. Sweeten, general manager, and William F. Van Benthuysen.

The Hart Manufacturing Company, Hartford, Ct. Represented by W. P. Crockett, manager Chicago office, and William Taylor, manager New York office.

General Electric Company. Represented by F. H. Gale, Schenectady, N. Y.; J. E. Livesey, manager Detroit office; F. N. Boyer, Chicago; William Hand, St. Louis, and P. L. Clark, Chicago.

The American Electric Heater Company, Detroit. Represented by President B. H. Scranton and Treasurer John Scudder.

The Crouse-Hinds Electric Company, Syracuse, N. Y. Represented by F. M. Hawkins, manager New York office; F. F. Skeel, Chicago; A. B. Hills and C. Snyder, Syracuse, N. Y.; C. T. Crofoot, Cincinnati, and M. Norden, New York.

The Norden-Bittner Company, New York. Represented by Mortimer Norden.

The Fuller Company, of Detroit. Represented by R. Fuller and F. Vollmer.

Patrick, Carter & Wilkins, Philadelphia. Represented by W. W. Winship.

National India Rubber Company, Bristol, R. I. Represented by P. T. Lyons.

Manhattan Electrical Supply Company, New York and Chicago. Represented by F. B. Pierce, of the Chicago office, and J. W. McDowell, of New York.

Michigan Nut and Bolt Works, Detroit, Mich. Represented by H. McLean and F. S. Bigler.

Carlton-Chase Electric Company, New York. Represented by Percy R. Frost and J. A. Vaughan.

Browning Manufacturing Company, Milwaukee, Wis. Represented by S. A. Dean and H. B. Wilkins.

National Carbon Company. Represented by E. J. Clyme and F. J. Kysefa.

F. Bissell Company, Toledo. Represented by F. Bissell and M. S. Walker.

Electric Gas Lighting Company, Boston. Represented by C. E. Lee and F. H. Sherman.

Allen-Hussey Company, Chicago. Represented by A. R. Hussey.

Sachs Electric Company, St. Louis, Mo. Represented by Gus Sachs.

Sawyer-Man Electric Company, New York. Represented by Clifford S. Jennings.

Yost Electric Manufacturing Company, Toledo. Represented by F. Harry Yost.

The Miller Anchor Company, Norwalk, Ohio. Represented by G. H. Miller.

Pass & Seymour, Inc., Solvay, N. Y. Represented by B. E. Salisbury, secretary and general manager; John W. Brooks, Chicago, and W. Brewster Hall, New York.

The Phelps Company, Detroit. Represented by W. J. Phelps, W. E. Phelps, J. Wiley Phelps and F. H. Funston.

Crescent Company, Chicago. Represented by J. H. McGill.

I. P. Frink, New York. Represented by Frank Stout.

DeVeau Telephone Manufacturing Company, New York. Represented by

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V. C. Gilpin and A. S. DeVeau, president.

The Cutter Company, Philadelphia. Represented by George L. Crosby, manager Cleveland office.

Thomas E. Clark Wireless Telegraph-Telephone Company, Detroit. Represented by Thomas E. Clark, Gustav F. Reissthal and Ackland Stiling.

Sprague Electric Company, New York. Represented by Alex. Henderson, of New York, and E. B. Kittle, Chicago.

The Bossert Electric Manufacturing Company, Utica, N. Y. Represented by F. T. Foxenberger and C. Nollitx, Cincinnati.

The Elblight Company of America, New York. Represented by Russel Spaulding, Eugene H. Abadie and Harry Shafer.

Westinghouse Electric and Manufacturing Company. Represented by Charles F. Medbury, manager Detroit office; A. L. Rathbone and W. C. Armstrong, of Detroit.

Johnson & Morton, Utica, N. Y. Represented by W. H. Morton.

Alphaduct Manufacturing Company, New York and Chicago. Represented by William M. Porter and M. Minchener.

American Circular Loom Company, Chelsea, Mass. Represented by Sales Manager H. B. Kirtland; R. B. Corey, New York; Thomas G. Grier, Chicago; J. L. Kirtland, New York, and Thomas Bibber, Boston.

H. L. Walker Company, Detroit. Represented by H. L. Walker, president, and William J. Hartwig.

Nernst Lamp Company, Pittsburg. Represented by T. H. Bailey Whipple, sales manager, and A. E. Fleming, manager Chicago office.

United Electric Heater Company, Detroit. Represented by R. Kuhn and F. Kuhn.

Harrison Safety Boiler Works, Philadelphia. Represented by F. T. Mason, of Detroit.

American Conduit Manufacturing Company, New Kensington, Pa. Represented by C. A. Flack.

The John A. Roebling's Sons Company. Represented by F. W. Harrington, New York; C. B. Cushing and G. W. Swan, Trenton; W. P. Bowerman, W. H. Richardson, W. W. Afflack and J. W. Brooks, Cleveland.

Atlantic Insulated Wire and Cable Company, Stamford, Ct., and New York. Represented by George F. Porter.

Sterling Electric Manufacturing Company, Warren, Ohio. Represented by W. C. Osborne.

Valley Brothers Electric Company, Cleveland. Represented by D. B. Scarborough.

Westinghouse-Church-Kerr Company. Represented by H. J. Raynor, Detroit.

Chase-Shawmut Company. Represented by Harry P. Moore.

H. W. Johns-Manville Company. Represented by H. S. Finney, Chicago.

Adams-Bagnall Electric Company,

W. H. MORTON.
Secretary.

Cleveland. Represented by J. G. Pomeroy, manager Chicago office.

M. B. Austin & Company, Chicago. Represented by M. B. Austin.

J. C. STERNS.
Sergeant-at-Arms.

A. L. Doxsee Electric Company, St. Louis. Represented by A. L. Doxsee.

W. R. Ostrander Company, New York. Represented by H. E. Monk.

The Jewell Electrical Instrument Company, Chicago. Represented by Edward W. Jewell, president.

The Peru Electrical Manufacturing Company, Peru, Ind. Represented by President Bouslog and George S. Searing, manager Chicago office.

Duncan Electrical Meter Company, La Fayette, Ind. Represented by W. H. Sinks.

American Electric Fuse Company, Chicago. Represented by George W. Rodomer.

Kuhlman Electric Company, Elkhart, Ind. Represented by E. Kuhlman.

Western Electric Company. Represented by Major Robert Edwards; L. G. Baldwin, St. Louis; S. W. Cobb, Cleveland; E. F. Field, Detroit, and E. S. Keefer, New York.

American Electric and Novelty Manufacturing Company, New York. Represented by J. W. Lecky, Chicago.

Michigan Electric Company. Represented by President Joseph E. Lockwood, H. Cameron, Edward Bullock, S. R. Fralick and others.

The Miller-Selden Electric Company, Detroit. Represented by W. H. Sheldon, Jr., D. F. Seidler and A. Miller.

Minnesota Electric Company, Minneapolis. Represented by W. J. Chapman.

Kohler Brothers, Chicago. Represented by C. R. Krider.

New England Engineering Company, Waterbury, Ct. Represented by Harvey E. Paige.

Edwards & Company, New York. Represented by P. C. Haviland.

National Electric Supply Company, Washington, D. C. Represented by E. C. Graham.

Resignation of Mr. Calvin W. Rice.

Mr. Calvin W. Rice, of the Nernst Lamp Company, of Pittsburg, Pa., has announced his resignation from the company, to the universal regret of his business associates, who found in him that combination of executive ability and personal popularity so much to be desired.

Since May, 1902, Mr. Rice has held the position of second vice-president, to which he later added the duties of sales manager. To his efforts is due much of the success of the company and its present substantial commercial standing, the past year having been a particularly successful one.

Mr. T. H. Bailey Whipple, who has been associated with the Sawyer-Man Electric Company as assistant to the second vice-president, succeeds Mr. Rice in the Nernst Lamp Company. Mr. Whipple, who was formerly connected with the Jandus Electric Company, of Cleveland, Ohio, is a man of wide experience and acquaintance in the electric lighting field, and eminently fitted for the position which he assumes.

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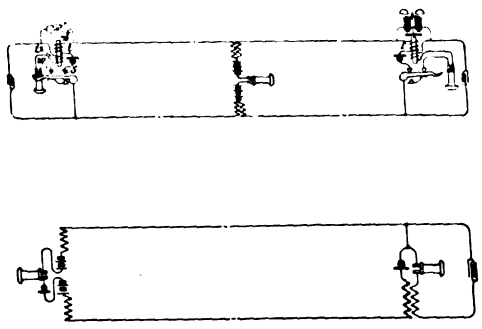
Electrical Patents.

The American Telephone and Telegraph Company, of New York, has purchased from Mr. Almon B. Stetson, of Malden, Mass., a patent on an improved substation telephone circuit. This invention relates to variable resistance transmitters and their operation, and especially concerns substation or subscribers' station circuit arrangements for instruments of this character by means of which the disturbing effects which tend to be exercised by such transmitters on the associated receiver or receivers at the same station may be prevented or at any rate greatly reduced. Sensitive and powerful transmitters, such as are now employed, not only reproduce the desired sounds or words in the receiver at the distant station, but also produce an echoing or resonant sound, colloquially termed the "side tone," in the associated receiver at the same or transmitting station. Moreover, in the operation of central source telephone exchanges involving toll or interurban lines it is often desirable in the interest of efficiency to supply the substation transmitters with working current under higher voltage than has ordinarily been employed, and under such conditions the microphonic action is materially intensified, so that in addition to the side tone there is present an increased tendency to create and manifest in the home receiver buzzing and crackling noises and sounds, as well as to take up and reproduce all such sounds as are being produced in the immediate proximity of the instrument. The noise in the ear of the person using the telephone becomes under these circumstances so loud as to be both unpleasant and confusing and operates to disturb and disconcert the user, making it very difficult for him to follow the conversation or intelligently receive the message. To reduce such side tone and other disturbances to the lowest possible point and generally to prevent the disturbing effects attributable to undesigned or abnormal action of the transmitter from manifesting themselves in the associated or home receiver, and to effect this without materially reducing the volume of transmission, are the objects of this invention. Attempts have heretofore been made to attain some of these objects by specially designed induction coils with associated balancing resistances, but such arrangements while fairly satisfactory with transmitters of moderate power operating under the local battery conditions shown in said patents are not completely successful under present conditions and apparently are not of a character capable of improvement or further development in such manner as to meet such prospective conditions as are now in sight. In the modern practice of a common and central battery exchange the substation apparatus comprises the call-bell, the telephone transmitter and an associated induction coil, the telephone receiver, the regular suspension-switch, serving as a support for the receiver when unemployed and operating by the displacement and replacement thereof, and a condenser. When the switch is in its normal or resting position with the receiver suspended upon the hook, the circuit is through the call-bell and condenser, such circuit in virtue of the inclusion in it of the said condenser preventing the passage of the steady current of the central station battery, but readily permitting the operation of the polarized bell by the alternating currents of the central station call-generator. When now the receiver is taken from the hook for



SUBSTATION TELEPHONE CIRCUITS.

use and the switch in consequence moves to its second and working position, the telephone circuits of the substation are brought into operative relation with the main or line circuit and the central source of current. Until recently the substation telephone circuit arrangement thus established has been substantially that of the United States patent to Charles E. Scribner, No. 669,710, of March 12, 1901. In this system (the switch being, as assumed, in its second position) the main circuit is conductively closed through one winding of the induction coil, and a local transmitting circuit is established which contains the telephone receiver, the condenser and the other winding of the induction coil. The transmitter is placed in a section of conductor which is common to and forms a part of both circuits and is therefore itself connected both in the local and main circuit; but its direct action is nearly altogether restricted to the local circuit, its effect upon the main circuit and the distant receiver being mainly exercised through the associated induction coil. The source of transmitter current is in the main circuit at the central station, and when the said main circuit is closed at the substation by the action of the switch in moving to its second position, as stated above, there is developed a steady current which flows through the main line, the substation transmitter and the main circuit winding of the induction coil. Differences of potential between the two sides of the transmitter are determined by the resistance variations produced in the operation of said transmitter, and as a consequence waves or surges in the local circuit, which circulating in the second winding of the induction coil induce similar currents in the first winding thereof, and these flowing through the main circuit act upon the distant receiver and cause it to reproduce the sound whereby the transmitter was originally actuated. In many respects the foregoing operative arrangement for the telephone circuits of substations is highly efficient; but it has a serious disadvantage in that it is subject in a high degree to the side-tone fault, which the present invention aims to prevent or remedy. In the present invention the transmitter is removed from that section of conductor which is common to both main and local circuits, being thus entirely separated from the circuit which contains the receiver, and consequently from the receiver itself, being placed instead in the main circuit alone, together with one winding of the induction coil. This change is the cardinal feature of the invention and is productive of decided advantage, since by it the unpleasant and annoying side tone is practically done away with without material loss in the volume or quantity of transmission. The invention as organized in a subscribers' or substation telephone apparatus or system of circuits thus comprises the main circuit or that part or loop thereof which is within the station, an associated local circuit wholly within said substation and an induction coil and condenser, one winding of the induction coil, together with the station telephone transmitter being serially arranged in the main circuit-loop, while the receiver and condenser are similarly connected, together with the other winding of the induction coil, in the local circuit. The invention also consists in associating the organization thus constituted with the telephone switch, the switch being placed in a section of conductor common to the main and local circuits and being thereby adapted to control them both. It further consists in combining the entire substation apparatus as thus constructed

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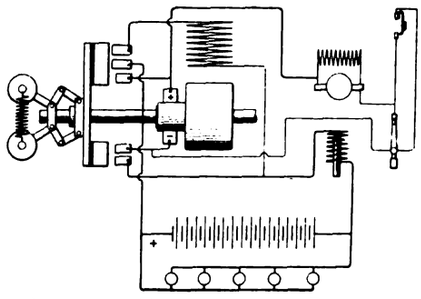
and organized with the telephone apparatus and common source of current of the central station, these being connected with the same main circuit, and likewise in a combination of a talking circuit extending between two substations through a central station, the several instrumentalities at both substations being arranged in conformity with the characteristic features of the invention as stated above, and the talking circuit being made up of two component circuits independently supplied with transmitter current developed from a source of current located at the central station.

An improvement in automatic regulators for electric generators has been patented by Mr. William A. Turbayne, of Buffalo, N. Y., who has assigned his interest to Mr. Charles M. Gould, of New York city. The invention is an improvement on a regulator patented by Mr. Gould in 1902, this regulator being particularly employed in connection with an electric lighting apparatus for railway cars, in which the electric current is generated by a dynamo mounted under the car and driven from one of the axles by a belt or the like. As the speed of the car axle has a considerable range of variation, it is desirable in order to maintain a practically constant output of the dynamo to drive its armature at a practically constant speed. Briefly stated, this is accomplished in the original patented device as follows: The dynamo is mounted to move toward and from the driving car axle, and an electric motor and connections are provided, which move the dynamo toward the car axle to slacken the driving-belt, so that it will slip and decrease the speed of the dynamo-armature when the speed of the car axle is greater than necessary for the normal operation of the dynamo and which move the dynamo in the opposite direction to tighten the belt when the speed of the car axle decreases to or below the speed required for the normal operation of the dynamo. The motor is driven in one direction by a current from the dynamo, and a reversing mechanism actuated by a solenoid is provided for determining the direction of movement of the dynamo. The solenoid is controlled by a current generated by the dynamo and operates the reversing mechanism to change the direction of movement of the dynamo when the output of the dynamo rises above or falls below a predetermined normal value. If the car axle rotates at an abnormally slow speed for a considerable time—as, for instance, when the car is moving slowly for some distance—the dynamo might be moved so far away from the driving car axle as to stretch or break the belt or injure some other part of the apparatus. If, on the other hand, the car axle is rotated at an abnormally high speed for a considerable length of time—as, for instance, when the car is run very rapidly for some distance—the dynamo might be moved so near to the driving car axle as to entirely stop the rotation of the dynamo-armature or injure or break some part of the apparatus. The object of the present invention is to provide a simple mechanism whereby the motor for shifting the dynamo is thrown out of operation before



AUTOMATIC REGULATORS FOR ELECTRIC GENERATOR.

the dynamo has been moved in either direction to such an extent as to interfere with the proper operation of the apparatus. This is accomplished by introducing into the electric circuit for operating the motor a limit-switch, which is operated by the shifting dynamo-carriage to break the motor-circuit and stop the motor before the dynamo has been shifted too great a distance in either direction.

The Northwestern Storage Battery Company, a corporation of Illinois, controls a patent recently issued to Mr. William Gardiner, of Chicago, on a new method of preparing electrolytes. Mr. Gardiner thus describes his invention: In electric storage or secondary batteries of that type in which caustic potash or caustic soda in solution is used as the electrolyte and in which one of the electrodes is a support on which zinc is deposited one great disadvantage is the weight and bulk of the electrolyte. Such an electrolyte has been heretofore produced by dissolving an oxide of zinc in a solution of hydrate of sodium and hydrate of potassium. A solution of hydrate of potassium or hydrate of sodium is capable of dissolving but a relatively small quantity of the oxide of zinc, and in order to obtain a secondary battery of this character having any considerable capacity it has heretofore been necessary to employ in each case an exceedingly large quantity or volume of solution. This has made such secondary batteries very heavy and bulky in proportion to their effectiveness. In carrying out my invention I use suitable electrodes. Any of the well-known electrodes employed in this class of battery, however, may be used, such as oxide of copper, for example, as the negative electrode and a support of copper gauze or iron gauze upon which the zinc is deposited in the charge as the positive electrode. I produce my improved electrolyte by means of a strong solution, preferably of pure caustic potash, in which I dissolve pure oxide of zinc made by the wet process. This solution is placed in the cells of a battery having suitable electrodes and subjected to a charging current in the well-known way until the greater portion of the zinc contained in the solution is deposited upon the positive element. The solution is then removed from the cells and is placed in a suitable receptacle for holding it temporarily. Oxide of zinc is then again dissolved in this solution and the solution replaced in the same cells as before and a charging current applied and the zinc deposited as before. This may be repeated and the process continued until zinc sufficient to equal the capacity of the desired battery is deposited or accumulated upon the positive electrode. When a sufficient quantity of zinc is deposited upon the positive electrode, the solution used to dissolve the oxide of zinc may be removed and a strong, fresh solution of pure caustic potash and water containing no zinc oxides substituted. The battery is then in readiness for discharge and charge in the performance of work. During the discharge the zinc accumulated upon the positive electrode in the prior charges dissolves or is taken up in the solution, so that after the discharge is completed a far greater quantity of zinc is dissolved or contained in this solution than could be possible by the old process, which consists in dissolving an oxide of zinc in this same solution before placing it in the battery. Inasmuch as the excessive bulk and weight of the ordinary battery of this type are caused by the capacity of the alkaline solution ordinarily to take up, absorb, or otherwise contain but a relatively small quantity of oxide of zinc, necessitating a large quantity of solution for any battery having any considerable output, it is obvious that by the method described an electrolyte for this type of battery may be obtained which is very much reduced in weight and bulk, primarily because a sufficient quantity of zinc for a given capacity of battery cell may be deposited in the charge upon the positive element and dissolved into the solution on the discharge. Obviously, also, a cell containing an electrolyte of the class described may be very much more quickly charged than in the ordinary cell of its kind, inasmuch as the electrolyte contains a great excess of zinc which is held in solution in an unstable condition and which is therefore deposited almost immediately when the charging current is applied.

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Reviews of Current Engineering and Scientific Literature.

A Fan Dynamometer.

This article describes an ingenious and simple absorption dynamometer constructed on the principle of a rotary fan. The dynamometer was designed and developed by Colonel Renard, and has been used in testing motors at speeds of from 600 to 1,500 revolutions per minute, developing from seven to sixty horse-power. For the smaller sizes the dynamometer is coupled directly to the motor shaft. For the larger sizes a special bearing is built for the machine. The machine itself consists simply of a horizontal shaft attached to the centre of an ash rod. To the latter are bolted two aluminum planes which act as fan blades when the shaft revolves. The power absorbed by this dynamometer is proportional to the cube of the angular velocity of the planes. To change the load on the motor, the distance of the planes from the axle may be changed, or planes of different sizes may be used. This gives each dynamometer a fairly wide range. The brake is calibrated experimentally, and it has been found that the power of brakes of different sizes, but geometrically similar, varies as the fifth power of their ratio. In use the brake is extremely simple and it maintains a constant load on the motor indefinitely, as there is nothing to heat. Moreover, after a brake has been calibrated, a reading of the speed is sufficient to give the output of the motor. This dynamometer has been used by the inventor in shop tests for the past five years, and has been found very satisfactory.—*Translated and abstracted from L'Industrie Electrique* (*Paris*), *June* 25.

Systems of Mains Laying.

Systems of laying conductors under the ground are becoming of greater importance every year. In this article, Mr. F. H. Davies gives an outline of the various systems in use, pointing out briefly the advantages and disadvantages of each. The subway system, the author considers to be in many ways the best. The chief advantages of this are accessibility and safety from mechanical injury to the wires. He holds that there can be but little doubt that the subway system is bound to become general. The first conduit system consisted of a trench in which bare copper strips were carried on insulators, the trench being covered over in some way. This system is somewhat costly, but can be increased in size easily. In more recent types, the conductor is insulated and laid in an iron or earthenware conduit. In pipe systems, either iron or earthenware pipes may be used. This system is more flexible than the conduit system. Laying directly in earth is the cheapest and most flexible method, and this is particularly suitable where there is no danger from mechanical injury. The nature of the soil must, however, be considered carefully, as this may corrode the lead sheathing. In this system, house connections are easily made. The solid system, in which the conductor is laid in a trough which is then filled with some higher insulating compound, is coming greatly into use. It has practically the same advantages as a direct laid system, is cheap and flexible. The cable should be plain lead-covered, not braided. The trough should be protected from mechanical injury by bricks or other hard material. In speaking of boxes, the author urges that they be made amply large in the first case, as this costs but little more and is far more satisfactory.—*Abstracted from Electrical Engineering* (*London*), *June* 19.

New Material for Simple Alternating Currents.

In this paper M. Marius Latour discusses the advantages of single-phase alternating-current distribution over polyphase, and shows how the former may be used for power distribution by means of the new types of induction motor. The author first says that the usual figures given for the economy of the three-phase system are fallacious and that the advantage should be given to the single-phase system, for the latter, in addition to its simplicity, will require no more copper if the difference of potential between each wire and the ground is the same as that in the three-phase system. The author then considers single-phase alternating-current motors, reference being made to the series motor, the objection to this motor being that it can not be used on high potentials because of the commutator, the rather poor power-factor, and that the stator is not heated equally at all points. The action of the Latour motor is then described. This motor is similar to the ordinary induction motor, except in the addition of a commutator to the secondary, upon which brushes connected together are placed. The action of this device is described, being shown how the motor becomes not only self-exciting with a power-factor as high as desired, but self-starting, and the speed may be regulated. A description is then given by M. Gratzmuller of the behavior of a motor constructed on this principle, characteristics and curves of current and electromotive force being shown. The latter demonstrate that the current is practically in phase with the applied electromotive force, but that the wave is slightly flattened at the peak. The motor is a two-pole machine operating on a frequency of twenty-five. The full-load efficiency was eighty-four per cent.—*Abstracted and translated from Bulletin De La Societe Internationale des Electriciens* (*Paris*), *June*.

An Experiment on the Change of Weight of Radium with Time.

The results of the test made by Herr Heydweiler, published some time since, that a preparation of radium furnished by Haën lost in weight daily 0.02 milligramme, inspired Herr Ernst Dorn to test this matter himself. In December, 1902, he enclosed in a small tube 29.9 milligrammes of very active "pure" radium bromide supplied by Buchler & Company. The tube was of alkali-free Jenaer glass, six centimetres long, with an outside diameter of 0.46 centimetre and a thickness of glass of 0.3 millimetre. The tube was closed by fusing. A counterweight was prepared of an equal length of the same glass tube, filled with sand, and also closed by melting. Both tubes were fitted with hanging eyes of equal lengths of the same platinum wire. The weight of the tubes amounted to from 1.1084 to 1.1088 grammes. For weighing the tubes were hung on the hooks of a balance beam. During the weighing the tubes came into contact with no foreign body except the ivory tweezers used in handling. For interpolation, a platinum milligramme weight was used and kept under a double bell glass. The balance was fitted with a reading mirror, and its sensitiveness varied somewhat with the temperature. It was set up in a large, arched, quiet room, with a stone floor, upon a brick table with a slate top. The reading telescope was set up on a seasoned hardwood stand. The balance was surrounded by a double walled box of bare zinc, with but one opening, that for observation. This was fitted

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with glass. The scale was lighted by a beam from an incandescent lamp, the balance being carefully shielded. To prevent disturbances, due to static charges, two tubes filled with radium chloride were placed under the balance box during the spring. Hydrometric observations were made during the weighing. The latter were made by the swinging method. An illustrative example is given. In every case the observations show that a loss of weight of more than 0.001 milligramme in about three months did not occur, while according to Heydweiler's result, obtained upon 5,000 milligrammes, the quantity of radioactive material here used should have shown a loss in ninety days of 0.011 milligramme. To test the relative activity of the two materials, that used by the author in this work and that used by Heydweiler, were compared by an electroscope, according to the method of Elster and Geidel. The results showed that Dorn's material was much more active than that used by Heydweiler.—*Translated and abstracted from the Physikalische Zeitschrift (Leipsic), July 1.*

The New Electricity Works of the Manchester Corporation.

In the second section of this serial, which describes in detail the Manchester works, are given particulars of the power plant and substations being erected after the designs of Mr. G. F. Metzger, the city electrical engineer. The first instalment of this scheme comprises a generating plant of 12,000 horse-power, but the buildings are designed to accommodate twice this amount. The steaming plant will consist of twelve Babcock & Wilcox boilers, each capable of evaporating 20,000 pounds of water per hour. These are provided with automatic stokers and superheaters. The generating plant will consist of two 3,750-kilowatt sets, each comprising a 6,000 indicated horse-power, vertical, triple-expansion, condensing engine, running at seventy-five revolutions per minute, and a three-phase alternator working at 6,500 volts, fifty cycles. The engines will be supplied by the Wallsend Slipway and Engineering Company. These engines will have four cylinders, with four cranks each, and work at 190 pounds pressure at the stop valve with superheated steam. The generators will be supplied by the Electrical Company, Limited, and will be of the revolving-field type, with the poles mounted on the periphery of a flywheel weighing 160 tons and twenty-seven feet in diameter. This station will supply power to ten substations, which will be much alike in design and equipment. The equipment will consist of four 150-kilowatt motor-generators and one 100-kilowatt motor-balancer. Provision is made for extensions with large units of 300 kilowatts each. These sets consist of three-phase synchronous motors, receiving current direct at 6,500 volts, coupled to a six-pole dynamo, giving 375 amperes at from 400 to 550 volts. In addition to these substations there are ten others, erected in connection with the plans of Dr. A. B. W. Kennedy, and supplied from the power-house which is described in the abstract of the first of these articles in the ELECTRICAL REVIEW of July 18. The motor-generator sets are similar to the ones just described, but have a capacity of 220 kilowatts. The dynamos of these sets are supplied with slip rings, to which are connected inductance coils, making each dynamo self-balancing, in addition to the balancing set. At the Dickinson street station were installed recently two 900-kilowatt Parsons steam turbines. These run at 1,040 revolutions per minute, and each drives two generators. This station also contains two Musgrave-Siemens and Musgrave E. C. C. steam dynamos, each of 1,500 kilowatts output.—*Abstracted from the Electrical Review (London), July 3.*

On Induction Machines and a New Type of Polyphase Generator.

This is the first half of an article by Mr. A. C. Eborall, and in it the author gives a short account of the polyphase generator designed by Alexander Heyland, with some remarks relative to its development. These generators are synchronous, although the operation of their fields is of the nature of that of asynchronous machines. They are self-exciting, and are scientifically and properly compounded, not only with regard to the magnitude of the current, but with regard to its character. In the standard induction motor the large wattless component of the stator current is due to the fact that the magnetic flux is produced by magnetizing the currents of the full frequency circulating in the stator winding. The magnetizing current in the best modern motors of normal design is of the order of twenty per cent of the full-load current, and consequently the volt-ampere input of the motor at no load is of the order of one-quarter of the apparent input at full load. The excessive amount of apparent energy required by the standard induction motor for the production of its magnetic flux is due to the high frequency of the magnetizing current, where a few volts would get this current through the stator windings if it was a direct current. It actually requires the full supply pressure. Nearly the whole of the applied pressure is required to balance the counter-electromotive force set up in the stator windings, and it is clear that if this back pressure could be done away with the magnetizing watts would be almost inappreciable. This has been accomplished by Heyland, who supplies a magnetizing current to the rotor, having the low frequency of the rotor currents. These currents are supplied to the rotor through a commutator, the segments of which are connected to the rotor conductors, and are also short-circuited by low-resistance conductors which, while lengthening the commutator a small amount, make no appreciable difference in its cost. The low-resistance connectors to the commutator bars short-circuit the rotor winding, prevent the current from being broken at the brushes, reduce the amount of current under the brushes, and take up the pulsation in the rotor current, and hence in the magnetic flux. The commutator brushes are so placed relatively to the stator that the converted magnetizing currents in the rotor bars have exactly the same direction as the corresponding stator currents, which these rotor magnetizing currents have to replace. The position and synchronous rotation of the magnetic flux are determined by the position of the brushes, and are independent of the speed of the rotor. The stator current of such a compensated motor is a pure energy current after the current led to the brushes has once been properly adjusted. In a properly adjusted compensated motor the power-factor is unity at all times. In the compensated motor the rotor flux is equal to the stator flux, plus the leakage flux, and an increase of magnetic leakage simply means that the rotor flux must be correspondingly increased. This is not objectionable, since the rotor iron losses are, in any case, small, and deepening the rotor slots to get in more copper produces no ill effects. When this compensating device is added to an induction generator it becomes self-exciting. The only difference between the compensated induction generator and the compensated induction motor is that the former requires relatively a little more excitation. The generator may be compounded or over-compounded for simple and inductive loads by passing the main stator current, or a portion of it, through the short-circuit rotor, in addition to the compensating current. When operated as a generator a small synchronous machine must be connected to the same circuit to fix the frequency.—*Abstracted from the Electrician (London), July 3.*

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BOOK REVIEW.

"Telephony." Arthur Vaughan Abbott. New York. McGraw Publishing Company. In six volumes. First three volumes now ready, Part I—The Location of Central Offices. 170 pages. 33 illustrations. Part II—The Construction of Underground Conduits. 190 pages. 62 illustrations Part III—The Cable Plant. 152 pages. 51 illustrations. Supplied by the ELECTRICAL REVIEW at $1.50 per volume; the set complete (if ordered together), $6 00. Uniform cloth binding.

The first volume of this series is devoted to the method of selecting central office location (or locations, if there is to be more than one central office), a discussion of the necessary trunking facilities, mileage of same, etc. The functions of an exchange are given in chapter i in a general way, and chapter ii is devoted to explaining the meaning of terms most commonly used for designating the various parts that go to make up the central office. Six chapters are then devoted to the self-evident fact that the location of the central office which will require the least wire mileage is that location which falls at the intersection of two straight lines drawn perpendicularly to each other following the street lines, being so located that there will be as many substations on one side of each line as on the other. The author then passes on to determining the necessary number of trunk circuits and the trunk wire mileage where more than one office is to be established, and finally evolves, at the end of the chapter, the equation $R = q \frac{(ST - S^1 T^1)}{ST}$. This equation represents the ratio of the number of outgoing trunk calls to the total number of originating calls, and in it q represents an "acquaintance" factor, which depends for its value upon the social and business relations of subscribers connected to different offices; S represents the total number of subscribers in the system; T the average number of originating calls for a substation per day in the system, and S^1 and T^1 the same, respectively, for any particular office. Here we have one equation for solution, with several unknown quantities, none of which can be determined until the exchanges are built and the peg counts are made. The author gives approximate values for these unknown quantities which may have held true for Chicago—in which city the author has probably collected his information—but are not borne out in other places. The equation represents the percentage of the total number of originating calls in any particular exchange which are outgoing trunk calls, such trunk calls being destined to any other exchange in the entire system. But what are we going to do with such an equation if we want to determine the number of calls from your north exchange to your south exchange, or from your north exchange to your west exchange? It is unquestionably true that good judgment can be used in designating the number of trunks from any exchange to another exchange, which will not be far wrong, but equations are of no value in such determinations.

The system described in this volume for the operation of the trunks is hardly up to date. In the best modern boards the B operator never rings a subscriber—she hasn't time. The A operator tests the subscriber's line for "busy," does the ringing through the trunk, and supervises the connection.

In the second volume a rather complete general description of underground conduit construction is given, but the prices and costs look as though they were made up from data gathered some years ago, and are far from being correct or reliable. The cost to-day of such work is considerably in excess of the figures given, on account of the increased cost of both labor and material, and although the author asserts in chapter xcvi that "the cost of conduit construction is constantly and steadily decreasing, owing to improvements and cheapening in the manufacture of materials employed, natural competition tending to decrease price, etc.," yet the fact is that "natural" combinations of manufacturers, labor unions, and the great demand for supplies of all kinds have served to increase the price of both material and labor all along the line, and the cost of such work is higher to-day than ever before.

In speaking of the advisable distance between manholes, a distance of 500 feet between them as recommended is too great, as by the adoption of cables carrying from 400 to 600 pairs, as is now being practised, shorter distances are necessary, as cables of the size mentioned would not well stand the strain, nor their lead sheath the wear in a pull of this distance. As regards the advisability of placing concrete at the sides and on top of the ducts, or not to do so—the estimated sum of $78,000 was saved in the construction of an underground system which has come under our observation recently, and the company for which the system was installed has never paid out one cent in repairs for damage due to careless street excavation for over a period of three and one-half years. There have been two cases of damage reported and repaired, in the nature of pick holes, in one instance damaging a cable, but the cost of the necessary repairs was promptly paid by the company whose employé caused the damage in each instance, and about half a dozen telephones were out of service for a period of twenty-four hours. In the system referred to the only covering of the ducts on the sides and top consists of cement mortar plastered on one-half inch thick.

In Vol. iii, entitled "The Cable Plant," the general description of manufacture and methods of installing, splicing and terminating is rather complete. The prices and costs, as in the former volumes, are not up to date. In the "contract and specifications for cable construction" (section twenty-three), it does not seem advisable to allow the contractor to use either single or double-wrap insulation. A double wrap wound on each wire in reversed layers costs little more, and is well worth the difference by reason of the additional assurance against crosses, and because it gives a more substantial body to the cable, and enables it to be handled with less danger of buckling. In cables of 200 pairs or over single wrap is necessary to keep the capacity within reasonable limits. In these same specifications it would also be well to specify the length of time of charge and exact voltage in making insulation and capacity tests. The practice of putting two or three per cent of tin in a lead sheathing is being abandoned, and, so far as the reviewer knows, no manufacturer can give a good reason for its use, except that it had always been used, until some one in the last few years called for commercially pure lead in his specifications. The earliest forms of paper-covered cables were made up by drawing the core into a lead pipe, and this pipe was then stiffened by an admixture of about three per cent of tin, so as to enable the manufacturer to draw the core in without bending the pipe. A sheath of commercially pure lead reduces the first cost, and the cable will last just as long. The author, in section twenty-seven, gives outside dimensions for 400-pair cables which would bar the use of that size in the underground systems as built to-day, in which the ducts would run about three and one-quarter inches in diameter; but fortunately the cable manufacturers make it with the same conductor resistance and capacity as called for by the author, and with a diameter outside of less than three inches.

In all of the three volumes received the prices and costs of materials and labor are given in too general a way. Costs, to be of any value, should be expressed in time units. For instance, to say that the cable splicer and helper will make one splice in a 2,200-pair cable in ten hours gives such information as can always be used, and simply requires adjustment of the schedule prices of labor; and the same thing is true of materials—they should be given in quantities. Tables and curves of costs are valueless in these days of rapidly changing prices, as one instance will illustrate—previous to this spring multiple tile conduit was laid by common labor; now this can not be done (in some sections of the country, at least) as the masons have ruled otherwise.

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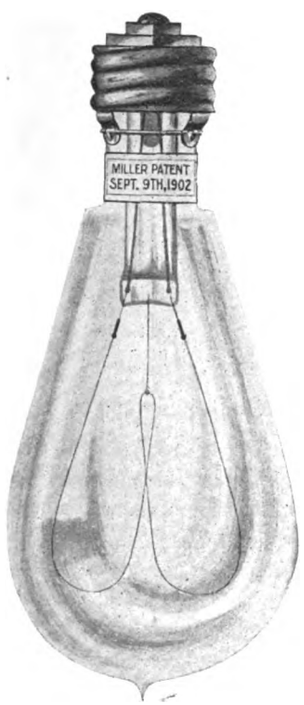
INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

A New Type of Incandescent Lamp.

The Missouri-American Electric Company, St. Louis, Mo., is placing on the market a new type of incandescent lamp for which a number of special features are claimed. The chief feature of this lamp is in the attachment of the bulb to the socket. This is a radical departure from the ordinary type. The locking device is entirely mechanical, and the accompanying illustration will give a good idea of the method in which this is accomplished.



NEW TYPE INCANDESCENT LAMP.

The metal cap is slipped over the stem of the lamp, and a porcelain plug is seated under the brass cap. One lead is drawn through the porcelain plug and soldered to a button which is slightly raised above the flanges on the porcelain plug. By means of a special cement this button is fastened to and becomes a part of the stem of the lamp. The other lead is carried alongside of the stem of the lamp, between the stem and the brass cap, and attached by a drop of solder to the cap. A brass tie-wire holds the cap, by means of four projections, to the stem of the lamp, the drop of solder which is part of the connection of one of the filament leads securing this permanently. This method of attaching does away entirely with the use of plaster of Paris and cements.

The manufacturer states that with this type of lamp, if a renewal is desired, the old bulb may be cleaned and fused to the base, or a new bulb may be fused to the base, as desired, in any case making a clean saving of the cap, button, stem and the platinum leads.

The company's purpose is to place on the market a lamp of the highest quality. It has equipped a plant at St. Louis with the most modern machinery and instruments, and states that its method of construction will be such as to produce the very best results. The Edison base is furnished with these lamps, and as the demand justifies it other types will be adopted. For the present the output will be fitted with the Miller patent Edison base. The anchored oval type of filament is used, but coil filaments will be fitted wherever specified.

A General Engineering Company.

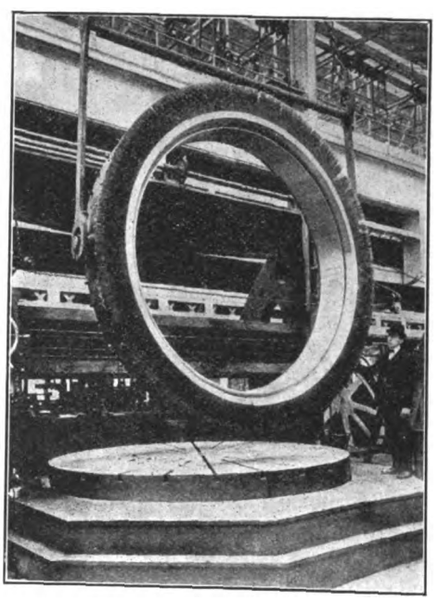
Articles of incorporation have been filed with the Secretary of State at Springfield, Ill., for the Cosmos General Engineering Company, with principal offices in the Fisher Building, Chicago. This company proposes to do general, consulting and contracting engineering in all of its branches and will sell any and all kinds of machinery. The officers and principal stockholders of the company are men of wide experience as engineers and business men, and while all of the business will be conducted under one general management, each individual department will be represented by a man who has built up a reputation for himself in his special branch of engineering. Therefore, any one desiring to obtain any certain results and not knowing his exact needs, will have only to write to the general office of the company explaining fully just what is required and he will be informed at once what is necessary to reach the best results in the shortest time, as well as the total cost of the same. In that way anybody wishing for information on a given subject will not have to go to the expense and trouble of experimenting or spending a lot of valuable time in corresponding or hunting for the information desired.

Offices will be established in all of the leading cities so that there will be as little delay as possible in attending to the wishes of its customers.

A Large Commutator.

The accompanying engraving illustrates the assembly of a commutator which is to form part of an 1,800-kilowatt, direct-connected generator under construction in the shops of the British Westinghouse Company, Manchester. The generator is being supplied to the order of the City of London Electric Lighting Company, and will be run in conjunction with units of similar size already supplied by the company, and working at the Bankside station. The external diameter of the commutator is ten feet, and there are 900 segments, each of hard-drawn copper, around the circumference. The generator is designed for a normal output of 1,800 kilowatts at 450 to 500 volts, and will be capable of supporting a continuous overload of twenty per cent of its total output.

The commutator serves to illustrate the class and size of work being turned out from the Westinghouse works, now that the organization has become settled into definite operation. The development of this large undertaking will be watched with considerable interest during the next few years, especially as some of the largest schemes for power distribution and railway operation are passing through the company's hands.



COMMUTATOR FOR 1,800-KILOWATT GENERATOR.

The escalator at the Twenty-third street station of the Sixth Avenue Elevated Railroad, New York city, which was shut down recently, has now resumed regular operation. Some time ago the motor driving the escalator was connected to take current from the third rail. It was found, however, that the voltage fluctuates over a considerably wider range than had been anticipated, and the shutdown was necessary in order that alterations might be made in the motor to secure better speed regulation. It is stated that during the interval in which the electrical changes were in progress the receipts of the station showed a marked falling off.

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New Type Induction Motors.

The Stanley Electric Manufacturing Company, Pittsfield, Mass., is placing on the market a comprehensive line of induction motors which, along with its line of high-grade alternating-current apparatus, it recommends as being of the usual "S. K. C." standard. As the conditions of operation for alternating-current motors cover a wide range, the Stanley company has deemed it expedient to develop three distinct types, and not make one style answer for all service.

Fig. 1 shows the type A induction motor with the armature or secondary removed, showing the field or primary winding and bearings in the end-frames. This is the most simple type of motor. The armature or secondary, which is shown in Fig. 2, is of the squirrel-cage type, and consists of straight copper bars laid in partly closed slots, with practically no insulation, and short-circuited by means of heavy end-rings, as may be seen in the illustration. Injury to the armature, either by heating or by mechanical displacement of the parts, is practically impossible, and the wear on the motor is reduced to that which takes place in the bearings. Owing to the great simplicity of armature construction, the type A motor is the most desirable where the conditions admit of its use, namely, where the motor is not required to start heavy loads, or where a large starting current will not injuriously affect the potential regulation of the system. It is possible to start the type A motor by simply closing the line switch, and this method is used with motors below five horse-power; but as the first rush of current, when so starting, amounts to several times the running current, it is advisable to use with the larger sizes of motors a device called a starting compensator, to reduce the voltage impressed upon the motor, and thus decrease the current taken.

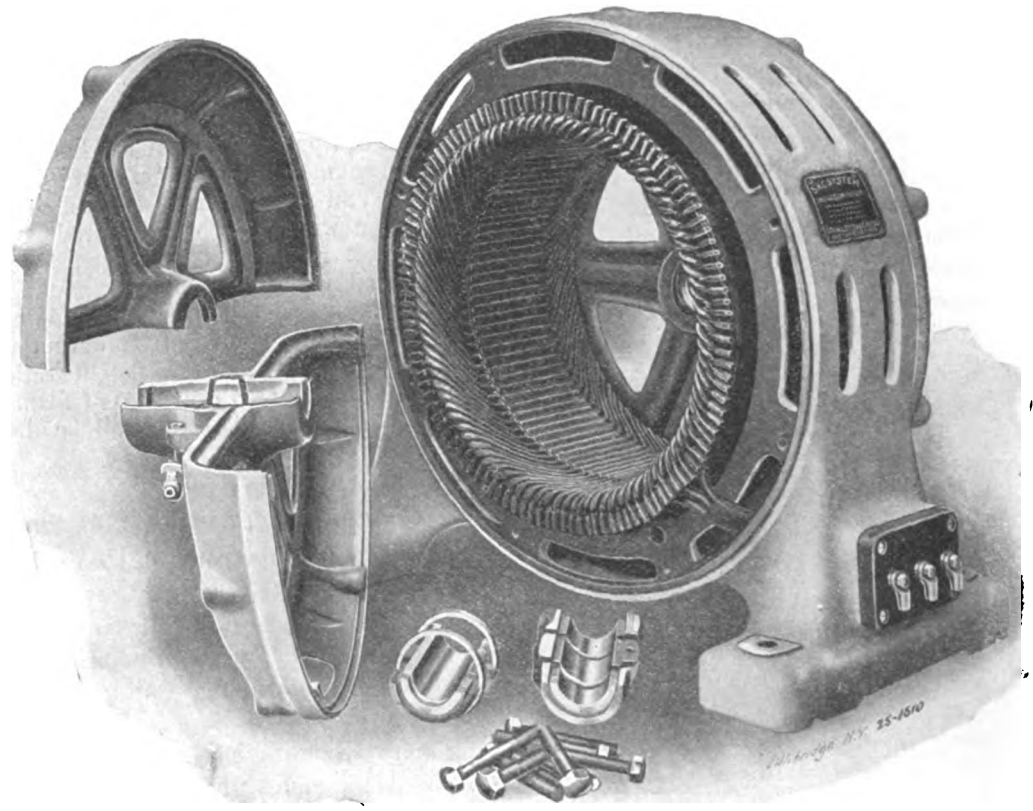

Fig. 1.—Induction Motor with Armature Removed.

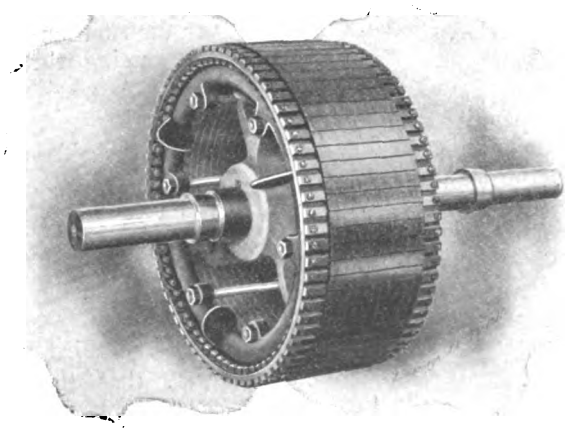

Fig. 2.—Armature or Secondary.

The starting compensator consists of a single-coil transformer in each phase of the circuit, with taps brought out at various points of the winding, in order that a number of potentials may be obtained. The compensator is provided with a double-throw oil switch, by means of which, after starting, the coils are cut out and the full voltage of the line applied to the motor. Fig. 3 shows diagrammatically the construction of the compensator, and the method of connecting it to the line and to the motor.

The point at which the compensator should be connected will depend upon the torque which the motor must develop in starting. Compensators connected to the first tap in the winding are furnished so as to give the minimum voltage, and therefore the least current. Should the torque thus developed be unequal to that necessary, a proper adjustment of the connections of the compensator to secure a higher potential can be readily made.

Fig. 4 shows the type B induction motor. In this type the starting current is kept low by introducing starting resistance within the secondary circuit. This motor does not possess the same simplicity of construction as the type A motor, owing to the fact that the armature has a polar winding, and a device for varying the armature resistance is necessary. But it has the advantage that it will start a given load with a current materially less than that taken by the type A motor. The type B motor is so designed that, for a given torque, the starting current will not exceed the running current. This type is

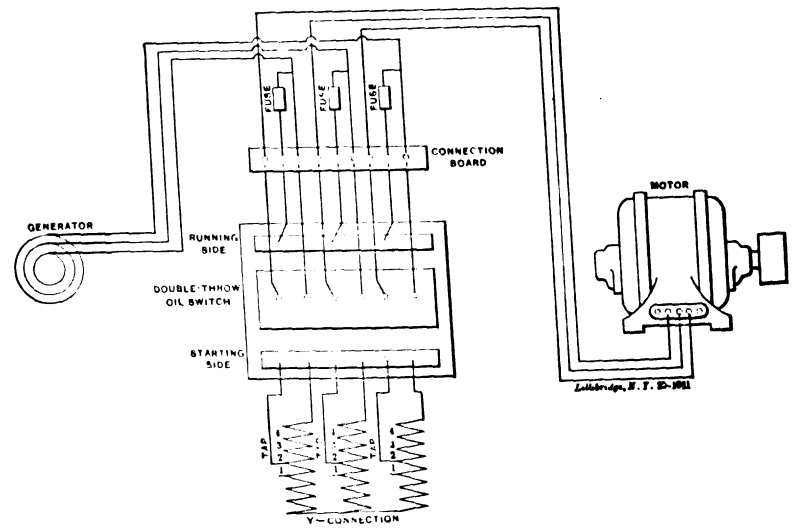

Fig. 3.—Compensator Connections Diagram.

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therefore recommended by the company where the motor must start heavily loaded, and where a large current, such as the motor with short-circuited armature takes when starting at full load, would be objectionable.

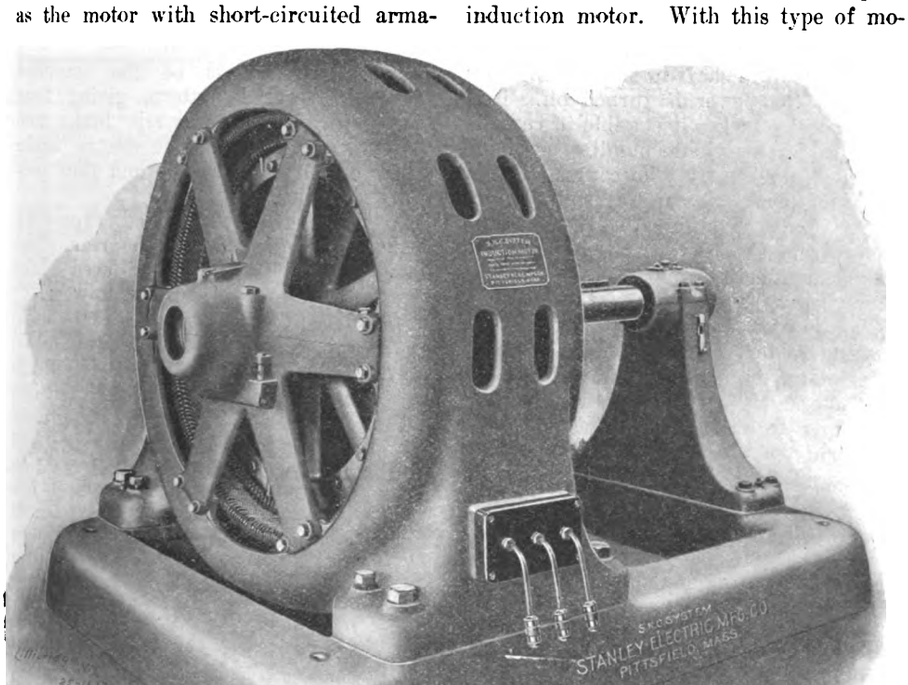

FIG. 4.—INDUCTION MOTOR WITH STARTING RESISTANCE IN SECONDARY.

The starting resistance is placed within the armature spider, and leads are brought out from several points of the resistance to a set of contacts parallel to the shaft. A lever on the outside of the motor operates a sliding collar, which is arranged to pass over the contacts so that the resistance on starting the motor can be short-circuited step by step. Fig. 5 shows the armature of the type B motor.

Fig. 6 shows the type C variable-speed induction motor. With this type of motor the armature winding is similar to that of type B. The leads from the windings are carried through a hollow shaft to the collector rings, by means of which connection is made with a suitable controller for cutting in and out the resistance external to the armature. In this way, with the rheostatic control, the desired speed variation is secured.

The manufacturer claims that these motors can develop a torque of at least 200 per cent of their normal full load. The temperature rise of a motor of either of the three types on a continuous run at full load will not exceed forty degrees centigrade. The speed of type A and type B motors varies but slightly from no load to full load, the variation not exceeding two per cent in the larger motors, and from five to six per cent in the smaller sizes. The standard induction motors are wound for frequencies of twenty-five, forty and sixty cycles. The standard potentials for the twenty-five-cycle motors are 220 volts for capacities under fifty horse-power, and 440 volts for capacities of fifty horse-power and above. The sixty-cycle motors are designed for the same potentials, and in addition, the regular line includes 2,080-volt motors, in capacities of fifty horse-power and above. The forty-cycle motors of all sizes are designed to operate at 550 volts.

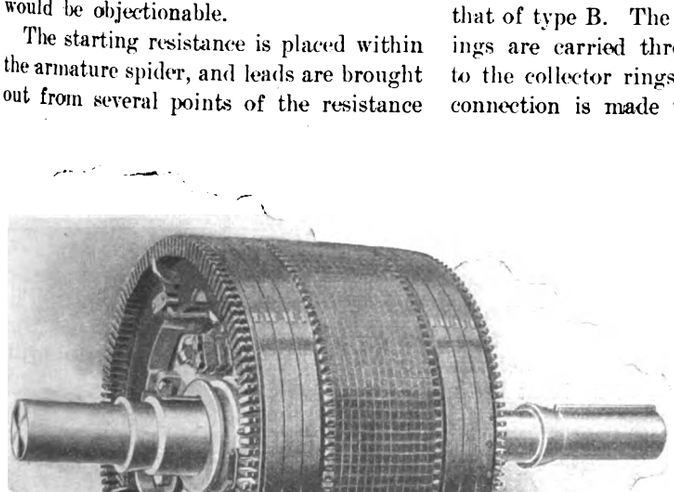

FIG. 5.—ARMATURE OF TYPE B INDUCTION MOTOR.

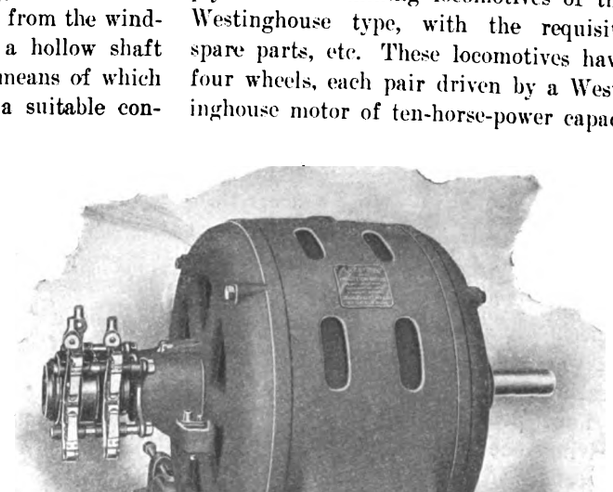

FIG. 6.—VARIABLE SPEED INDUCTION MOTOR.

Westinghouse Mining Locomotives for De Beer's Consolidated Mines.

Mule haulage is to be replaced by electric traction on the De Beer's mines, an order having just been placed with the British Westinghouse Electric and Manufacturing Company, Limited, for the supply of twelve mining locomotives of the Westinghouse type, with the requisite spare parts, etc. These locomotives have four wheels, each pair driven by a Westinghouse motor of ten-horse-power capacity at a conservative rating. They can thus develop a full load draw-bar pull of about 900 pounds, running at six to ten miles per hour on the level. The most interesting feature of these tractors is

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that the gauge being very narrow—eighteen inches—the motors have to be mounted clear of the wheels. The motor pinion meshes in the ordinary way with an additional intermediate gear-wheel. The journals of the shaft carrying this gear-wheel run in boxes working in pedestals over the main journal boxes of the locomotives and rigidly connected to them. Thus the locomotive frame, which is supported on springs in the usual manner, is free to rise and fall on the axles and without disengaging the gears. The motors are hung on the shafts of the intermediate gear as if these were the ordinary wheel axles, and the usual "nose" suspension is employed. These locomotives are built to last, both mechanical and electrical parts being of very strong, workmanlike construction.

Columbia Electric Five-Ton Truck with Four-Motor Drive and Electrical Steering.

The new Columbia electric five-ton truck, made by the Electrical Vehicle Company, of Hartford, Ct., presents marked advances over large self-propelled vehicles of previous types, in that it exemplifies the first commercially successful attempt to apply power to all four wheels and to steer by other than manual power. The general lines of the construction of the vehicle proper follow quite closely standard horse truck construction of the well-known "New York gear" type. The large fifth wheel at the front permits the front axle and wheels to be swung at right angles to the body, giving a short turning circle and permitting the vehicle to be turned around in a space which is practically of its own length. All four wheels are alike and of the standard Sarven type, mounted on large roller bearings.

Four powerful motors are used for driving, one for each wheel. These are suspended directly from the body of the vehicle, transmitting power to the wheels by heavy roller chains. The wheel sprockets are bolted directly to the spoke, giving a simple but strong construction. Chain adjustment is provided by a powerful strut between the axle and the motor. This is so made as to allow for working and twisting of the body without any twist being imparted to the strut.

The front truck is steered by means of an electric motor. A large, broad-faced steering sector is carried by the truck. This sector meshes with a large pinion at the lower end of a short, thick vertical shaft, at the upper end of which is a worm-gear driven by a worm on a short shaft which can be clutched to the steering motor or not as desired. This arrangement affords a rigid back-lock, holding the wheels securely wherever the motor leaves them. In order to give perfect steadiness of steering, especially when coasting or when little power is required, a solenoid-released brake is put on the armature shaft to stop its rotating instantly the power is turned off. This simple device makes it possible to run the truck as fast as eighteen miles per hour and hold a perfectly true course. When the front truck is swung at right angles to the body it automatically cuts the power from the rear wheel motors, this arrangement preventing the front tires from being shoved sidewise when the vehicle is turned in a short circle. The steering motor is controlled by a short tiller placed immediately above the main controller. It is so adjusted that if it is swung through, say, fifteen degrees, the front truck swings through the same angle and then comes to rest. The direction of the tiller is always indicative of the direction of the progress of the vehicle. Means are provided to steer the truck by hand in case of accident to the motor or battery.

The truck is provided with a powerful winch operated by the steering motor when it has been unclutched from the steering gear and coupled to the clutch gear. This change can be quickly made by the operator.

The battery consists of forty-four exide cells of 280-ampere-hours capacity, arranged in a tray hung below the body by the well-known exclusive Columbia method. The battery can be readily removed by one man, although it weighs 3,500 pounds. A new method of battery suspension from three points has been introduced in this vehicle. With so large a truck, having a platform approximating sixteen feet by six feet in dimensions, it is naturally difficult to keep it perfectly flat at all times when it is in service, and by means of this suspension all warping and twisting of the battery is eliminated, which could not be the case if it were suspended from four points. The usual Columbia automatic contacts are used on the tray, simplifying the work of loading and unloading batteries.

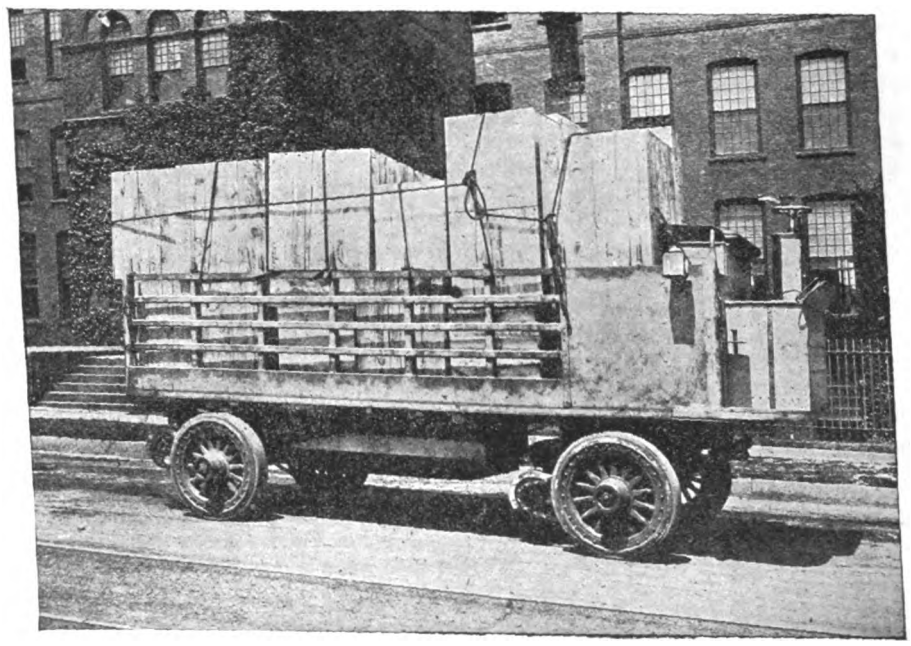
The controller is of the standard Columbia vertical pattern, giving four speeds forward, an electric brake and three reverse speeds. The electric brake works on all four wheels and thus prevents skidding.

A powerful foot-operated expanding brake works directly on the rear wheel sprockets. This is a wood-faced brake arranged for easy adjustment to wear.

The largest solid tires made are used, and, as power is applied equally to all four wheels, not only is the driving strain per tire reduced fifty per cent, but the actual weight carried per tire is greatly reduced, inasmuch as only fifty per cent of the total weight of the truck need be supported on each axle, whereas with the two-motor drive from sixty to seventy per cent of the weight must be carried by the driving axle.

This truck is especially designed for heavy traffic in crowded centres. The fact that it can be swung entirely around in its own length in from five to ten seconds does away with all the backing and filling which has proved so tedious to operators of heavy hand-steered trucks and which involves great wear on tires and mechanism. The four-wheel drive reduces the dead load per tire and cuts the driving strain in half; it also reduces liability to skid and greatly simplifies control of the vehicle under a heavy load. The matter of accessibility has been carefully attended to and all working parts, including motor, commutators and bearings, can quickly be got at for cleaning and oiling, adjustment and repairs.

The Electric Vehicle Company has several orders on hand for these new vehicles, two of which have been completed.



FIVE-TON ELECTRIC TRUCK—FOUR-MOTOR DRIVE, AND ELECTRICALLY STEERED.

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CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

NEW CANADIAN WESTINGHOUSE COMPANY INCORPORATED—The Canadian Westinghouse Company has been incorporated by George Westinghouse, manufacturer, Pittsburg; Henry Herman Westinghouse, manufacturer, New York; George Carson Smith, capitalist, Pittsburg; Frank Hendrickson Taylor, Pittsburg; Loyall Allen Osborne, manufacturer, Pittsburg; Thomas Ahearn, manufacturer; Warren Young Soper, manufacturer, Ottawa and Paul Judson Myler, manufacturer, Hamilton.

CHICAGO TRACTION IMPROVEMENTS—Judge Peter S. Grosscup has taken official cognizance of the arguments recently made before him in respect to the ninety-nine-year claim, instructing the receivers of the Union Traction Company, of Chicago, to suffer no interference with the company's rights in Chicago streets. The Court hands down instructions to the receivers, declaring that the situation invites a settlement of the problem and pledges the Court's support; and the Court orders the sum of $580,000 expended on immediate improvements, including the purchase of additional cars and electrifying of parts of the cable system.

NEW PENNSYLVANIA-OHIO TROLLEY SYSTEM—It is announced that a large electric railway system is to be built between Avalon and Freedom, in the Ohio Valley. This is said to be the project of officials of the Pennsylvania Railroad. It is thought that because of the recent location of large industries at Leetsdale and Ambridge the building of a street railway system is necessary. While it is alleged that the steam railroad company has opposed the introduction of trolley lines into the Sewickley Valley, it is now prepared to withdraw any opposition, and will use its influence toward securing the construction of an electric street railway, provided that it is of up-to-date construction and operated so as to assist in building up the community through which it will pass.

MEXICAN POWER SCHEME—The Mexican Light and Power Company, Limited, whose New York offices are in the Columbia Building, 29 Broadway, is about to let contracts for the initial equipment for its plant at Necaxa, from which place power is to be transmitted to Mexico City, some nineteen miles distant. The first installation will be of some 28,000 horse-power, which will be generated by four 7,000-horse-power water turbines, direct-connected to generators of 5,000 kilowatts each. The available head is 725 feet. The average flow of water is at the rate of six cubic metres. In the winter and dry season it averages four cubic metres. The equipment will operate at 300 revolutions per minute. Mr. James Ross, of Toronto, is president of the company. Mr. F. S. Pearson is vice-president of the company, and is also chief electrical expert.

ILLINOIS TROLLEY SYSTEMS—Projects for connecting the principal cities of Illinois by an electric railway system are receiving prominent attention. It is estimated that within the next five years $5,000,000 will be expended in the construction of these lines, most of which will be constructed in central Illinois, the northern portion being pretty well supplied. Unless there is an unexpected hitch it will be possible within the next five years to travel from St. Louis, Mo., to Chicago, Ill., by trolley, and to visit every city of importance in the state by the same means. The principal system will be known as the W. H. Knight, which includes a line forty miles in length between Bloomington and Decautur; a line the same length between Bloomington and Peoria, and one of 150 miles between Springfield and Peoria, which circles around to take in Havana and Fulton County, with its principal cities. This company also proposes to construct a line to connect Springfield and Decatur. Another company will shortly commence operations between Bloomington and Joliet, to connect with the trolley line from the latter city to Chicago. The franchises from the principal towns and villages have been mostly secured and large amounts of stock subscribed.

NEW LINE OPEN BETWEEN JACKSON AND BATTLE CREEK, MICH.—The Jackson & Battle Creek Traction Company's line between these cities in the state of Michigan has been formally opened. This road is a section of one of the most important interurban railroads now being constructed in the country. The Jackson & Battle Creek Traction Company, whose lines have been placed in operation, passes through the cities of Jackson, Albion, Marshall and Battle Creek, a distance of forty-five miles. This company will, it is said, be consolidated in the near future with other sections now in operation and under construction through the cities and villages of Jackson, Grass Lake, Chelsea, Dexter, Ann Arbor and Plymouth to Detroit, forming a continuous line from Detroit to Battle Creek of 122 miles. These sections are to be completed and in operation under one management by January 1, 1904. As these different sections represent what is known as the Boland system, it is the purpose to extend this line west, ultimately to Chicago, making a total length of line of 285 miles. The entire road will be operated with a third-rail system on private right of way outside of the villages and cities, where the trolley will be used on a steam railway road-bed.

THE LARAMIE RIVER, WYO., TO BE THE SITE OF A NEW POWER PLANT—A syndicate of eastern capitalists has just been organized for the development and operation of electric power from the waters of the Big and Little Laramie rivers in the vicinity of Laramie City, Wyo. The syndicate's offices will be in Toledo, Ohio, with R. St. John as president and general manager, and Frank Smith as local superintendent, with headquarters at Jelm, Wyo. The electric generating station will utilize the flow of the Big and Little Laramie rivers and their tributaries. The cañon of the Big Laramie River has, just above the mining town of Jelm, a fall of eighty feet within a distance of one mile, while one mile below Jelm a second cañon of the same stream has a fall of 100 feet in one and one-half miles, the Big Laramie carrying at low water 400 cubic feet of water per second. On the south fork of the Little Laramie River, six miles north of Jelm, is a fall of 200 feet in one mile. Six miles farther north, the middle fork has a 250-foot fall in one-half mile; while six miles further northward the north fork of the Little Laramie River and Liberty Creek each offers a fall to the mile of over 200 feet. It is proposed by the Toledo syndicate to concentrate all of these water powers at a central distributing station, to be located either at Jelm or Pollock. The estimated cost of the power plant and building is about $1,000,000. The initial development of the electric plant will reach 5,000 horse-power, with the object of furnishing light and current for motors to the cities of Laramie, Cheyenne, Fort Collins, Rawlins, Saratoga and Encampment, with an eventual distribution to Steamboat Springs and to Greeley, and to all the towns on the Colorado & Southern between Fort Collins and Denver.

TELEPHONE AND TELEGRAPH.

MERRILL, WIS.—The Merrill Telephone Company has increased its stock from $10,000 to $25,000.

LINCOLN, NEB.—The Nebraska Telephone Company will make improvements to its local plant at a cost of $10,000.

DAWSONVILLE, GA.—The Bell Telephone Company intends putting up a line to Gainesville, and also a line from Dahlonega to Dawsonville.

HARRISBURG, PA.—The United Telephone Company has absorbed the Enterprise Telephone Company, an independent service in eastern Lancaster County.

WALTON, N. Y.—A local telephone company has been organized here with the following officers: J. S. Gillet, A. Owens, C. Liddle, W. C. Hulbert, G. Keeler and others.

ST. LOUIS, MO.—The Armory & Tupelo Telephone Company has filed articles of incorporation with a capital of $10,000. The incorporators are L. B. Camp and R. E. Camp.

OMAHA, NEB.—The stockholders of the York Telephone Com-

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pany held a meeting recently for the purpose of increasing the capital stock of the company from $50,000 to $500,000.

MACON, MISS.—The Cumberland Telephone Company is to become the owner of the Laurel Telephone Company, of Laurel, Miss., which has a system in that city and in Ellisville.

GERMANTOWN, OHIO—The Independent Telephone Company has purchased the Bailey and Flinchpach lines which run west from this place, and will extend the line to Winchester.

ST. LOUIS, MO.—The Bluff City Telephone Company has decided to increase its capital, and will lay a cable across the Mississippi River at Hannibal, to connect with the Illinois lines.

PHOENIX, R. I.—Work on the construction of the lines of the Coventry Telephone Company has been commenced. The officers of this company are J. H. Hill, J. H. Hill, Jr., F. G. Bates and J. S. Carpenter.

DALLAS, TEX.—The McKinney Telephone Company has been organized and succeeds the Southwestern company at McKinney. The officers are J. E. Farnsworth, J. Shanne and W. R. Faught, with a capital of $30,000.

RICHMOND, VA.—A charter has been granted to the Asheville Telephone and Telegraph Company, with a capital of $300,000, and incorporators are as follows: C. R. Craig, W. S. Proctor, F. Carter, W. T. Gentry and H. Chipley.

LOS ANGELES, CAL.—The Santa Ana Home Telephone and Telegraph Company has filed amended articles of agreement, with a capital stock of $100,000. The directors are F. F. Graves, F. W. Watcher, J. Van Liew, C. L. Zahm and A. Wright.

TERRE HAUTE, IND.—The Citizens' Telephone Company, of West Terre Haute, will install a switchboard and connect with the Citizens' exchange at Terre Haute. The new concern has a capital of $5,000, with F. P. Silbey, A. F. Miller and T. Posolt as incorporators.

NEW INCORPORATIONS.

COLUMBUS, OHIO—Scott Telephone Company. $5,000.

HARRISON, ARK.—Reick Telephone Company. $10,000.

PIERRE, S. D.—Enterprise Telephone Company. $10,000.

HARRISBURG. PA.—Annville Electric Light Company. $10,000.

NASHVILLE, TENN.—Nashville Railway and Light Company. $6,500,000.

MARLTON, N. J.—The Marlton Light, Heat and Power Company. $10,000.

WATSEKA, ILL.—Watseka Home Telephone Company. $20,000. Incorporators: J. E. Bundy, J. A. Bundy, H. M. Fisk.

OWOSSO, MICH.—The Laingsburg Telephone Company. $25,000. Incorporators: R. Simpson, W. Simpson and J. L. Hisey.

AUGUSTA, ME.—Southwestern Land and Power Company. $1,500,000. Incorporators: F. L. Dutton and M. H. Simmons.

SPRINGFIELD, ILL.—Kewanee Home Telephone Company. $125,000. Incorporators: J. L. Dunn, M. C. Shoemaker and C. K. Ladd.

LYNCHBURG, VA.—The Elba Telephone Company. $5,000. Incorporators: R. T. Ramsey, T. C. Creasy, E. B. Fitzgerald, W. O. Smith and J. R. Glenn.

BEAUMONT, TEX.—Beaumont Light and Power Company. $600,000. Incorporators: W. A. Myrick, Russell Myrick, Horace Myrick and Walter J. Crawford.

FAYETTEVILLE, VA.—The Fayetteville and Electric Company. $33,000. Incorporators: W. A. McKenney, of Washington, D. C.; W. H. Basley, of Baltimore, and others.

BROOKLYN, N. Y.—Tocula Electric Light and Power Company. $300,000. Directors: David H. Valentine, Clinton L. Rossiter, Timothy S. Williams and Henry Seibert.

INDIANAPOLIS, IND.—The Terre Haute Electric Traction Company. $3,000,000. Directors: Ray G. Jenckes, Buena V. Marshall, Bertie McCormick, S. C. McKeen, G. F. Wells, Finley A. McNutt and Allen H. Donham.

ELECTRIC LIGHTING.

EDWARDSVILLE, ILL.—The city council has passed an ordinance granting a seventy-year franchise to the Edwardsville Electric Light and Power Company.

ELDORA, IOWA—The Eldora Electric Light and Heating Company's plant has been sold to Ferris Brothers, of Monmouth, Ill., by its owner, William S. Potter. It is said that the consideration was $40,000.

MEXICO, MO.—A company composed of S. M. Locke, president; J. W. Woolridge, vice-president; F. A. Morris, secretary and treasurer, and E. R. Locke has purchased the Mexico Electric Light Company's plant from Thomas Waddell, Harry Rubey and W. E. McCully, of Macon city, for a price in the neighborhood of $35,000.

NEWARK, N. J.—The board of works has awarded a five-year contract for street lighting to the United Electric Company for the lighting of the city streets. The contract is to continue in force for five years, and the price charged per lamp is $95. The city now uses 1,860 lamps, making the total cost more than $176,000 per year.

RIVERSIDE, CAL.—Corona is to have an up-to-date lighting plant. Franchises have been granted by the city trustees to the Corona Gas and Electric Company, capitalized at $50,000, and the work will be begun at once. The officers of the company are M. W. Findley, president; F. P. Cooper, vice-president; M. Terpening, treasurer; A. F. Le Gaye, secretary.

HOUSTON, TEX.—The Houston Electric Company has decided to expend about $100,000 in improvements upon its power-house, the work to be commenced at once. The effect of these improvements will be to increase the capacity of the plant almost twofold, and provide for the handling of any amount of business in any emergency. In connection with this increased output, it is said that the Harrisburg line is a certainty, and that the improvements are for the purpose of meeting this increased strain on power, as well as for other extensions which are to be built next year. The Harrisburg road will be commenced early next year. High-speed electric cars will be operated between Houston and Harrisburg.

ELECTRIC RAILWAYS.

DES MOINES, IOWA—An electric road will be built from Council Bluffs to Rockport, Mo.

TRENTON, N. J.—The Yardley and Newtown branch of the New Jersey & Pennsylvania Company's road has been opened, bringing Newtown into direct connection with Trenton. The distance is twelve miles.

MATTOON, ILL.—The capital stock of the Mattoon Street Railway Company has been increased from $100,000 to $500,000, and work on the interurban road between this city and Charleston will begin at once.

JAMESTOWN, N. Y.—The New York railroad commissioners have granted the application of the Chautauqua Traction Company, and work on the proposed street railway from Lakewood to Mayville will be begun as soon as possible.

HARRISBURG, PA.—A charter has been issued to the Wilkinsburg, Turtle Creek & East Pittsburg Railway, with a capital of $36,000, to build six miles of road in Allegheny County. The road will extend from Wilkensburg to Turtle Creek.

EXETER, N. H.—A mortgage deed of trust given by the Portsmouth, Dover & York Street Railway to the State Street Trust Company, of Boston, of all its property, rights and franchises, to secure an issue of $650,000 bonds, has been recorded.

DAYTON, OHIO—Work has been begun on the Franklin & Lebanon traction line, which will be about eleven miles in length, and which is backed entirely by local capital. Private rights of way and franchises have been secured by the entire route.

ST. JOSEPH, MO.—It is stated that the new electric road to be built between Kansas City and St. Joseph, touching at Atchison, Parkville and other points along the route, is to be a St. Joseph enterprise primarily, and that the name of the company will be the St. Joseph, Atchison & Kansas City Railway Company.

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ELECTRICAL SECURITIES.

Although it was the general opinion at the close of last week that securities had reached their lowest levels, still further declines have been evident during the week just closed which have carried securities to new low levels for the year, and, in some cases, to the lowest point in many years. Some slight improvement was evident the latter part of the week, though it is evident that the bear interests are still active. The money situation and outlook promises to be the chief factor in stock market conditions for the balance of the year. Although no stringency is expected at the present time, opinions are very conservative as to the outlook in the fall.

Railroad earnings are very large, and general trade activity continues unabated. Crop reports are, in general, very favorable. it being stated that the agricultural outlook is even better at the present time than as shown in the last government report. If the harvest turns out as expected there is no doubt that the general trade of the country will be greatly stimulated and conditions materially improved.

ELECTRICAL SECURITIES FOR THE WEEK ENDING JULY 18.

New York:	*Closing.*
Brooklyn Rapid Transit	51⅛
Consolidated Gas	185
General Electric	165½
Kings County Electric	200
Manhattan Elevated	133
Metropolitan Street Railway	118½
New York & New Jersey Telephone	154
Westinghouse Manufacturing Company	190
Boston:	*Closing.*
American Telephone and Telegraph	132
Edison Electric Illuminating	242
Massachusetts Electric	82
New England Telephone	123
Western Telephone & Telegraph preferred	85
Philadelphia:	*Closing.*
Electric Company of America	8¾
Electric Storage Battery common	54
Electric Storage Battery preferred	54
Philadelphia Electric	5⅞
Union Traction	44¾
United Gas Improvement	84
Chicago:	*Closing.*
Chicago Telephone	120
Chicago Edison Light	144
Metropolitan Elevated preferred	65
National Carbon common	23
National Carbon preferred	94
Union Traction common	4
Union Traction preferred	32

PERSONAL MENTION.

MR. ADOLPH M. BARRON, president of the New Albany, Ind., Waterworks Company, and a consulting engineer who has been identified with a number of electric lighting and water companies in the Middle West, has moved from South Bend to Indianapolis, where he will reside.

MR. G. M. GEST, the well-known conduit contractor, was a visitor to the East last week, looking up a number of his contracts in this territory. Mr. Gest reports a very busy season just closed, and anticipates a still greater demand for subway construction and material during the closing summer months and the early fall season.

MR. AZA M. MATTICE, who for several years has been chief engineer of the Westinghouse Electric and Manufacturing Company, has been appointed chief engineer of the Westinghouse Machine Company. He will, however, retain his connection in a consulting capacity with the former company. Mr. Mattice will be succeeded in his duties by Mr. B. G. Lamme, who is appointed to this position with the title of acting chief engineer.

MR. GEORGE H. GIBSON has resigned as manager of the advertising and publication department of the B. F. Sturtevant Company, Boston, Mass., to accept an appointment with the International Steam Pump Company, having offices at 114-118 Liberty street, New York city. Mr. Gibson was formerly connected with the Westinghouse Companies' Publishing Department, of Pittsburg, Pa., and was for two years a member of the editorial staff of the *Engineering News*, New York city.

MR. F. C. MOTT, who for some time past has been associated with Mr. G. M. Gest, the conduit contractor, will be in charge of the new office in New York city which has been opened by the American Conduit Company, manufacturer of electrolysis-proof bitumenized fibre conduit. This office is in addition to those which the company operates in Philadelphia, Chicago and Los Angeles. The demand for this material during the past season is stated to have run into many millions of feet.

MR. WILLIAM D. SARGENT, vice-president of the New York & New Jersey Telephone Company, has recovered from a severe cold that confined him to his home for several days. Mr. and Mrs. Sargent are spending the summer at their beautiful Long Island home at Arverne-by-the-Sea, where one of the chief attractions is the daily concert by Theodor Gordohn, the talented young Russian director and composer. These concerts are given at the Arverne Hotel and the Casino, and attract the keenest interest of lovers of classical as well as popular music, thus presented by a master in his profession.

PROFESSOR HENRY S. CARHART, professor of physics at the University of Michigan, Ann Arbor, Mich., delivered a lecture on July 3 before the summer school of that institution, upon "Electrical Oscillations." Professor Carhart introduced his lecture by an explanation of the meaning of the nodes and antinodes of open and closed organ pipes. He then passed to electrical circuits, showing how these could be tuned with respect to each other. When an antenna was connected to one of these oscillating electrical circuits, the nodes and antinodes could be shown by means of a Geissler tube, when brought into the region of the oscillating circuit.

OBITUARY NOTICES.

MR. LUTHER STIERINGER died at Pasadena, Cal., of lung trouble, Friday, July 17, at the age of fifty-four years. His remains will be cremated and the ashes deposited alongside of those of his wife on Long Island. He leaves no family. Mr. Stieringer was very widely known in the electrical field, having been identified with it since the earliest days of electric lighting. He was particularly successful in the work of electric light decoration, and his services were in demand where large artistic effects were desired. He was associated with Edison in the early years of electric lighting, and was identified with the World's Fair at Chicago, the Pan-American Exposition and other expositions of this country. Mr. Stieringer was awarded early this year by the Franklin Institute the John Scott Legacy Premium and Medal for "Improvements in the Art of Electric Illumination." Although the deceased had been informed of this award, he had never seen the medal, as it is still in the engravers' hands.

MR. THOMAS CHALMERS, father of W. J. Chalmers, chairman of the executive committee of the Allis-Chalmers Company, died on July 13, and was buried on Thursday, July 16. Thomas Chalmers was the founder of the firm of Frazer & Chalmers, which firm was recognized as one of the world's largest producers of mining machinery. Mr. Chalmers was born in Dronley, near Dundee, Scotland, June 14, 1816. At the age of fourteen he was apprenticed to a Dundee machinery firm to learn the trade of machinist, which he followed in all its branches in Scotland and England for thirteen years. On July 2, 1840, he was married to Janet Telfer, of Greenock, Scotland. Mr. and Mrs. Chalmers came to America in 1843 and settled in a farming site between Joliet and Lockport, Ill. Mr. Chalmers built Chicago's first waterworks, and a study of his career would be parallel with the history of the industrial growth of Chicago, Ill. In 1855, with Mr. P. W. Gates and Messrs. E. S. Warner, A. G. Warner and David R. Frazer, Mr. Chalmers formed the firm of Gates, Warner, Chalmers & Frazer, which was succeeded in 1857 by the Eagle Works Manufacturing Company. In the winter of 1871-1872 this corporation was dissolved, and with Mr. Frazer, Robert Anthony and David Marchant, Mr. Chalmers formed the firm of Frazer & Chalmers. Two years ago this company, with three others, was merged into the Allis-Chalmers Company, and Mr. Chalmers, Sr., withdrew from active participation in its management.

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INDUSTRIAL ITEMS.

THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, Rochester, N. Y., and Chicago, Ill., has recently sold a special type despatcher's desk with telephones to the Interurban Railway and Terminal Company, of Cincinnati.

THE ALPHADUCT MANUFACTURING COMPANY, New York and Chicago, distributed a most unique souvenir at the recent Contractors' convention at Detroit, in the form of a pipe with an amber stem, the bowl of which was of "Alphaduct" conduit with silver trimmings.

THE CROCKER-WHEELER COMPANY, Ampere, N. J., is distributing a handsomely printed pamphlet descriptive of the equipment of a railway shop. This portrays the new locomotive and car shops of the Lake Shore & Michigan Southern Railway, at Collingswood, Ohio, which are equipped with the Crocker-Wheeler motor-driven apparatus.

THE AUTO DEVICE MANUFACTURING COMPANY, 79 Dearborn street, Chicago, Ill., is placing on the market an auto switch for gas engines. This may be either for a touch-spark or a jump spark system of ignition. The company has published some interesting literature on this subject, which it will be pleased to send upon request.

THE WYCKOFF PIPE AND CREOSOTING COMPANY, Stamford, Ct., manufacturer of creosoted conduits for underground wires and cables, poles, cross-arms, railroad ties, wharf and bridge timbers, etc., has issued a new catalogue which tells a great deal about the processing of timber with dead oil of coal tar. This company has been more than ordinarily successful with this material, and its literature is worth preserving.

THE CONNECTICUT TELEPHONE AND ELECTRIC COMPANY, Meriden, Ct., has printed another issue of its new catalogue. and this will be mailed on request. This company has just purchased a new building to enlarge its capacity, which is made necessary by the increasing demand for its apparatus. The company has effected a number of new and valuable improvements in its apparatus, and will be pleased to describe these on request.

THE COLONIAL SIGN COMPANY, Akron, Ohio, is the manufacturer of an attractive sign device which is unique in design and of durable construction. The patents cover a concave letter of such a form that it will reflect the light in parallel rays, enabling the sign to be read from a great distance and at almost any angle. The letters are constructed of porcelain, and are easily kept clean. Where colors are used, the colors are burned in so that they are permanent.

THE ELBLIGHT COMPANY OF AMERICA made a very elaborate display of its lighting system at the exhibition given in Detroit in connection with the meeting of the National Electrical Contractors' Association. A portion of the building was festooned with Elblight cables, covered with evergreens, and from the cables Elblight lamps were lighted. The company's booth was an artistic affair lighted with a myriad of small lamps. The whole effort was a demonstration of the rapidity with which the Elblight system may be put in place.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, Pa., has, through Mr. A. B. Dupont, vice-president of the St. Louis Transit Company, closed a contract for the installation of a 3,000-kilowatt storage battery, to be used in the substation, with rotaries having a capacity of 6,000 kilowatts. The battery will regulate fluctuations and assist in caring for the morning and evening loads. The substation is in the centre of the city, and this installation is one of the extensions being made for the purpose of caring for increasing traffic.

THE JEFFREY MANUFACTURING COMPANY, Columbus, Ohio, is distributing its catalogue No. 19. This is descriptive of mining machinery, and describes and illustrates coal cutters and coal drills operated by electricity and compressed air; electric locomotives for mine and surface haulage, and complete electric plants for mining properties. Outside of the typographical and mechanical treatment, which is handsome in the extreme, the catalogue is a valuable addition to the literature on this subject. The book is very fully illustrated, and the text carefully outlines the function of the apparatus.

THE SWEDISH-AMERICAN TELEPHONE COMPANY, 88 and 92 West Jackson Boulevard, Chicago, Ill., has recently furnished complete exchange equipments to the following telephone companies: The Ney Telephone Company, Ney, Ohio; the Potosi Telephone Company, Potosi, Mo.; the Palo Telephone Company, Palo, Mich.; the Idaville Mutual Telephone Company, Idaville, Ind.; the Illiopolis Telephone Company, Illiopolis, Ill. The Swedish-American Company announces that the prospect for business was never better, and that it does not anticipate the usual slump in business during the summer months. The company's apparatus is more popular than ever.

THE CROUSE-HINDS ELECTRIC COMPANY, of Syracuse, N. Y., lighted a large portion of the exhibition recently given in connection with the National Electrical Contractors' convention, at Detroit, using the "Norbitt quick-put-up" specialties. In the company's booth an artistic trade-mark had been worked out in colored incandescent lamps. In this booth "Norbitt" mouldings and conduit receptacles were shown on the oak railing. An aquarium had been arranged with gold-fish in which a "Norbitt" temporary decorative socket with a sixteen-candle-power lamp placed under the water showed the absolute water-proof qualities of the appliance. This company also exhibited switchboards and panel-boards.

THE EUREKA ELECTRIC COMPANY, Chicago, Ill., in its catalogue No. 23 describes a splendid line of telephone apparatus, including central energy instruments, series telephones, bridging telephones, tandem bridging telephones, complete portable desk sets, magneto series and bridging telephones, intercommunicating telephones, transmitters, receivers, five-bar bridging generators, lightning arresters, switch hooks, switchboards and numerous accessories. The illustrations and descriptive matter are supplemented by a number of diagrams of circuits, which are interesting and instructive. The catalogue is carefully indexed and well designed in every way.

THE JOSEPH DIXON CRUCIBLE COMPANY, Jersey City, N. J., is distributing a pamphlet describing the Dixon "Eterno" indelible pencil. This pencil writes black, and may be used for all manner of work requiring an ordinary lead pencil, but it also possesses the valuable feature of being a perfect copying pencil, making an indelible mark. While the pencil writes black, it copies purple, and it is stated by the company to possess the other valuable features which go to make the Dixon pencils so popular. Straight-grained Florida cedar and pure Ticonderoga graphite combine with the best aniline colors in a secret process to afford these qualities.

THE ARMOUR INSTITUTE OF TECHNOLOGY, Chicago, Ill., has ready its year book for 1903-1904. A number of excellent courses in mechanical engineering, electrical engineering, civil engineering, chemical engineering and architecture are offered, and the trustees are desirous of affording the students of this institution the very best training that a careful faculty can devise. A new course has recently been established which will be designated as a course in fire insurance protection engineering. This course has been commended by a number of prominent men, both from a commercial and from a scientific point of view. Mr. William E. Curtis, the celebrated writer, in a special article in the Chicago *Record-Herald*, of June 29, pays a high tribute to the conditions existing in the work of the correspondence instruction courses conducted by the Armour Institute.

THE LUNKENHEIMER COMPANY, Cincinnati, Ohio, manufacturer of brass and iron steam specialties and engineering appliances, tendered to its employés its forty-first annual outing at Woodsdale Island Park, on Saturday, July 18. Seven hundred employés and their families participated in the outing, about 2,000 people, including children, enjoying the different events. Everything was free, including transportation, refreshments, music, dancing, etc., the entire expense of the outing being paid by the company. Woodsdale Island Park is about thirty-one miles from Cincinnati, on the C., H. & D. Railway, and it required two sections of ten coaches each to carry the passengers. The events of the day were opened by a flag-raising ceremony and a concert by the First Regiment Band. Baseball games were held in the morning and afternoon, and a series of fourteen athletic events was conducted for valuable prizes.

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CHANGES for advertisements should be in this office by Friday noon for the following week's issue.

NEW ADVERTISEMENTS should be in the office not later than Monday noon to assure publication in that week's issue.

QUALITIES NEEDED IN ELECTRICAL ENGINEERS.

In this issue of the ELECTRICAL REVIEW is printed an abstract of an interesting and valuable discussion of the problems that are facing electrical engineers of to-day and the qualities of mind and character which are needed to meet them, by Mr. J. G. White. Mr. White is an engineer and contractor of high standing and wide experience, and any opinions which he may advance are of great value to instructors in technical schools, and particularly to the young engineers themselves.

Mr. White makes an earnest plea for a less restricted preparation, and indicates those studies which seem to him most essential in the education of engineers. His close touch with the leading engineers both of this country and abroad, and his experience with the many young men who have been associated with him, enable him to speak on this subject with interest and weight.

ELECTRICAL HOISTING IN MINES.

At a recent meeting of the British Mining Institution an interesting paper was read, describing an adaptation of electric driving to this work which has been developed abroad.

Method a Modification of an Older System.

The system seems to be a modification of a method of control which is well known, which has been adapted to meet the peculiar demands of this service. In the usual system of hoisting there are two cages carried on ropes wound on drums attached to the same axle. One cage is lowered as the other is being raised. At the moment of starting, the hoisting motor has not only to start the cage and overcome its inertia, but has to lift the weight of the cage and the attached rope. This makes the work at the moment of starting the greatest. As the cage rises, its rope is wound up, but that attached to the descending cage is unwound, so that a point is reached where the descending load is heavier than that rising, and this tends to run the motor as a dynamo.

Value of the System.

Starting a motor under these conditions by the usual rheostatic control is exceedingly wasteful, as the system is most inefficient at the time of greatest load. In the improved system the hoisting motor is supplied with energy from a local generator driven by a motor which draws its own power from the supply mains. This motor also drives a small exciter for furnishing exciting current for both generator and hoisting motor. The motor armature is electrically connected directly to that of the generator, and control is effected by varying the excitation of both generator and motor. This gives an efficient control. In addition, a heavy flywheel is attached to the generator shaft.

Flywheel as a Load Balancer.

The use of the flywheel here is peculiar, as it serves to store up the energy which would either be dissipated in a brake or which might be pumped back into the system. This energy stored up in the flywheel is called upon to help in the next operation of raising, and it is not quite apparent why a flywheel should be used, rather than pumping back into the system, unless it be that the chief work of the station is to operate the hoisting gear, and that there is little or no other work to take up this supply. In the discussion of the paper mention was made of storage batteries, which might be used in place of the flywheel to store up this energy, but these were thought to be unreliable. This seems rather strange, as storage batteries would seem admirably adapted for just this purpose, and would certainly be as reliable as the mechanical arrangement depended upon in the system described above, particularly as there must be some delay at each end of the trip.

MODERN VIEWS ON MATTER.

At the recent International Congress of Applied Chemistry an admirable address was delivered by Sir William Crookes, on "Modern Views on Matter," in which he reviewed the progress which had been made and explained the new ideas which are now being put forward by certain eminent physicists.

Coordination of Independent Work.

Sir William showed how the independent researches of many investigators, extending over many years and giving results of the greatest importance, are, in the light of more recent work, being coordinated. Heretofore the interrelations of these results were not understood, but now they seem to fall naturally into place and to form a good foundation upon which to erect a pretty theory.

The Pioneer Work.

Crookes, himself, first showed that when an electrical current was passed

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through a tube exhausted to a high vacuum, there was a real flow of matter in the tube. Lenard and Rœntgen showed that the phenomena outside of the vacuum tube surpassed in interest those which took place in the tube. Then came Becquerel's discovery that the salts of uranium constantly emit emanations which have the power to penetrate substances and affect a photographic plate. Following closely upon Becquerel's work, M. and Mme. Curie carried out their brilliant researches upon the radioactivity of bodies accompanying uranium. Their discoveries are of the greatest importance, as they throw much light on matters hitherto but little understood, and they have been the means of bringing together the isolated facts which previously seemed widely separated. The remarkable results obtained by these brilliant workers have naturally stimulated others to join in the great work, and many fruitful paths for investigation are being followed diligently, so that almost every week some announcement is made of a new discovery which seems to fall into its logical position.

New Theories Put Forward.

It is not to be wondered that when results are coming in so rapidly, certain minds are prone to speculate and theorize and to suggest hypotheses which seem to them to account for all these facts. But this is as it should be, and these theories are helpful so long as they are in agreement with the known facts and point out lines of work which lead to further results. If the new facts agree with the hypothesis, well and good; and if they do not, the theory has simply led to facts which prove its falsity, and in this way it has accomplished its purpose.

Stand Taken against the New Theories.

But while a theory put forward by a broad mind, cognizant of all the facts, may lead to fruitful results, speculations of every dabbler in the science can be of but little use and may even lead others astray. There are some who dread the errors which a theory based upon insufficient experimental knowledge entails, and we therefore find eminent scientists making a decided stand against the new theories put forward so enthusiastically by their framers. This point of view is useful, for not only do these conservative minds serve to balance the whole, but by taking a stand against the theory they attack the weak points and thus are the means of either bringing the whole structure to the ground or stimulating work which adds to and strengthens the theory.

New Lustre Added to Old Names.

An interesting part of Crookes' address was that in which he pointed out how the mere suggestions and speculations of Davy, Faraday and others seem to fit in with the newer ideas. How much we are warranted in drawing from those statements which heretofore have seemed vague it is impossible to say at this time, but it is, to say the least, pleasing to find that even in the newest theories we are still reminded of the work of those great men who did so much to build up physical science in the early part of the last century. The magnificent work of recent years has added to the lustre of the old names, so that to-day they shine more brightly than ever before.

SHOULD TECHNICAL COURSES BE BROADENED OR SPECIALIZED?

Throughout the several excellent papers on engineering education read at the joint meeting of the American Institute of Electrical Engineers and the Society for the Promotion of Engineering Education, there was a plea for broadness in the education of engineering students. While one paper would treat the subject from one point of view and suggest one way of accomplishing what seemed to the author desirable results, others would suggest other ways of broadening the course, with an entirely different end in view. Some thought that the course should be broadened so as to make the graduate more valuable immediately after graduation. Others looked to the future and planned for ultimate results rather than immediate returns.

Useful Studies Suggested.

Those who looked to more immediate results suggested the addition of courses such as elementary law, business methods, accounting, which would give the student some familiarity with ordinary business processes. Work of this character can only be introduced into a technical course at the expense of instruction which has up to this time been considered essential. While it would be broadening in the sense that it deals with subjects other than a narrow line of engineering work, in another sense it might be narrowing by cutting out work which, although technical, lies in a branch of engineering other than the special line which the student is preparing for.

Broader Men Asked For.

Those who took the other stand and asked for a broader preparation, so that broader men might result, suggested the introduction of general non-technical courses at the expense of specialized work. This policy, if adopted, would turn out young men with an excellent preliminary training, but who, on account of the limitations in time, could have but little training in any special branch of work. Such men might, of course, follow up their preparatory work by a post-graduate course along some special line. This, however, would merely amount to adding one or two years to the present four-year course. It would keep the young man that much longer at college, at the expense of practical work.

Disadvantages of Additional College Work.

This would not be a serious matter if there was not such an insistent demand for men with technical training and if the working lifetime were not shortened by that amount given to study. It was undoubtedly surprising to the many eminent teachers present to have these ideas expressed so forcibly and so frequently. For some years past there has been a demand for students with a specialized training. The young men have been told to learn one thing and to learn it well, and these teachers have done their best to satisfy this seeming need. They know probably better than any other class of men the disadvantages of the narrow courses which must be followed if the student is to cover what seems to be absolutely essential. The idea of a four-year college course, followed by a two-year engineering course, is not new, but conditions have not seemed to warrant this arrangement.

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Practical Telephone Engineering—III.

By William W. Handy.

THE exchange locations and equipment, the subway and cable systems, pole lines and other matters of general design of a telephone plant having been determined upon, the next features to be considered by the engineer are the details of all construction and apparatus to be installed.

SUBWAY.

There are several forms of construction adopted by modern practice for underground conduit work, all of which have their respective advantages. These are briefly as follows: Single-duct vitrified clay conduit, multiple-duct vitrified clay conduit, creosoted wood conduit, iron tube cement-lined pipe, and bituminized fibre conduit, the latter being used more for lateral connections than for the main conduit lines.

The single-duct vitrified conduit has a circular section inside, the diameter generally used being three and one-quarter inches, while for the multiple duct the holes are square, the dimensions being generally three and three-eighths inches. The capacity of the square-hole conduit is about twenty-five per cent greater than the round-hole duct. It is almost impossible to draw more than one cable into a round-hole duct, due to the fact that the cable tends to follow around the circular wall of the duct spirally, completely blocking the duct and preventing the second cable from entering. With the square-hole duct this is not the case, and the area being larger, it is often possible to draw in more than one cable provided that the cables are small. However, for the main conduit lines the cables are mostly 200-pair or over, and therefore even the square duct would not hold more than one cable. The selection of single or multiple duct is generally decided by the comparative cost of the conduit, the cost of laying it, and various other matters such as the possibility of the ducts getting out of line and becoming clogged. Often in a conduit line constructed of single ducts, one of the ducts may get out of line without interfering with the others, while in a multiple-duct line if one section is disturbed the total number of ducts may be thrown out of line, thereby necessitating digging up the conduit for repairs. The multiple-duct conduit is generally wrapped at the joints with burlap saturated in tar, which quite effectively prevents cement or dirt from getting into the ducts. This advantage, however, is often made impossible by careless workmanship. In lines composed of single ducts, a layer of cement is put over each layer of duct and on the sides of the conduit, without covering the joints previously, and if these joints should not be fitted together closely or the ends of the sections be broken, cement would get into the ducts thereby clogging them. For this reason it is always necessary in conduits constructed in this way to clean the ducts very carefully before the cables are drawn in. This item of cleaning should be considered, as the expense for a large system is considerable. There is, therefore, as may readily be seen from the above and various other features which the writer has not mentioned, ample reason for a great diversity of opinion among engineers as to the best form of vitrified duct.

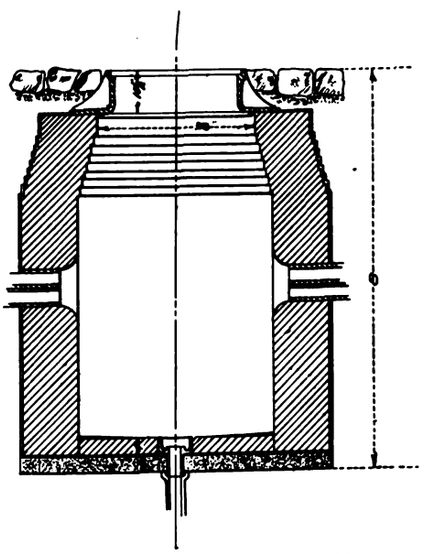

FIG. 6.—CONSTRUCTION FOR SMALL MANHOLE.

Creosoted wood and fibre conduit has a number of advantages, some of these are briefly as follows: There is less chance of electrolytic injury to the lead cables contained in the ducts; the joints of the conduits are self-aligning and fairly tight; the inside surface is non-abrasive, thereby, to a great extent, preventing injury to the lead covering of cables; the sections are longer than the other forms of ducts and very light, which makes the cost of laying less than the heavier clay conduit. The bituminized fibre conduit is manufactured in a number of sizes, having, approximately, inside diameters of two, two and one-half, three and three and one-half inches, and is also made up into a number of elbows and bends of various angles, making it particularly applicable for lateral connections.

For lines made up of single-duct clay conduit, the ducts should be laid on a four-inch concrete foundation surfaced with cement mortar to form a proper bed for the ducts. Each layer should be covered with cement mortar before the next layer is put in place, and the conduit, when completed, covered with cement mortar on both top and sides. Around this should be filled in with a three-inch layer of concrete. This gives the most substantial construction, but it is sometimes customary to omit the concrete covering from the sides and top, concrete being laid only in the bottom of the trench.

All trenches should be dug to a depth sufficient to allow for the proper laying of the conduit and of a width sufficient to allow a space of at least four inches on either side thereof. It is generally best for the trenches to be sufficiently deep to place the conduits below other subsurface work, such as other lines and water and gas pipes, as the conduits are less liable to injury when placed at this depth.

For multiple-duct lines the construction is the same, with the exception that the joints are wrapped and the cement between layers is omitted.

In lines constructed of other material, such as creosoted wood and fibre, it is often customary to omit the concrete entirely, which makes the construction very much less costly, but not so substantial.

In the business districts of cities it is common practice to install two conduit lines, one directly on top of the other, the lower being used for the main cables, and the upper line composed generally of only a few ducts being used for the distributing cables. Junction boxes, constructed either of brick, terra-cotta or iron, are placed at frequent intervals on this upper line, and underground lateral connections made from them to adjacent buildings. This system of construction is not often used in subway systems intended for telephone distribution alone, but has been employed for municipal subway systems, which are intended to carry telephone, telegraph and electric light and power cables.

Manholes should be built on a four-inch concrete foundation with thirteen and one-half inch brick walls plastered on the outside, and the bottom of the manholes covered with a layer of brick placed on edge and grouted in and then covered with cement. A four-inch drain trap should be placed at the bottom of each manhole,

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and connected with a four-inch terra-cotta pipe connecting with a sewer. Manholes are covered in several ways. For very small sizes it is sufficient to draw in the walls at the top, as illustrated in Fig. 6, leaving an opening of the proper size to fit the manhole cover. In larger sizes other construction must be used, and the designs shown in Figs. 7 and 8 illustrate good types. In Fig. 7 the end walls are arched over to meet the iron beams at the centre, brick or terra-cotta arches being thrown between these beams to cover the manhole at the sides, an opening being left between these arches, above which is placed the cover. Fig. 8 shows a similar form of construction to this, with the exception that channel irons are placed on the end walls and brick or terra-cotta arches built between them and the central beams. All beams should be connected by

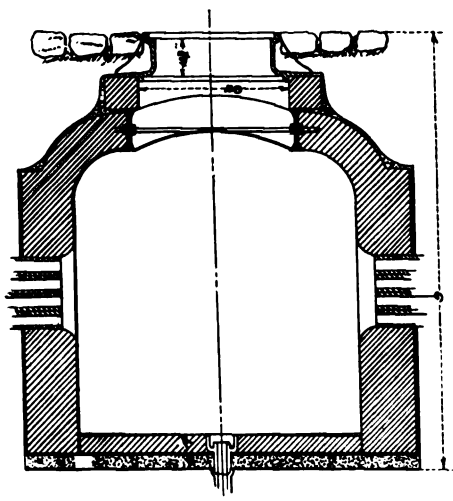

FIG. 7.—ARCHED CONSTRUCTION FOR LARGE MANHOLE.

tie-rods, as shown, to prevent settling of the arches. Modern practice seems to have selected an elliptical form of manhole as the best design. This makes the walls very strong and in addition does away with square corners and sharp bends in the cables, which latter are supported on the manhole walls. It is often found, however, due to gas and water pipes, which sometimes run directly through the manholes parallel to the walls, that it is a better design to make the walls straight instead of elliptical. The depth of the manholes should always be, if possible, several feet lower than the bottom of the entering conduits. This is advisable in order to handle the cables properly, and to prevent water from running out of the manhole through the ducts. Manholes should never be made any smaller than absolutely necessary, as it is often impossible, due to the small space available, to properly distribute the cables around the walls and at the same time leave room for a man to work to advantage.

DISTRIBUTING TERMINALS.

Distributing pole construction is illustrated in Fig. 9. The connection from the conduit manhole being a single wrought-iron pipe through which the cable is drawn to the terminal at the top. There are many forms of terminals, all of

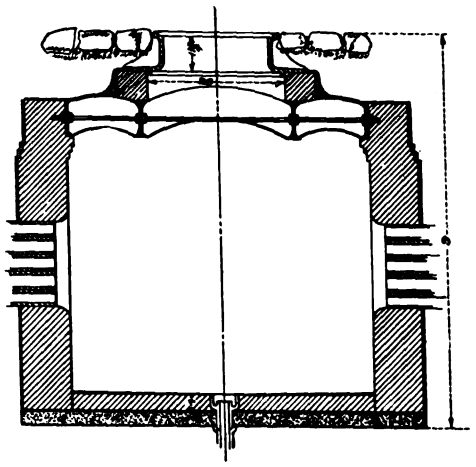

FIG. 8.—USE OF CHANNEL IRONS IN MANHOLE CONSTRUCTION.

which have their advantages. From the terminal the subscribers' wires are fastened to the insulators supported on the distributing ring, and from there are distributed to the subscribers' telephones by means of bare or insulated wire.

Where underground lateral connections are made directly from the conduit to buildings, the cables are brought direct to iron terminals located in the buildings. These terminals may sometimes be located in the manholes themselves and small cables brought from them through the lateral connections to other smaller terminals inside the buildings, from which the wires are carried to the subscribers'

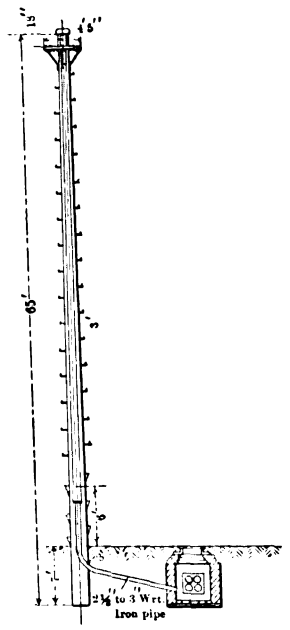

FIG. 9.—DISTRIBUTING POLE.

telephones. For large office buildings an iron terminal should be placed in the basement, and rubber-covered cables carried from this terminal to distributing terminals located on the different floors. If the distribution is to be made from an iron terminal in one building to all the other subscribers located in the same block, these rubber-covered cables may be carried through the walls between the buildings and branch wires taken from them to the telephones. If it is found impossible to run the wires in this way through the building walls, the terminals may be located on the rear wall of a certain building, and the wires distributed from the terminal so located along the outside walls to the telephones. In some cases it is common practice to obtain permission from the owner of a high building to locate a terminal on the roof, carrying the cable from the conduit up through the building to this terminal, and distributing from it to the telephones located in

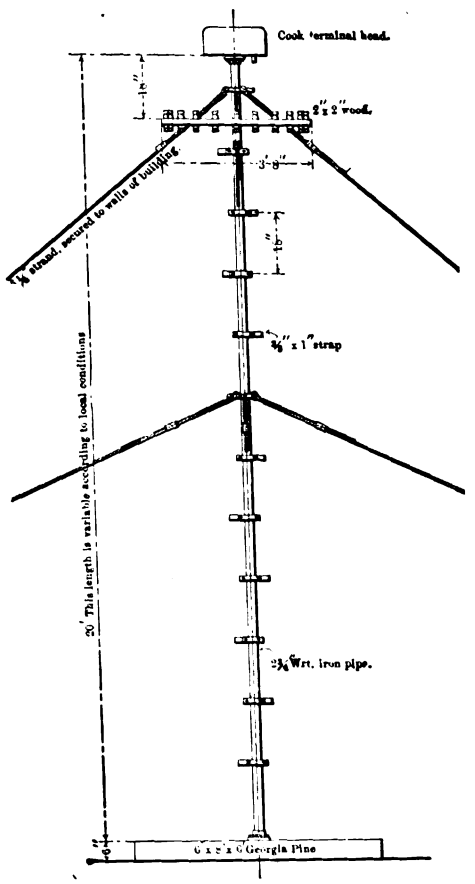

FIG. 10.—DISTRIBUTING POLE FOR HOUSE TOP.

the block. A terminal of this description is illustrated in Fig. 10.

POLE LINE CONSTRUCTION.

The details of pole line construction are so well known that it hardly seems advisable to say much on this subject. Modern practice has adopted wherever possible shorter poles, not only due to the decreased first cost, but also to the smaller cost of maintenance. Short poles, however, can only be used on lines in suburban districts, and where there are no other lines over which the wires must be carried. Chestnut has the longest life and should therefore be used wherever possible, but the kind of pole depends very largely on the locality. Canadian cedar has nearly as long a life as chestnut, and for plants in extreme northern localities should be used. Cypress and juniper poles are used extensively in the South, the juniper poles having become very popular and extensively used within the last few years. All poles

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should be well seasoned before setting them in the ground, and before seasoning should be peeled and the knots trimmed off. Various preserving processes have been used for increasing the life of poles, the best known being creosoting, which has been used to some extent in this country recently for distributing poles, but has not been used much for pole line work due to the increased first cost. It is quite customary for some companies to coat the poles with pitch for about six or seven feet from the butt before setting, and this very materially prolongs the life of the pole. All poles used in cities should be painted if possible. This increases the life to some extent and very much adds to the appearance.

Standard pole construction is shown in Fig. 11 for a fifty-foot pole, which should be set in the ground at a depth of not less than six feet. The pole is provided with standard ten-pin yellow pine cross-arms, fastened to the pole by through bolts, and held in place by galvanized braces; pole steps of nine-sixteenths-inch iron should be used, and for a short distance above the ground butt steps of some approved design. The diameter of pole at the top should be not less than seven inches, and six feet from the butt from fourteen to sixteen inches. All pole lines should be properly braced by means of guy wires at the end poles and on corners. Sometimes for the end poles, instead of the ordinary method of guying, an anchor pole of construction similar to that illustrated in Fig. 12 is provided. This makes a very substantial construction, and presents a much better appearance than the ordinary guy wire construction.

For distributing subscribers' wires from aerial cables, terminals are installed on poles selected for this purpose, the

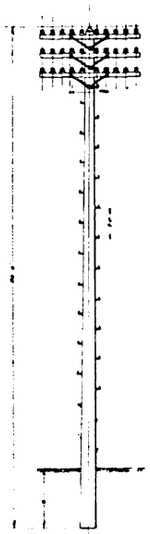

FIG. 11.—STANDARD TELEPHONE POLE.

cables or branches from them being connected to these terminals and the subscribers' wires carried from them along the pole lines. An example of terminal pole construction is illustrated in Fig. 13.

CABLE WORK.

For underground cables, each conductor should be of soft-drawn copper No. 20 B. & S. gauge, and insulated with two wraps of paper, the wires being twisted together in pairs. The core formed of these twisted pairs of wires to be covered with two wraps of paper, and enclosed in a sheath of commercially pure lead, having a thickness of about one-eighth inch for the large cables and one-tenth inch for the smaller cables below about fifty pairs. Aerial cables should have the sheath made of lead with an admixture of about three per cent of tin, the thickness of the sheath being somewhat less than used for the underground cables.

EXCHANGE EQUIPMENT.

Central energy switchboards have been adopted almost universally for large mod-

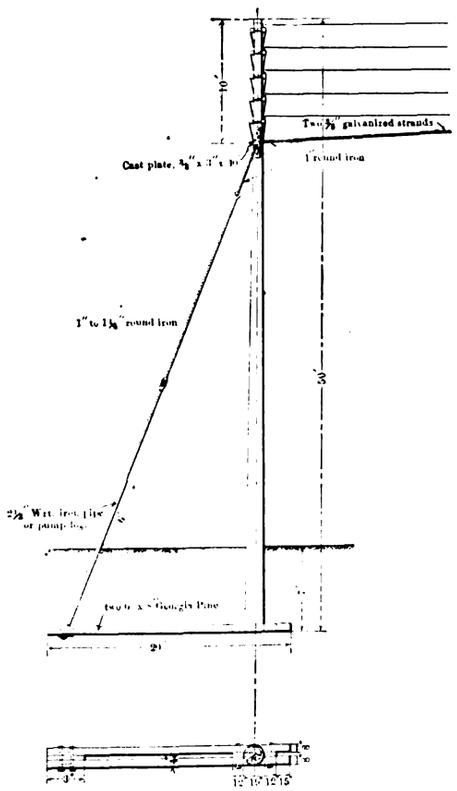

FIG. 12.—ANCHOR PLATE FOR END POLE.

ern work, and to illustrate as briefly as possible one of these boards, we will take as an example the equipment required for the main exchange described in the last article on this subject. This exchange was intended to have an immediate capacity of 4,320 lines and an ultimate capacity of 6,000 lines, and to connect with two other exchanges, one having a capacity of 1,920 immediate and 2,880 ultimate, and the other a capacity of 720 immediate and 1,120 ultimate. The equipment, therefore, in addition to the main switchboard requires an incoming trunking board of about two sections. The main board should have eighteen sections multipled with each other, each section being equipped with drops for 240 lines and space left for additional drops to a capacity of 300 lines. The total immediate capacity of this board would therefore be 4,320 lines, and sufficient blank space for additional jacks must be left at the top of the board to increase its capacity if necessary to 6,000 lines.

Each section of the switchboard should be provided with thirty pairs of cords and plugs, with corresponding listening-in keys and outgoing call keys, and with supervisory relays and lamps.

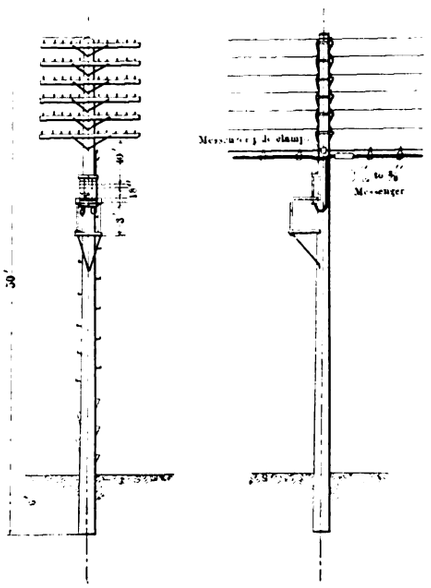

FIG. 13.—TERMINAL POLE FOR AERIAL CABLE.

Each line must be provided with a relay, which will operate by the insertion of a plug into one of the jacks connected to the line and cut off the calling annunciator belonging to that line.

The board should be provided complete with about 130 outgoing trunk lines, multipled at each section, and for this purpose the necessary jacks should be provided at each operator's position. The separate trunking board for the incoming trunk calls should be of the same design as the main board, having a capacity of 480 lines and spaced for six operators. This board to have multiple jacks arranged as on the main board, and answering or trunk line jacks.

The manager's desk should be equipped so that he can talk to each operator on both main and trunking boards. Motor-generating sets for ringing subscribers should be provided in duplicate. Also two sets of storage battery, each of a capacity sufficient for the exchange requirements. A power board for the operation of the motor generators, batteries and lights must also be provided.

The distributing board should be of ample capacity, say 8,000 lines, and so designed that it will never be necessary to interfere with the main switchboard wiring.

There are many other details in connection with a switchboard of this design which the writer has not discussed, as it would take much more space than is available for the present article. Careful consideration, however, should be given to the details of the calling system, clearing-out system, lamp signals, subscribers' drops, busy test, wiring, jacks, plug cords and other matters.

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MODERN VIEWS ON MATTER—THE REALIZATION OF A DREAM.[1]

BY SIR WILLIAM CROOKES.

For nearly a century men who devote themselves to science have been dreaming of atoms, molecules, ultramundane particles, and speculating as to the origin of matter; and now to-day they have got so far as to admit the possibility of resolving the chemical elements into simpler forms of matter, or even of refining them altogether away into ethereal vibrations or electrical energy.

This dream has been essentially a British dream, and we have become speculative and imaginative to an audacious extent, almost belying our character of a purely practical nation. The notion of impenetrable mysteries has been dismissed. A mystery is a thing to be solved—"and man alone can master the impossible." There has been a vivid new start. Our physicists have remodeled their views as to the constitution of matter and as to the complexity if not the actual decomposability of the chemical elements. To show how far we have been propelled on the strange new road, how dazzling are the wonders that waylay the researcher, we have but to recall—matter in a fourth state, the genesis of the elements, the dissociation of the chemical elements, the existence of bodies smaller than atoms, the atomic nature of electricity, the perception of electrons, not to mention other dawning marvels far removed from the lines of thought usually associated with English chemistry.

The earliest definite suggestion in the last century of the possible compound nature of the metals occurs in a lecture delivered in 1809 by Sir Humphry Davy at the Royal Institution. In that memorable lecture he speculated on the existence of some substance common to all the metals, and he averred that "if such generalizations should be supported by facts, a new, a simple and a grand philosophy would be the result. From the combination of different quantities of two or three species of ponderable matter we might conceive all the diversity of material substances to owe their constitution."[2]

Again, in 1811, he said: "It will be useless to speculate upon the consequences of such an advancement in chemistry as that of the decomposition and composition of the metals. . . . It is the duty of a chemist to be bold in pursuit. He must not consider things as impracticable merely because they have not yet been effected. He must not regard them as unreasonable because they do not coincide with popular opinion. He must recollect how contrary knowledge sometimes is to what appears to be experience. . . To enquire whether the metals be capable of being decomposed and composed is a grand object of true philosophy."[1]

Davy first used the term "radiant matter" about 1809, but chiefly in connection with what is now called radiation. He also used the term in another sense, and the following passage in its clear forecast is prophetic of the modern electron: "If particles of gases were made to move in free space with an almost infinitely great velocity *i. e.*, to become radiant matter—they might produce the different species of rays, so distinguished by their peculiar effects."[2]

In his lectures at the Royal Institution, in 1816, "On the General Properties of Matter," another prescient chemist, Faraday, used similar terms when he said: "If we conceive a change as far beyond vaporization as that is above fluidity, and then take into account also the proportional increased extent of alteration as the changes rise, we shall, perhaps, if we can form any conception at all, not fall far short of radiant matter; and as in the last conversion many qualities were lost, so here also many more would disappear." Again, in one of his early lectures he strikes a forward note: "At present we begin to feel impatient, and to wish for a new state of chemical elements. To decompose the metals, to reform them, and to realize the once absurd notion of transmutation, are the problems now given to the chemist for solution."

A year later Faraday startled the world by a discovery to which he gave the title "on the magnetization of light and the illumination of the magnetic lines of force." For fifty years this title was misunderstood and was attributed to enthusiasm or confused ideas. But to-day we begin to see the full significance of the Faraday dream.

In 1879, in a lecture I delivered before the British Association[3] at Sheffield, it fell to my lot to revive "radiant matter." I advanced the theory that in the phenomena of the vacuum tube at high exhaustions the particles constituting the cathode stream are not solid, nor liquid, nor gaseous, do not consist of atoms propelled through the tube and causing luminous, mechanic or electric phenomena where they strike, "but that they consist of something much smaller than the atom—fragments of matter, ultra-atomic corpuscles, minute things, very much smaller, very much lighter than atoms—things which appear to be the foundation-stones of which atoms are composed."[1]

I further demonstrated that the physical properties of radiant matter are common to all matter at this low density. "Whether the gas originally under experiment be hydrogen, carbon dioxide or atmospheric air, the phenomena of phosphorescence, shadows, magnetic deflection, etc., are identical." Here are my words, written nearly a quarter of a century ago: "We have actually touched the borderland where matter and force seem to merge into one another—the shadowy realm between the known and unknown. I venture to think that the greatest scientific problems of the future will find their solution in this borderland, and even beyond; here, it seems to me, lie ultimate realities, subtle, far-reaching, wonderful."[2]

The now generally accepted view that our chemical elements have been formed from one primordial substance was advocated in 1888 by me when president of the Chemical Society, in connection with a theory of the genesis of the elements. I spoke of "an infinite number of immeasurably small ultimate—or, rather, ultimatissimate—particles gradually accreting out of the formless mist, and moving with inconceivable velocity in all directions."[3]

Pondering on some of the properties of the rare elements, I strove to show that the elementary atoms themselves might not be the same now as when first generated; that the primary motions which constitute the existence of the atom might slowly be changing, and even the secondary motions which produce all the effects we can observe—heat, chemic, electric and so forth—might in a slight degree be affected; and I showed the probability that the atoms of the chemical elements were not eternal in existence, but shared with the rest of creation the attributes of decay and death.

Our minds are gradually getting accustomed to the idea of the genesis of the elements, and many of us are straining for the first glimpse of the resolution of the chemical atom. We are eager to enter the portal of the mysterious region too

[1] An address delivered before the Congress of Applied Chemistry at Berlin, June 5, 1903.

[2] "Works of Sir Humphry Davy," vol. viii, p. 325.

[1] *Loc cit.*, vol. viii, p. 330.

[2] *Loc cit.*, vol. viii, p. 349.

[3] "British Associations Reports," Sheffield meeting, 1879. *Chemical News*, vol. xl, p. 91. *Phil. Trans. Roy. Soc.*, 1879, Part I, p. 585. *Proc. Roy. Soc.*, 1880, No. 205, p. 469.

[1] Sir O. Lodge, *Nature*, vol. lxvii, p. 451.

[2] "Matter is but a mode of motion" (*Proc. Roy. Soc.*, No. 205, p. 472).

[3] Pres. address to Chem. Soc., March 28, 1888.

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readily ticketed "unknown and unknowable."

Another phase of the dream now demands attention. I come to the earlier glimpses of the electric theory of matter.

Passing over the vaguer speculations of Faraday and the more positive speculations of Sir William Thomson (now Lord Kelvin), one of the earliest definite statements of this theory is given in an article in the *Fortnightly Review* for June, 1875, by W. K. Clifford—a man who in common with other pioneers shared that "noblest misfortune of being born before his time." "There is great reason to believe," said Clifford, "that every material atom carries upon it a small electric current, if it does not wholly consist of this current."

The idea of units or atoms of electricity—an idea hitherto floating intangibly like helium in the sun—can now be brought to earth and submitted to the test of experiment.[1] Faraday, W. Weber, Laurentz, Gauss, Zöllner, Hertz, Helmholtz, Johnstone Stoney and Sir Oliver Lodge have all contributed to develop the idea—originally due to Weber—which took concrete form when Stoney showed that Faraday's law of electrolysis involved the existence of a definite charge of electricity associated with the ions of matter. This definite charge he called an electron. It was not till some time after the name had been given that electrons were found to be capable of existing separately.

In 1891, in my inaugural address as president of the Institution of Electrical Engineers,[2] I showed that the stream of cathode rays near the negative pole was always negatively electrified, the other contents of the tube being positively electrified, and I explained that "the division of the molecule into groups of electro-positive and electro-negative atoms is necessary for a consistent explanation of the genesis of the elements." In a vacuum tube the negative pole is the entrance and the positive pole the exit for electrons. Falling on a phosphorescent body, yttria, for instance—a collection of Hertz molecular resonators—the electrons excite vibrations of, say, 550 billion times a second, producing ether waves of the approximate length of 5.75 ten millionths of a millimetre, and occasioning in the eye the sensation of citron-colored light. If, however, the electrons dash against a heavy metal or other body which will not phosphoresce, they produce ether waves of a far higher frequency than light, and are not continuous vibrations, but, according to Sir George Stokes, simple shocks or solitary impulses; more like discordant shouts as compared with musical notes.

In the years 1893-5 a sudden impulse was given to electric vacuum work by the publication in Germany of the remarkable results obtained by Lenard and Rœntgen, who showed that the phenomena inside the vacuum tube were surpassed in interest by what took place outside. It is not too much to say that from this date what had been a scientific conjecture became a sober reality.

In 1896 Becquerel, pursuing the masterly work on phosphorescence inaugurated by his illustrious father, showed that the salts of uranium constantly emit emanations which have the power of penetrating opaque substances and of affecting a photographic plate in total darkness, and of discharging an electrometer. In some respects these emanations, known as Becquerel rays, behave like rays of light, but they also resemble Rœntgen rays. Their real character has only recently been ascertained, and even now there is much that is obscure and provisional in the explanation of their constitution and action.

Following closely upon Becquerel's work came the brilliant researches of M. and Mdme. Curie on the radioactivity of bodies accompanying uranium.

Hitherto I have been recounting isolated instances of scientific speculation with apparently little relation to one another. The existence of matter in an ultra-gaseous state; material particles smaller than atoms; the existence of electrical atoms or electrons; the constitution of Rœntgen rays and their passage through opaque bodies; the emanations from uranium; the dissociation of the elements—all these isolated hypotheses are now focused and welded into one harmonious theory by the discovery of radium.

> Often do the spirits
> Of great events stride on before the events,
> And in to-day already walks to-morrow.

No new discovery is ever made without its influence ramifying in all directions and explaining much that before had been mystifying. Certainly no discovery of modern times has had such wide-embracing consequences, and thrown such a flood of light on broad regions of hitherto inexplicable phenomena, as this discovery of M. and Mdme. Curie and M. Bémont, who patiently and laboriously plodded along a road bristling with difficulties almost insuperable to others who, like myself, have toiled in similar labyrinths of research. The crowning point of these labors is radium.

Let me briefly recount some of the properties of radium, and show how it reduces speculations and dreams, apparently impossible of proof, to a concrete form.

Radium is a metal of the calcium, strontium and barium group. Its atomic weight according to C. Runge and J. Precht is probably about 258.

The spectrum of radium has several well-defined lines; these I have photographed and have also measured their wave-lengths. Two especially are strong and characteristic. One at wave-length 3,649.71 and the other at wave-length 3,814.58. These lines enable radium to be detected spectroscopically.

The emanations cause soda-glass to assume a violet color, and they produce many chemical changes. Their physiological action is strong, a few milligrammes brought near the skin in a few hours producing a wound difficult to heal.

The most striking property of radium is its power to pour out torrents of emanations bearing a certain resemblance to Rœntgen rays, but differing in important points.

The emanations from radium are of three kinds. One set is the same as the cathode stream now identified with free electrons—atoms of electricity projected into space apart from gross matter—identical with "matter in the fourth or ultragaseous state," Kelvin's "satellites," Thomson's "corpuscles" or "particles," Lodge's "disembodied ionic charges, retaining individuality and identity." These electrons are neither ether-waves nor a form of energy, but substance possessing inertia (probably electric). Liberated electrons are exceedingly penetrating. They will discharge an electroscope when the radium is ten feet or more away, and will affect a photographic plate through five or six millimetres of lead and several inches of wood or aluminum. They are not readily filtered out by cotton-wool;

[1] "The equivalent weights of bodies are simply those quantities of them which contain equal quantities of electricity: . . . . it being the electricity which determines the equivalent number, because it determines the combining force. Or, if we adopt the atomic theory or phraseology then the atoms of bodies which are equivalents to each other in their ordinary chemical action, have equal quantities of electricity naturally associated with them."—Faraday's "Experimental Researches in Electricity" par. 869, Jan., 1834. "This definite quantity of electricity we shall call the molecular charge. If it were known it would be the most natural unit of electricity."—Clerk Maxwell's "Treatise on Electricity and Magnetism," First Edition, vol. i, 1873, p. 311. "Nature presents us with a single definite quantity of electricity . . . . For each chemical bond which is ruptured within an electrolyte a certain quantity of electricity traverses the electrolyte, which is the same in all cases."—G. Johnstone Stoney, "On the Physical Units of Nature," British Association meeting, Section A, 1874. "The same definite quantity of either positive or negative electricity moves always with each univalent ion, or with every unit of affinity of a multivalent ion."—Helmholtz, Faraday Lecture 1881. "Every monad atom has associated with it a certain definite quantity of electricity; every dyad has twice this quantity associated with it; every triad three times as much and so on."—O. Lodge, "On Electrolysis," *British Association Report*, 1885.

[2] "Electricity in Transitu: from Plenum to Vacuum" (*Journ. Inst. Electrical Engineers*, vol. xx, p. 10, January 15, 1891).

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they do not behave as a gas, *i. e.*, they have not properties dependent on inter-collisions, mean free path, etc.; they act more like a fog or mist, are mobile and carried about by a current of air to which they give temporary conducting powers, clinging to positively electrified bodies and thereby losing mobility, and diffusing on the walls of the containing vessel if left quiet.

Electrons are deviable in a magnetic field. They are shot from radium with a velocity of about one-tenth that of light. but are gradually obstructed by collisions with air atoms, so that some become much slowed, and then are what I formerly called loose and erratic particles, which diffuse about in the air, and give it temporary conducting powers. These can turn corners, can be concentrated by mica cones into a bundle and then produce phosphorescence.

Another set of emanations from radium are not affected by an ordinarily powerful magnetic field, and are incapable even of passing through thin material obstructions. These emanations have about one thousand times the energy of those radiated by the deflectable particles. They render air a conductor and act strongly on a photographic plate. Their mass is enormous in comparison with that of the electrons, and their velocity is probably as great when they leave the radium, but, in consequence of their greater mass, they are less deflected by the magnet, are easily obstructed by obstacles, and are sooner brought to rest by collisions with air atoms. The Hon. R. B. Strutt[1] was the first to affirm that these non-deflectable rays are the positive ions moving in a stream from the radioactive body.

Rutherford has shown that these emanations are slightly affected in a very powerful magnetic field, but in an opposite direction to the negative electrons. They are therefore proved to be positively charged bodies moving with great velocity. For the first time Rutherford has measured their speed and mass, and he shows they are ions of matter moving with a speed of the order of that of light.

There is also a third kind of emanation produced by radium. Besides the highly penetrating rays deflected by a magnet, there are very penetrating rays not at all affected by magnetism. These accompany the previous emanations, and are Rœntgen rays—ether vibrations—produced as secondary phenomena by the sudden arrest of velocity of the electrons by solid matter, producing a series of Stokesian "pulses" or explosive ether-waves shot into space.

[1] *Phil. Trans. R. S.*, A, 1901, vol. cxcvi, p. 525.

(To be concluded.)

New Illuminating Material Discovered.

An important discovery has been made by the well-known German chemist Hermann Blau, of Bavaria, writes Consul-General James H. Worman, under date of June 13, from Munich, Germany. His method is to separate, by a process of rectification, the methane and hydrogen from the other constituents of oil gas, collecting the same in steel receivers subject to a pressure of forty atmospheres, whereby he converts it into liquid form.

A comparison of the cost of the various illuminating materials is shown in a table drawn up by Fischer in his "Chemical Manual" (1900):

Per 100 heat units.	Cost.	
	Pfennigs.	Cents.
With petroleum burners:		
Flat	13.2	3.14
Round	7.3	1.73
With incandescent alcohol	9.1	2.16
With coal gas	4.5	1.06
With electricity	27.3	6.49
With acetylene	9 to 16	2.14 to 3.81

With the liquefied gas made according to Blau's method, the cost is reduced to 6.3 pfennigs (1.5 cents), including freight.

As seen from the above table, this new illuminating material compares very favorably in cost with all others. The ease with which it can be handled and the beauty of its light should make it preferable where a lighting material is wanted as a substitute for petroleum, alcohol or acetylene.

As Blau's light is much more easily turned on or off, it is certainly more convenient. Its low cost and its beautiful color may give it preference even to the electric light. It will undoubtedly open a new field of industry and should be promptly looked into as an enterprise and investment for Americans.

On December 24, 1902, a test was had for the first time to produce the liquefied gas. The trial showed how practical and very simple the process of preparation was. It has since been decided to erect an oil-gas furnace and to reconstruct the rectifying apparatus in accordance with the practical observations obtained by the experiments of last December.

A new test has recently been made and shows a most marked improvement and a remarkable productive power in every respect. It was also found that by the addition of a considerable amount of tar, which is in no wise detrimental, a beautiful yellow color was given to the gas.

A test tube filled with the liquefied gas needed only the warmth of the hand to cause it to effervesce. It also effervesced when poured upon a metallic plate and on water. In the latter case a crust of ice was formed.

Its odor is pyroligneous aromatic. The concentration amounted to 537 grammes instead of 550 grammes per litre under a pressure of forty atmospheres. The specific gravity, when in a gaseous state, was 1.26 (taking air at 1); absolute weight, 1.03.

The trial whose result was so satisfactory was carried out in the Holshaeuerschen (Maschinenfabrik) Machine Works of Bavaria, built for the apparatus and which are now backing the project.

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The more the world knows of engineering, the more it will need it. The progressive engineer will also seek to belong to organizations which will bring him into contact with business men and he will certainly become a member of the local engineering society and one or more of the national organizations.

One real reason for the slow advancement of some engineers is that they are not as wide-awake as they might be to opportunities for improving their situation. Business men seek to sell their goods at the highest price and the best possible terms. They are constantly on the outlook for new customers. There is no reason why an engineer should not pursue the same course in regard to his services, which are his goods. A personal application or a carefully written letter does not cost much and may be the means of a considerable advance. The discontented grumbling so often heard among salaried men could well be replaced by a cheerful effort to find something better. The present will seem more bearable, the future more hopeful and better work will be done. A safe rule for the beginner would be, first catch your job and then get a better one.

The foregoing may be ridiculed as "get there" preachifying from one who has not got so very far. The writer has, however, only endeavored to apply the principles of successful business promotion to the personal promotion of engineers, having in mind praticularly the young engineers who may read this article. Critics may also be reminded that we have Mr. Carnegie's authority for the statement that thrift is a duty and a competence an indispensable element of a happy life. A technical college education is desirable for many ends other than money getting, but that is no good reason why you should not make all the money out of it that you can.—*George H. Gibson in the Michigan Technic.*

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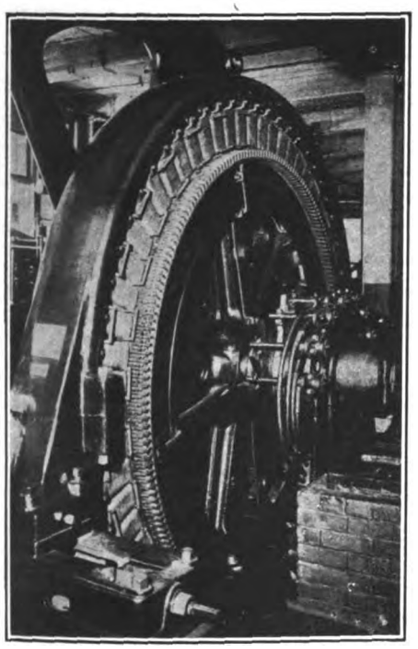
MORGAN STEAM POWER PLANT.

BY C. P. NEWTON.

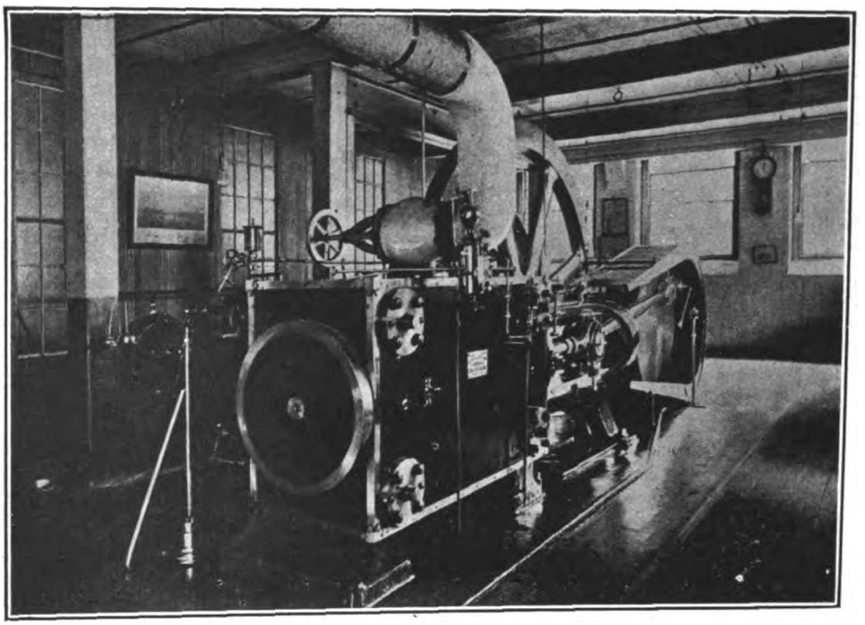
This plant, known as the Morgan Steam Power Plant, consists of twelve buildings, which are rented to small manufacturers, retail stores, offices, etc. Power is furnished from a central plant, formerly transmitted through shafting and belting from building to building. In May, 1900, a contract was made with the Westinghouse Electric and Manufacturing Company for the following electric machines, installed by the writer, and put in commission January 1 to March 15, 1901.

The new plant consists of one 200-kilowatt, 220-volt, two-phase, 7,200-alternation, sixty-two-pole generator, direct-connected to a 20 by 24-inch Hewes & Phillips Corliss engine, running at 116 revolutions per minute. This unit is for the main power. Current for incandescent lights through most of the year is taken from this unit.



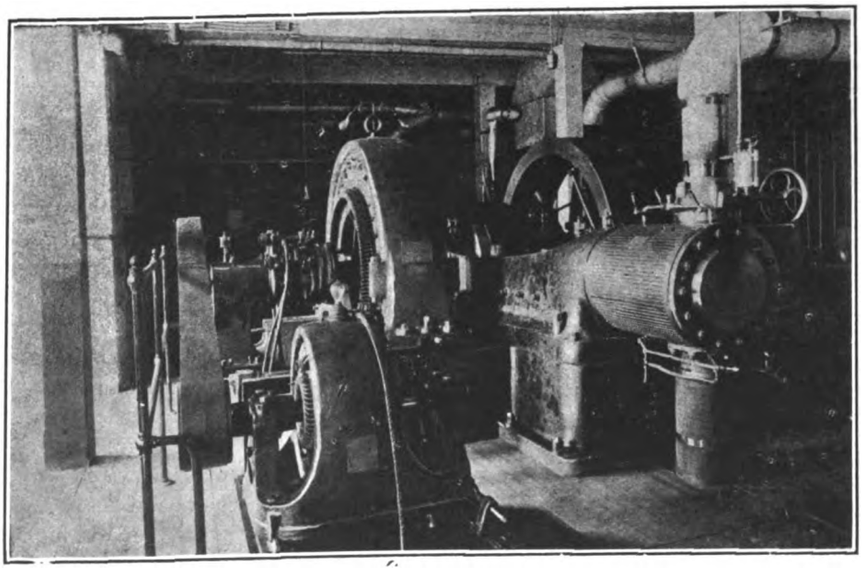
TWO-PHASE GENERATOR, 200 KILOWATTS, 220 VOLTS, MORGAN STEAM POWER PLANT.

For the auxiliary unit, a 125-kilowatt, thirty-pole, 220-volt, two-phase, 7,200-alternation generator is direct-connected to an 18 by 16-inch Ames Iron Works engine, running at 240 revolutions per minute. This unit is for lighting short days and also for an independent power unit. For lighting at 110 volts, two twenty-kilowatt regulating coils were installed, making a three-wire system of each phase, 110 volts each side of the neutral wire. Five twenty-horse-power, one thirty-horse-power, one forty-horse-power, one fifty-horse-power, two three-horse-power and one ten-horse-power, making eleven induction motors, were installed in the different buildings, one and two in each building, belted to line shafts, also one fifteen-horse-power, direct-coupled to a shunt generator for charging the batteries.



MAIN GENERATING SET CONSISTING OF CORLISS ENGINE DIRECT-CONNECTED TO 200-KILOWATT TWO-PHASE GENERATOR, MORGAN STEAM POWER PLANT.

A three-panel, two-inch marble switchboard was furnished, arranged so that the generators can be run in parallel, or either generator can be run on motor and lighting load, or either generator can be run on either lights or motors. The distributing switchboard was built by the writer, and is arranged so that any motor can be instantly cut out and each motor can separately be switched in circuit with a 200-ampere wattmeter, so that the work done by each motor can be indicated. The new plant was installed and the change made from the old mechanical transmission without interruption, and the tenants hardly knew when the change was made. The new plant has been in operation since January 1, 1901, without accident or shutdown of any description, minimizing the friction and being of immense advantage in cleanliness and simplicity, doing away with nearly a mile of old shafting and worn-out bearings, and belts from twelve to twenty-four inches. The largest belt running now is one twelve-inch.



AUXILIARY GENERATING SET CONSISTING OF HORIZONTAL ENGINE DIRECT-CONNECTED TO 125 KILOWATT TWO-PHASE GENERATOR AND EXCITER, MORGAN STEAM POWER PLANT.

As stated before, the motors are belted to line shafts in the different buildings which are occupied by various manufac-

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turers. The forty-horse-power motor runs one building 45 by 100 feet, eight stories high, which is occupied wholly by the Springfield Printing and Binding Company, which does a general jobbing, publishing and bookbinding business. The fifty-horse-power motor runs one building, 45 by 300 feet, and six stories high, which is occupied wholly by the Morgan envelope division of the United States Envelope Company, manufacturing toilet paper, envelopes, etc. Another building, 45 by 200 feet, and six stories high, contains machinery driven by four motors, one of thirty-horse-power, one of twenty-horse-power and two of three-horse-power. The building is occupied by the American Writing Paper and United States Envelope companies' executive offices, whip manufacturing, camera manufacturers, printers, Brooks Bank Note Company, jewelry manufacturers, etc. The other buildings are driven each by a twenty-horse-power motor, and contain various manufacturers, such as overall, butchers' frocks, photo-engraving, printing and binding, wire working, box making, cutlery and grinding, soda-water bottling, plumbing and gas fitting shops, bicycle repair shop, and general stores, all requiring a small amount of power.

Exhibit of the American Electrochemical Society.

A committee of the American Electrochemical Society has been appointed to take charge of an exhibit of the society in the Electricity Building of the Louisiana Purchase Exposition. The committee is anxious to secure all the information possible regarding the whereabouts of historical and experimental apparatus which can be exhibited either in the original form or by reproduction or by photograph. Any who will be able to make personal contributions to this collective exhibit should correspond with the secretary, Mr. C. J. Reed, 929 Chestnut street, Philadelphia, Pa.

Wireless Telegraphy Around the Pacific.

It is stated that the De Forest Wireless Telegraph Company is constructing four stations for its transpacific service by way of the Alaskan and Kamchatkan peninsulas. Two of these will be located on the American side, one at Cape Flattery and the other at Dutch Harbor, Alaska. The remaining two will be located on the other side of the ocean, one on the Kamchatkan peninsula and the other at Hong Kong. This land route has been planned to avoid the necessity of having to send messages over very great distances, as no interval between any two of the four stations is over 2,000 miles.

At the station at Cape Flattery there will be a tower 220 feet high, on a cliff 170 feet above the water. This tower has been especially designed to withstand the high winds which are frequent in this locality. This station will be equipped with a 100-horse-power generating plant.

THE PROBLEMS THAT ARE FACING THE ELECTRICAL ENGINEER OF TO-DAY AND THE QUALITIES OF MIND AND CHARACTER WHICH ARE NEEDED TO MEET THEM.[1]

BY J. G. WHITE.

The qualities of mind and of character needed by the electrical engineer of to-day are too well known to need to be specified.

He should be accurate in his calculations, thorough in his investigations, logical in his deductions, lucid and concise in his statements.

He should have untiring energy, an alert mind, abundant initiative, and reasonable self-confidence.

He should be absolutely honest in all his dealings, truthful in all statements, loyal to his clients, faithful to his employer's interests, considerate of his subordinates, diplomatic in his negotiations and tactful in all his relations.

However, instead of attempting to rear a structure on the foundation of the text assigned to us, may we not rather use it as a spring-board from which to vault into the general field under discussion to-day?

This might be summarized under the title: "What education should the electrical engineer of to-day have."

As is frequently remarked, this is the age of great industrial combinations and of specialists. Not satisfied with this, the specialists now specialize. The engineering field was formerly divided into the two general classes of military and civil engineers. From the latter gradually developed marine, mining and mechanical engineering, and as an offshoot from this last branch, there was recently added electrical engineering. Civil engineers to-day are subdivided into such classes as "hydraulic engineers," "bridge engineers," "railroad engineers," etc. We also find that electrical engineers are classified as "telegraph engineers," "electric light engineers," "electrochemical engineers," "telephone engineers," etc. A few years ago many of us would have supposed that the problems of the "telephone engineer" were those of a high-class artisan and that they would consist largely of trying to unravel tangled cobwebs of fine wires, and to understand and to be able to operate mazes of signaling, connecting and protecting devices.

In the early days it was thought that a room of almost any shape and size, with a couple of empty boxes for seats, and a switchboard of primitive design and construction, was all that was needed to make a telephone exchange. Owing to the wonderful growth of their business, telephone companies now erect buildings specially designed to meet the requirements of their exchanges, and a "telephone engineer" must know something of architecture, the strength of materials and other factors entering into modern steel building construction, and many other subjects which should be a part of a broad engineering education, but which are not ordinarily supposed to come within the province of a "telephone engineer," as narrowly applied.

It is at least equally important that other engineers who have specialized and must know well some part of the field of engineering should likewise have a general knowledge of the science and of the broad underlying principles of engineering, based on a thorough mastery of elementary mathematics, and supplemented by some study of languages, history, civics and other studies of general educational value.

The question naturally arises, how can the engineering student possibly secure a satisfactory knowledge of all of these important subjects? Much of his special knowledge must be acquired after he has commenced the practice of his profession. If unusually energetic and capable, all or any part of his education may be gained after he enters professional life, but it is preferable that his broader education be well started during his school years. For a considerable time it has been clearly recognized that law and medicine require, for general and special study, more time than is possibly available in the ordinary college course of four years.

If lawyers and doctors can afford the time and money necessary to get such educations, should not engineers, in view of the very wide range of subjects with which they must now be reasonably familiar, adopt a similar plan? The decision of this question will have to be made individually by the young men themselves, important factors being the time and money available for educational purposes.

It is well to remember, however, that more important than a knowledge of any study or group of studies is the ability to master thoroughly any subject of which a knowledge is desired.

In education especially quality is more important than quantity. A thorough mastery of arithmetic and algebra is better than a mere "pass grade" knowledge

[1] Abstract of paper read at the joint session of the American Institute of Electrical Engineers and the Society for the Promotion of Engineering Education, Niagara Falls, N. Y., July 8, 1903.

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of these and all the higher mathematics, which is then ordinarily soon forgotten.

It is better never to have seen the inside of a Latin, French or German grammar, and to use correct English, than to have the ordinary three or four years "translating knowledge" of all three of these foreign languages and still say: "I seen."

As in nearly all practical engineering problems, this one of engineering education can perhaps be best set forth by arranging a balance sheet showing the credit and debit sides. Against the extended education we have expense involved, time necessary before the earning period is reached, time required for general study which might be devoted to mastering some special branch of engineering, thus more quickly ensuring a comfortable salary, danger to health if too much study is crowded into a given period, etc. On this side also we have the danger that by widely extending the field of endeavor we may produce a student rather than an engineer, or that the work may be superficial. The importance of thoroughness is supreme.

This implies also that the education of the engineer must develop not a dreamer, but a worker, thoroughly competent in his sphere, whether great or small.

It is better for the world and for the man that he should be a high-class mechanic or artisan, with a good common school education, than that he should be nominally an "engineer," having a smattering of many subjects, and ekeing out an existence amongst more competent fellows.

On the credit side of the extended education we have, first, the direct satisfaction to be had from its possession and the ability to enjoy on even terms the society of educated people.

Secondly, there is the practical use to which this knowledge can be put.

Third and more important than the knowledge actually acquired, is the learning how to know a subject, and where or in what direction to look for information specifically wanted.

Fourth, there is the certainty that with equal industry and attention to his work, the young engineer of ability with a broad education will ultimately take higher rank in his profession and be more successful in business.

The qualified phrase, "young engineer of ability" is used advisedly. The engineer of ordinary or less than ordinary ability will, in practical life, accomplish most by not attempting to have his education cover too wide a field, and learning some special department thoroughly. If a young man will take for his motto "thoroughness," and, in planning his list of studies, will include first those of prime importance, and then add those of decreasing importance, until all his available time is occupied, he will be planning most wisely. Ordinarily the young man will not be able to arrange a course entirely to suit his individual requirements, but he can use the method above suggested to help him in deciding as between various courses offered. The choice should, when time and mental capacity make it possible, be in favor of a broad general education, supplemented by thorough technical training. This may, and frequently will, lead to a general college course to be followed by a technical course of two or more years.

People are to-day looking for engineers and would gladly pay salaries of $6,000 to $10,000 per annum for men of exactly the right qualifications. It would be easy to find hundreds of men who have had all the necessary general education, and scores who have had as well all the needed technical training. The questions which are asked, however, are such as the following:

Has he good business judgment?

Has he tact?

Has he the mental capacity and breadth to develop into a "big man?"

Is he diplomatic, with ability to negotiate?

Has he initiative, without being erratic?

Will he get results?

We might divide the studies which are worthy the attention of the electrical engineer into four general classes.

In the first place we may put these studies which will teach to think clearly and express lucidly, which will teach how to learn, and which will give a comprehensive knowledge of the fundamental facts and principles underlying his profession. These should be learned most thoroughly, and would include English, arithmetic (mental and written), algebra, geometry and trigonometry, chemistry, physics (especially mechanics), general knowledge of principles of electrical engineering, practical ethics.

The second class may include some subjects which will especially tend further to develop clear thinking and clear writing, some which will further increase the knowledge of the general principles of his profession, and some which will give knowledge which will be professionally and commercially useful. This class includes: Calculus and vectors, surveying, Latin (usual preparatory course), French (speaking and reading, not translating knowledge of), electrochemistry, advanced engineering studies, business law, general principles of modern accounting, civics.

The third class may include some subjects which are likely to be of direct professional or commercial use, and others, the study of which will be of general educational value. This class includes: Spanish, geology, physiology and temporary care of injured, logic, quaternions and subjects which are studies of engineering details rather than of general principles, etc.

The fourth class may include those studies which will help in rounding out the education of the man rather than in furnishing the essential equipment of the engineer. This class includes: Mineralogy, botany, zoology, history, political economy, mental and moral philosophy, art, music, etc.

The third and fourth classes of subjects are useful to round out and complete the foundation and framework provided by the first and second classes, but should not be indulged in at the expense of the relatively more important. A few non-technical subjects merit individual mention.

President Butler, of Columbia University, is reported to have said: "The first two evidences of an education are correctness and precision of speech, and refined and gentle manners." The latter must be acquired almost entirely at one's home and from contact with one's associates. The correct speech must be acquired largely in the same way, but may be learned to a considerable extent in the preparatory schools and in the college or university. There is nothing more important for the young engineer to learn than "the skilful and correct use of language, whether to state a fact or convey an idea," understanding that "clear thinking precedes clear speaking." English should be taught from beginning to end of the preparatory school work, and also from beginning to end of the college course.

More attention may well be paid in the preparatory schools to algebra and arithmetic, especially mental arithmetic.

During the college course it would seem advantageous even for the electrical engineer to devote a moderate amount of time to the study of the various methods of surveying now practised. These can be quickly understood if the student has thoroughly mastered his arithmetic, geometry and trigonometry, and a general

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knowledge of surveying is very likely to be useful in practical work.

French and Latin are included in the second class, because of the mental training and polish to be gained by their study. Some knowledge of Latin will greatly assist in thoroughly mastering English, and is in this respect more useful than the study of German.

A knowledge of French which will enable the young engineer to speak and read with ease is strongly recommended. The educated people of Mexico, South America, Russia and other countries speak French and as this for centuries has been the polite and diplomatic language of the world, the advantages to be derived from mastering it are likely to be not only educational and social, but commercial as well.

On the contrary, there is little prospect that American engineers can practice their profession profitably in Germany or German-speaking countries. Nearly all important scientific papers are now promptly translated into English, and there is no longer any special need of the engineer knowing any foreign language for the sake of keeping advised as to the progress made in the work of his profession.

The general educational value of learning one modern language seems about equal to that to be gained from learning another. Consequently the social and commercial advantages of French give it first place for the American engineer.

The study of a second modern language should be undertaken only in case the first can be spoken fluently. Then it would seem that Spanish is the best language to learn.

The time devoted to various engineering studies in class 1, as well as class 2, must depend largely upon the facilities of the college attended, and the special work for which it is intended to prepare.

Somewhere in the general course there should be included a moderate amount of training in modern business methods and practices.

All engineering students should have some reasonable training in accounting, so that they would not be entirely ignorant and without power of speech if, after beginning the practice of their profession, they are asked some elementary questions about the annual report of a street railway, electric light or manufacturing company.

A moderate amount of time should also be devoted to the study of fundamental principles of business and corporation law. An engineer, in practice, should at least be able to draw a contract which will be legal and explicit.

A modern engineer is dependent for his success largely on the financier. If the engineer does not know that bonds should pay interest, and that stocks, if possible, should pay dividends, and has no conception of the difference between a stock certificate and a promissory note, the financier is likely to form an undeservedly low opinion of the engineer's technical knowledge.

If a young engineer will have before him constantly the ultimate and best interests of his employer, will endeavor always to be tactful and never to irritate unnecessarily, will—without flattery—say only what is pleasant, unless right demands a plain statement of an unpleasant truth, then his advance will surely be more rapid than if these things are forgotten or neglected.

The technical problems which face the engineer are certain to be recognized as they come up. Too frequently the importance of problems connected with one's business and social relations with employers, fellow employés and others is not appreciated. These deserve careful and persistent study. Their correct solution and an accurate appreciation of the proper proportion of things, constitute business sagacity. The paramount importance of such matters should be repeatedly impressed on students and they should be led to understand thoroughly that their satisfactory solution will be rewarded not only by a pleasanter life during working hours, but also by increased esteem and greater business success.

A Test of Selective Wireless Telegraphy.

A successful test of the Stone selective wireless telegraph system was made at Cambridge, Mass., July 20. The transmission was overland, the air line distance between stations at Cambridge and Lynn being twelve miles. This line crossed the factory district of Cambridgeport and a considerable portion of the city of Lynn. The mast of the sending station was 100 feet high, and that of the receiving station, ninety-four feet high. The spark-gap used at the transmitting station was one-quarter of an inch in length, yet in spite of the fact that the electric railway passes within fifty feet of the base of the receiving mast, it is reported that signals were sent with great precision and without any outside interference.

This system of selective wireless telegraphy was patented by Mr. John Stone Stone last December, and was fully described in the ELECTRICAL REVIEW of December 20, 1902.

Electric Traction in the United Kingdom.

A summary of what has been done during the past half year in converting steam lines to electric traction in the United Kingdom is given in the current issue of the *Railway News*. The first line to be converted is the line under the Mersey River, connecting Liverpool and Birkenhead, which road was opened to the public early in May. Four other English railways are in process of conversion. These are the entire systems of the Metropolitan and the District Railway companies, the Newcastle lines of the North-Eastern, and the Liverpool and Southport line of the Lancashire & Yorkshire system. On all of these substantial progress has been made with the electrical equipment, while the portion of the district between Ealing and South Harrow is about to be worked electrically, a train equipped by the British Thomson-Houston Company has been already used on this section. Effort is being made to standardize the position of the third rail for all the lines in England, but up to the present time it has not been found possible, and there are now three different positions in use.

Certain of the railway lines in England are inclined to favor the self-contained system of electrical propulsion, and some automobile trains of this type are being introduced by the North-Eastern between East and West Hartlepool. On the joint line of the South-Western and Brighton companies, between Fratton and Southsea, a steam motor vehicle has been introduced and several other companies have declared their intention of adapting the principle of the automobile to railway work on that section of lines with which there is an acute tramway competition.

The electrical locomotives have been withdrawn from the line of the Central London Railroad and replaced by multiple-unit trains worked on the Sprague Thomson-Houston system. This system has been adopted on the Great Northern and the City Tube Railway, which is to be opened for traffic as soon as the underground station at Finsbury Park is ready to admit the trains of the tube line. The Thomson-Houston system has been adopted by the North-Eastern company for its Newcastle lines. In London progress has been made with the construction of the Charing Cross, Euston & Hampstead Railway, the Baker Street & Waterloo Railway, and the Great Northern & Piccadilly Railway.

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THE FACTORS WHICH AFFECT THE ENERGY LOSSES IN ARMATURE CORES.[1]

BY J. WALTER ESTERLINE AND C. E. REID.

The investigations which form the basis of this paper have been conducted primarily to develop an apparatus suitable for rapid yet accurate testing of sheet metal used in armature cores; secondary to this was the study of the effect of certain factors upon the energy losses which occur in the armature cores of generators and motors.

THE APPARATUS.

A general view of the apparatus is given in Fig. 1. The wrought-iron field-ring is fourteen inches in diameter, three inches in width, with an inner diameter of ten and three-eighths inches. This yoke is provided with five sets of poles, as follows: (1) two poles, solid wrought iron; (2) four poles, solid wrought iron; (3) six poles, solid wrought iron; (4) eight poles, solid wrought iron; (5) two poles, built of 0.022 sheet steel. The poles are so dimensioned that fifty per cent of the armature core is covered by each set.

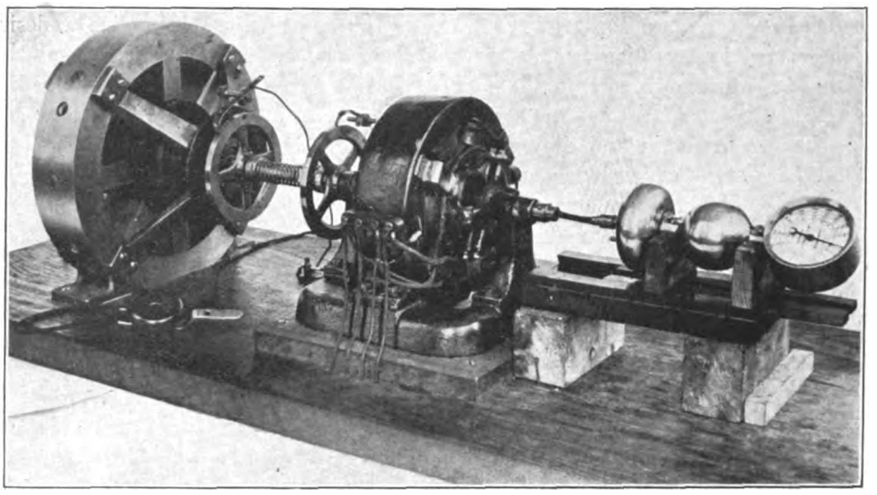

FIG. 1.—APPARATUS USED IN DETERMINING THE FACTORS WHICH AFFECT ARMATURE LOSSES.

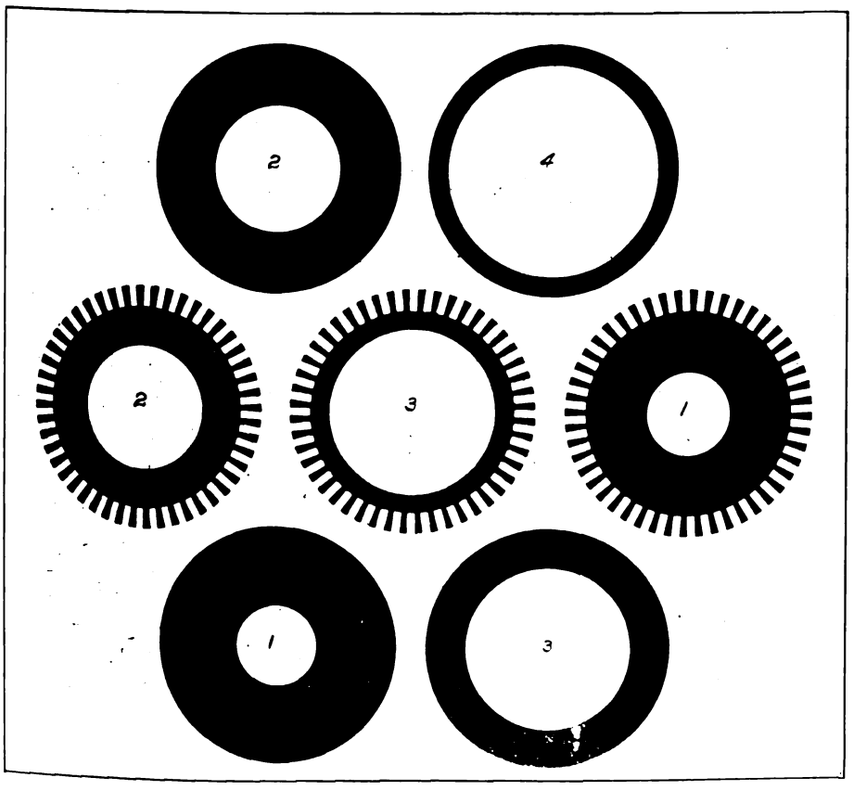

FIG. 2.—CORE DISCS USED IN DETERMINING FACTORS AFFECTING ARMATURE LOSSES.

The apparatus was designed so that the specimens for test would be in the form of ordinary armature punchings, and the samples tested consisted of seven cores built up of sheet steel discs 0.015 inch thick. Fig. 2 is from a photograph of discs from the different cores. The outer diameter of these is six inches, while the inner diameters vary from two to five inches, in different cores. Four of the specimens tested have a smooth periphery, and three others, with corresponding inner diameters, are slotted. The slots in these cores are forty-eight in number and three sixteenths inch wide by one-half inch deep.

To ensure a uniform quality of metal in all the cores, the discs were all stamped and then thoroughly shuffled, after which the holes were punched in the different lots. The slots were milled in the cores which were to be toothed, and all the discs were carefully annealed.

The punchings were given a coat of shellac and mounted on hardwood sleeves which fit a heavy steel shaft carried in bearings fastened directly to the field-ring.

In order to ensure a uniform density in the air-gaps under the different poles, so that there would be no undue increase in the bearing friction when the fields are excited, and to ensure an equal distribution of the flux in the core, the poles were bored while clamped in the field-ring, the tool being carried on the shaft.

The shaft was driven by a small direct-current motor through a modified form of the Goldsborough torsion dynamometer.

In order to detect and correct for any change of the bearing friction, should the armature become magnetically unbalanced, or the lubrication of the bearings imperfect, the bearings were made of special design. The shaft runs in the phosphor-bronze bearing which is mounted in a ball bearing. When the shaft is rotating, the friction tends to cause the bearing to rotate with the shaft, as the friction of the ball bearing was found by test to be negligible in comparison with that of the plain bearing, but it is held back by a spring attached to a suitable arm which also carries a pointer. At the beginning of a run the adjustment was made such that the pointer stood at zero when the machine was running at the speed at which the test was to be run. Any increase in the friction of the bearings is measured by the movement of the pointer in the direction of rotation, and the reverse for any decrease, indicating the correction to be made.

The driving motor was operated sepa-

[1] Abstract of paper read at the annual convention of the American Institute of Electrical Engineers, Niagara Falls, July 2, 1903.

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rately excited and variable speed was obtained by changing the impressed electromotive force of the armature. The speed was indicated by a Buss-Sombart tachometer attached to the armature shaft of the motor.

PURPOSE AND METHOD OF THE TESTS.

The energy losses which attend the rotation of an armature core in the magnetic field consists of the bearing friction and windage, hysteretic and eddy current loss in the core in the case of smooth cores, to which is added an eddy current loss in the pole-faces when the cores are toothed.

Hysteretic losses may be said to depend upon the quality of the iron, the frequency of the flux reversals and the maximum density reached during a cycle. The frequency is a function of the number of poles and the speed. The distribution of the magnetic flux through the core depends mainly upon the depth of the core, the number and pitch of the poles and the dimensions of the tooth and slot. The cores of different internal diameters were tested to determine the effect of the variation in the flux distribution upon the core loss. The frequency and flux distribution both being dependent upon the number of poles in a machine, these cores were tested under different numbers of poles also.

When an armature core is slotted, the magnetic density in the teeth is greatly increased for a given air-gap or core density, and the presence of teeth on the core is attended by an eddy current loss in the poles. The latter may be greatly reduced by laminating the poles, so that a comparison between tests of a toothed core under solid and laminated poles should indicate to what extent this loss in the pole-faces may be reduced. The increase in the energy expended due to the higher densities in the teeth may be shown by comparing tests of smooth and toothed cores under well laminated poles.

To make a core, enough discs of one kind were selected to give a gross length of three inches. These were weighed, given a coat of shellac and assembled. Before placing the core within the field an exploring coil was wound about the face of one of the poles and another wound so as to embrace the total flux passing through one section of the core. After placing the sample in the apparatus, a saturation curve was taken by means of a ballistic galvanometer in connection with the exploring coils just mentioned. These curves show the relation between ampere-turns per pole and average magnetic density in the core.

The field-poles were next thoroughly demagnetized by an alternating current. On starting the motor, the dynamometer reading indicates the bearing friction and windage; the springs which hold the bearings were adjusted so that the reading of the pointers P were zero.

The speed adjusted to give a desired frequency, it was held constant, and the exciting current varied stepwise, readings of current in the fields, dynamometer, scale for bearing friction, being taken

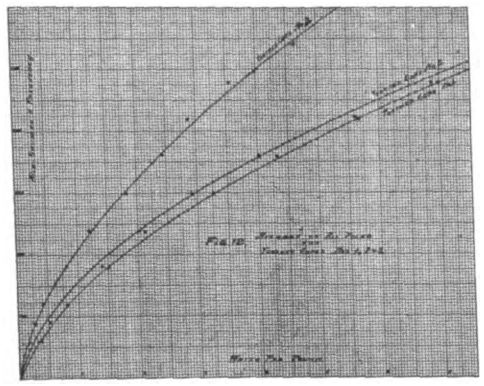

FIG. 3.—RELATION BETWEEN CORE LOSS AND CORE DEPTH. TOOTHED CORES.

simultaneously for each value of current. When maximum current was reached, the fields were again demagnetized, the speed changed to give the next desired frequency, the bearing springs adjusted and the operation of varying the current repeated. Each core was tested in this manner under five sets of poles, at five different frequencies and varying magnetic densities, making 225 complete tests.

When the fields are excited, the power required to drive the core consists of the

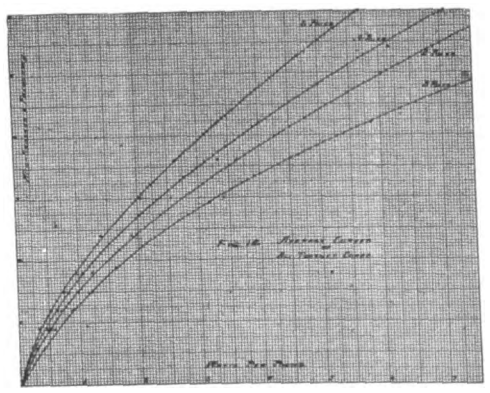

FIG. 4.—RELATION BETWEEN CORE LOSS AND NUMBER OF POLES. TOOTHED CORES.

friction and windage and iron losses. The difference between the dynamometer reading for any current, and the friction reading, is the iron loss. If the pointers attached to the bearings indicate any change in the friction, the amount so indicated can be subtracted from or added to the original friction reading, depending upon whether the friction has decreased or increased, since the scales E are graduated in degrees of the dynamometer spring. From the corrected dynamometer readings the watts core-loss in watts was determined, which divided by the weight of the core gives the watts per pound. Referring to the saturation curve, the densities in the core for the different values of ampere-turns per pole are found, and curves were plotted for each frequency, average density as ordinates, watts per pound abscissæ. The current in the exciting coils was taken from a storage battery and measured by a Weston laboratory standard ammeter. The dynamometer was frequently calibrated, and gave the same result each time. The centering of the cores in the bore of the poles was so successfully accomplished, that there was very little increase in the friction due to magnetic pull. So sensitive, however, were the ball bearing attachments, that the increase of friction due to a drop of cold oil in one of the bearings was readily shown by the pointer.

RESULTS.

To illustrate the relation between the core loss and any one of the four variables —frequency, magnetic density, number of poles and depth of core—curves have been drawn from data derived from the thirty-five original curves. In order that the results should be representative, the three variable factors not under consideration were eliminated by averaging all of the tests, for each value of the variable under consideration. Tests of the cores having teeth showed considerably higher losses, due to the energy loss in the pole-faces and the increased hysteresis loss resulting from the high magnetic density in the teeth of the core.

In studying the effect of variable numbers of poles and depth of core, the product of the frequency and magnetic density was considered as a single variable. The relatively shallow cores, in which the magnetic density is more nearly uniform, show the lowest values of core loss for the same average magnetic density and frequency. The same is true for the toothed cores, as shown in Fig. 3. The lines of force in passing from pole to pole through the core seek the path of least reluctance, and in so doing increase the density in the outer portions of the core. Of the toothed cores, the results from which are given in Fig. 3, core No. 1 has a depth below the teeth of 1.5 inches, No. 2, one inch and No. 3, 0.5 inch.

But little change was found in the core loss for different numbers of poles, for the same magnetic density and frequency, so far as the smooth cores are concerned. The result for eight poles differs from that for the other three, probably due to the fact that it was impossible to obtain as

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high magnetic densities with these poles as with the others, but the frequencies obtained were of course somewhat higher. However, in the case of the toothed cores, as shown in Fig. 4, there is considerable variation in the core loss for different sets of poles, at the same frequency and density.

In Fig. 5 curve No. 1 is the average of four curves, and is a summation of all data taken on the cores having smooth periphery. Curve No. 2 in the same figure is a similar deduction from all the data on the slotted cores. The increase in the loss of energy due to the slotting of the core is plainly set out, as shown by the difference of the values of the abscissæ of the curves 1 and 2. Curve No. 3 is a final average of the result from all the smooth and all the toothed cores and is the result of some 12,000 observations.

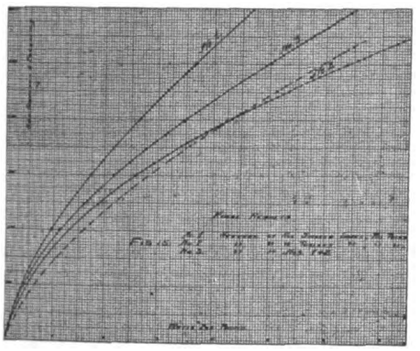


FIG. 5.—AVERAGE CURVES SHOWING RELATION BETWEEN CORE LOSS AND FLUX DENSITY AND FREQUENCY.

Curve No. 1, Fig. 6, is the mean result of all the toothed cores tested under a pair of laminated poles, while curve No. 2 in the same figure is the result of tests of the same cores under a pair of solid poles; the difference in the abscissæ of these two curves denoting the reduction of the eddy current loss in the poles due to lamination of the same. In building up the laminated poles, no effort was made to produce a laminated pole in any way superior to those obtained in commercial practice. After the poles were built up, they were faced inside and out, in the lathe; and the tests conducted on the poles just as they came from the lathe, no attempt being made to remove the effects of the tool in forcing the plates together. It will be noted in curve No. 1, Fig. 16, that the toothed cores and laminated poles check fairly closely with curve No. 3 of Fig. 5, which is the average of the smooth and toothed cores under solid poles, and also that the difference between curves 2 and 3, Fig. 5, is very nearly equal to the difference between the curves in Fig. 6. This being the case we should expect curve No. 1, Fig. 5, to be representative for smooth cores under either solid or laminated poles; curve No. 3 for toothed cores with laminated poles, and curve No. 2 for toothed cores and solid poles. The broken curve, Fig. 5, is from the core loss tests of a large number of machines having, in the majority of cases, toothed cores and solid cast poles. Since these machines were built and tested by the manufacturing company which furnished the material for the cores which were the subject of these investigations, the last conclusion at least seems justifiable.

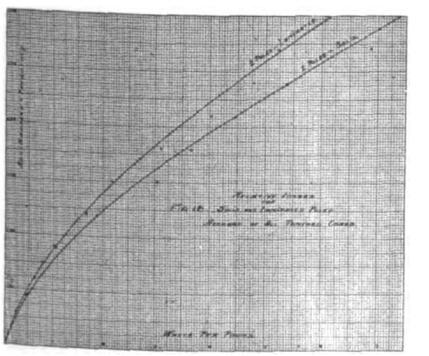
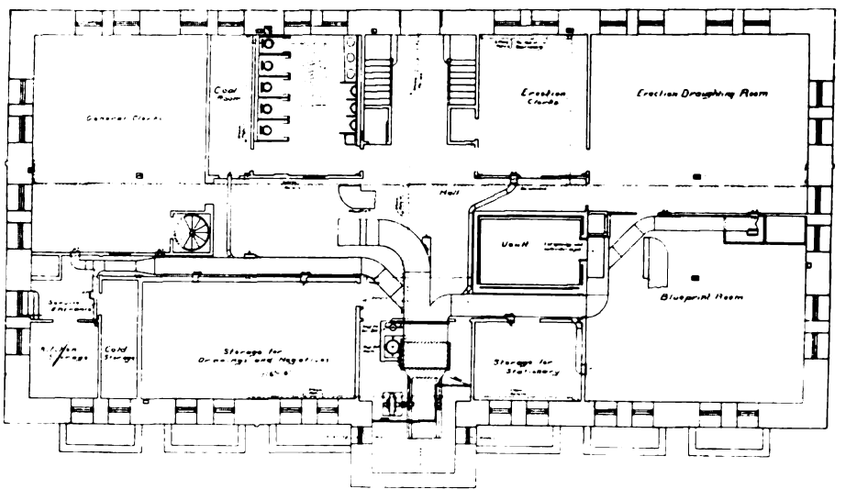


FIG. 6.—AVERAGE CURVES SHOWING EFFECT OF LAMINATED POLES ON LOSSES OF TOOTHED CORES.

Heating and Ventilating Equipment for the Shops and Offices of the Pennsylvania Steel Company, at Steelton, Pa.

The Pennsylvania Steel Company has recently erected at Steelton, Pa., a large shop and an office building for its bridge and construction department. The plan of heating apparatus and the first floor of the office building is shown in the accompanying drawings.

The fan and heater or "hot-blast" system of heating and ventilating has been adopted in these buildings. In this system the steam piping is concentrated in a compact heater, which is enclosed by a steel housing. Due to the greater velocity of the air over the pipes of the heater, much less length of pipe is required than if the piping were scattered throughout the shop and all dangers from freezing and bursting of pipes, setting fire to woodwork, etc., are of course eliminated. Air taken either from the shop or from out of doors is forced through the heater by a fan and is then carried to various points about the shop by a system of galvanized iron piping. The exhaust from the fan engine is condensed in a section of the heater arranged for that purpose, and there is, therefore, no loss of steam due to the engine.



PLAN OF FIRST FLOOR OF OFFICE BUILDING, SHOWING HEATING SYSTEM. PENNSYLVANIA STEEL COMPANY, STEELTON, PA.

The distribution of the heated air in the shop is a very important question and requires for its proper solution great care and long experience in this class of work. The hot air should be so delivered that there is no perceptible draft upon the workmen, but at the same time the outlets should be placed at short intervals apart and directed toward the floor, since that is where the heat is wanted. By this means it has been found possible, as in the works of the New York Shipbuilding Company, at Camden, N. J., to keep

Dedication of an Engineering Building at the Iowa State College.

On Friday, May 22, the new engineering building of the Iowa State College was formally dedicated with impressive ceremonies. This is a handsome four-story building which will afford excellent accommodations for the various engineering departments. During the services an address was made by Dr. R. H. Thurston, director of Sibley College, Cornell University, upon "Functions of Technical Science in Education." Dr. Thurston spoke of the value of scientific education, both as a training and as a preparation for the study of applied science, and emphasized the need for thoroughness in this work. He then discussed the value of a technical education, showing the great need there is in this country for thoroughly trained, competent young men.

Addresses were also made by Mr. W. Clyde Jones, of Chicago, upon "The Engineers," and by Mr. J. M. Rigg, of Toledo, Ohio, upon "The Making of an Engineer."

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a zone of nine or ten feet in height comfortably warm, while the space overhead is in comparatively free communication with the outside air.

In the bridge and construction shops of the Pennsylvania Steel Company there are eight fan and heater equipments, consisting each of a steam-coil heater in connection with a steam engine-driven exhaust wheel. The heaters, with the remainder of the equipment, were furnished by the B. F. Sturtevant Company, and are built on that company's patent, corrugated, cast-iron sectional bases, with one-inch steam pipes set staggered and at the proper distance on centres to obtain the highest efficiency from the heating surfaces without restricting the passage of the air. The sections rest on heavy wrought-iron bases with ample provision for contraction and expansion. The fans are enclosed in three-quarter, steel-plate housings, the lower part of the fan scroll being underground and forming a part of the foundation. They are driven by direct-connected, horizontal, side-crank engines. A system of galvanized-iron pipe distributes the air throughout the buildings, the air being discharged through branch drop-connections having outlets near the floor. The ducts are of large size with bends of long radius to reduce the frictional losses to a minimum. Each drop pipe is fitted with a butterfly damper with a counterweight for holding the same open or closed, as may be desired. The entire apparatus is of sufficient capacity to heat the buildings to sixty-five degrees Fahrenheit in zero weather. In the case of the receiving-shed this applies only to a section fifty feet in width in the middle of the building, but extending its whole length. Under the conditions of the contract the heater must take all the fresh air from out of doors. However, as the number of occupants in the building are few compared with the cubic contents, it will be found perfectly feasible and more economical to return a certain portion of the air from the buildings, and the apparatus is so arranged that this can be done. The apparatus is capable of changing the air in all the buildings every twenty-five minutes, and in the paint shops, every twenty minutes.

The office building in connection with this department, as noted above, is heated by the same method, the apparatus being designed to furnish 21,430 cubic feet of air per minute which is discharged into rooms having a total capacity of 289,763 cubic feet, thus providing for a complete change of air about every fifteen minutes. The fan of the office building heating plant is not driven by a steam engine, as in the case of the sets furnished for the shop, but is direct-connected to a Sturtevant motor running at 200 revolutions per minute.

ELECTRICAL MINING NOTES.

ELECTRICAL DAY AT THE INSTITUTION OF MINING ENGINEERS.

BY SIDNEY F. WALKER.

The ever-increasing importance of electricity in connection with mining was well illustrated at the recent meeting of the Institution of Mining Engineers, in London, when practically one of the two days on which papers were read was devoted to electrical matters. The Institution of Mining Engineers, it should be mentioned, is really a federation of several institutes, and has only recently assumed the name by which it is now known. Coal is found in Scotland in the basin extending across from the Firth to the Clyde; in the north of England in the basin extending across from the Tyne to the Solway; further south in the great Midland basin which extends from Lincolnshire and Northamptonshire to the west coast, including the counties of Yorkshire, Lancashire, Derbyshire, Nottinghamshire, Staffordshire, Leciestershire, Warwickshire, Cheshire and North Wales; further south again, there is the great South Wales coal basin, pricipally confined to Glamorganshire and Monmouthshire, the Forest of Dean coal basin, and the Somersetshire. The last two are very small. Each of the coal basins, however, has had its own mining institute, and the great Midland coal basin has nine. All of these have been federated for some years now, under the leadership of the north of England institute, the parent of mining institutes in that country, except the Manchester Geological Society and the South Wales institute. The several institutes maintain their own individuality, much as do the several states of the American Union. They hold their own meetings, so many times a year, in their own centres, and any member of any of the institutes in the federation is at liberty to attend any of the meetings of the different institutes.

All papers read before each individual institute are open for discussion at every institute of the federation, and they are all printed by the central body. Twice, and sometimes three times a year, the federation meets as a whole. One meeting is always in London, and this is the most important meeting of the year. Another meeting is held in some important mining centre. The second meeting this year will be in Nottingham.

The electrical papers presented to the institute included one on pneumatic and electric locomotives in coal mines, one on electric plant failures, one on electric driving of winding gears, and one on electric power distribution by continuous current in North Wales. A paper on electric coal-cutting, which was to be presented, was withdrawn as the owners of the colliery where the experience had been had had doubts of the wisdom of publishing a table included. It was very amusing and instructive to find that, though the subject of coal-cutting by electricity was barred from discussion, nearly every member who took part in the discussion referred to coal-cutting. The recent Home Office enquiry has opened men's minds very much. At any rate it has made them think upon the matter, and they were unable to keep off the burning question, "Is coal-cutting by electricity dangerous?"

The paper on locomotives was a résumé of the practice in America. The writer of the paper, who was employed by the *Colliery Guardian* to go through some of the collieries in America, and report on the coal-cutting as it was carried out there, and whose articles formed a corollary to those of the present writer on the same subject with reference to British collieries, saw a good many things in America that are not to be seen in England. They have no electric locomotives in that country, though they have them on the Continent. But in American mines they are almost the rule. In fact, in a large number of American collieries it appears to be merely a question whether a compressed air locomotive or an electric locomotive shall be employed.

The subject of this paper was a comparison between compressed air and electric locomotives as used in American mines. The author described his experience when traveling in some of the mines in America—lying on the top of a truck running into the mine at a pretty high speed with a live trolley wire at 500 volts within a few inches of his head—as exhilarating. At a meeting of the institute last year this writer explained that, from his experience in America, if a man could not look after himself under the conditions ruling in coal mines, operators in the United States had no use for him. He also in his paper explained that air was compressed to a pressure of 1,000 pounds per square inch, transported into the mine, and there reduced in pressure to about seventy pounds, at which it was used for driving the coal-cutting machines and other apparatus, and to 140 pounds for locomotives. According to his ac-

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count the compressed air locomotives were very much more cumbersome than the electric locomotives, a thirteen-ton compressed air locomotive having overall dimensions of five feet three inches high by six feet wide and sixteen feet long, with a drawbar pull of 4,500 pounds, while an electric locomotive of thirteen tons, with a drawbar pull of 4,300 pounds, was only three feet high, four feet eight inches wide and twelve feet six inches long. It will be noticed that it is principally in the dimensions that the electric locomotives have the advantage, not in weight. The electric locomotives referred to would be those taking current from the trolley wire. It should also be remembered that American coal mines are all shallow at present, and therefore, drifts or levels running into the coal from the surface are easily arranged, and in these locomotives are also easily worked, if other conditions are favorable. The fact that the mines are shallow also implies that gas is not usually present, and therefore electric locomotives, with naked trolley wires and the sparks they entail, would usually be safe. As the coal seams deepen, below the surface, the gas usually increases, approximately in proportion to the depth. The writer of the paper on locomotives mentioned that he had seen a man get a shock from a trolley wire at 250 volts, which appeared to daze him, but nothing more.

In the discussion on this paper it was pointed out that compressed air locomotives were used in the north of England for some time some years ago. The present writer remembers them in the collieries owned by the Earl of Durham. They were made by the Grange Iron Company, and, he believes, worked at a pressure of 300 pounds per square inch. As the speaker who mentioned the fact at the mining institute pointed out, one great difficulty with locomotives underground, at the present time, is the fact that the roads are so low. The best seams, in many of the mining districts, are worked out, and those that are being worked are from two feet upward in thickness. In some cases even seams of eighteen inches in thickness are being worked with coal-cutting machines. In Somersetshire seams of even one foot and less are worked. As far as possible, the thickness of the seam is made the height of the road along which coal and men have to go, as any addition in height adds to the cost of getting the coal. Height is always added in the north of England collieries, though not always in the Midland counties' collieries, but the height made is as low as possible, and usually not sufficient to allow of working compressed air locomotives, with the monkeys on their backs and the receivers of compressed air which it is necessary for them to carry. The author of the paper appeared to think that considerable loss was incurred by compressing air to 1,000 pounds per square inch, and reducing it down to seventy pounds for coal-cutting machines. Really, however, the question has not been studied fully on this side. Writers and speakers glibly say that you generate heat by air compression which is lost, and that this heat is greater as the pressure is greater, but they forget that the quantity of air to be transmitted and to be compressed is less with high pressures than with low pressures. Thus, if you compress air to 50 pounds per square inch you generate a certain quantity of heat, which is lost. If you compress to 1,000 pounds per square inch you generate, approximately, twenty times the amount of heat, but the air which is so compressed will do the same work as twenty times the air compressed to fifty pounds per square inch. There is an additional loss in using higher pressures, as there always is, but this is more than made up for by the decreased losses in transmitting the air, provided that leakage is guarded against. The great losses which take place with compressed air are from leakage. An attempt was made to find out from the writer of this paper what precautions were taken in the United States coal mines to prevent leakage with air compressed to 1,000 pounds per square inch, but he had not observed. With air pipes laid in coal mines, the joints break, and the pipes themselves are apt to break, owing to the heaving of the roadways of the mine, and it is evident that the leakage must be greater with higher pressures.

A large portion of the discussion upon this paper, and upon subsequent papers, turned upon the question whether three-phase apparatus or continuous current apparatus was best for collieries. As usual, there were advocates of each, who could see nothing good in the other. Professor Silvanus Thompson, in his evidence before the committee which has been sitting at the Home Office, when he was asked by the chairman of the committee whether he would prohibit the use of three-phase currents in coal mines, replied that, if anything, he would rather put it the other way, and forbid the use of continuous currents. The electrical papers reported that he advocated the prohibition of continuous currents, and this was quoted by a speaker at the meeting of the mining institution who was strongly bitten with the three-phase idea. The fact is, as the present writer pointed out to the meeting, each case must be decided on its merits. There will be cases where three-phase is the best, as where large distances have to be worked over, and there will be other cases where continuous currents are best, and there will be many cases where either will be suitable, each will be economical or the reverse, according to the special conditions ruling, and often according to the men who have the designing and the carrying out of the work. This is only another instance of the well-known fact that there are always at least two methods of solving every engineering problem. At the moment, in mining circles in the United Kingdom, the burning question is continuous current *vs.* three-phase current, but if mining men were to go into electrical circles they would find an equally burning question between the two and the three-phase men. A somewhat unpleasant incident occurred in connection with the discussion on the paper on mining locomotives. It has often occurred before, and it illustrates rather forcibly why invention goes ahead in America and Germany faster than in the United Kingdom. An able man, a skilled mining engineer and a man who commands the respect of all who know him, a man who also is one of his Majesty's most trusted mines inspectors, after the discussion on the locomotive paper had gone on for some time, arose and said that when electrical engineers had made up their minds which was the best system, three-phase or continuous current, mining engineers would look into the matter.

Looked at from an impartial business point of view, the speech reported above, as made by one of H. M. principal mines inspectors, was singularly silly. Colliery owners and colliery managers have not the slightest intention of waiting till electrical engineers have made up their minds, and can not afford to do so. Coal-getting, like everything else, is a commercial operation, and if the owner of a colliery, say in Derbyshire, is getting his coal out at a less cost than his neighbors by the aid of electricity, his neighbors must follow suit or see their trade go to others. At the dinner which, as usual, took place on the night of the first day's meeting, the present writer chaffed the colliery managers of his acquaintance on these lines. "Have you colliery men arrived at the proper method of working all your coal, have you decided which is the best coal?" he asked. The reply to the latter was, of course, the coal produced by the pit which each individual colliery manager bossed was the best. But there is as much diversity among mining engineers about the methods of working coal, and more, as between electrical engineers about the different methods of delivering electrical energy.

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NOTES ON X-LIGHT.

BY WILLIAM ROLLINS.

NOTE CLXVII—ON LARGE INSTEAD OF SMALL RADIANT AREAS IN X-LIGHT TUBES EMPLOYED IN THERAPEUTICS.

In note clxvi I explained a new principle in the therapeutic application of X-light, namely, the use of tubes with diffused sources of X-light. I obtained a diffused source of X-light by making the cathode stream spread, instead of bringing it to a focus, as in all tubes previously used in therapeutics. Consequently the subatoms of the cathode stream struck the glass walls of the tube over a large area. As X-light arises wherever the cathode stream particles strike with force, the source of X-light was a large surface instead of a spot about two millimetres in diameter, as in focus tubes. In the present note the importance of this principle in other therapeutics will be shown. In earlier papers the principle to be followed in using X-light in therapeutics was stated, namely, when we wish to affect the superficial tissues most strongly we should use X-light from a tube of low resistance, because the X-light from such a tube is most absorbed by the tissues, placing the source of X-light near the surface to be treated. For treating deeper tissues we should use the X-light from a tube of higher resistance, because this form of X-light is less absorbed by the superficial tissues, placing the source of X-light so far away that the intensity of the radiation where it enters the body shall not be measurably stronger than when it has reached the deeper tissues we desire to treat. These principles have now been accepted by a number of physicians who are using X-light in therapeutics. They are mentioned again to make clear the ideas on which the tubes to be described are designed. One other statement made in the paper mentioned needs to be considered.

It was shown that within the limits of the experiments the action of the X-light on the tissues diminished like the photographic intensity as the square of the distance. Beforehand one would have expected this, but it could not have been accepted as a guide in therapeutics until tested on animals. Therefore the experiments reported were made, thus furnishing a safe rule to follow in using X-light in therapeutics.

If a tube is placed with the target (the source of X-light) ten centimetres from the skin, the diseased area we desire to treat being ten centimetres below the surface, then the superficial tissues will be exposed to a radiation about four times as intense as the tissue we desire to treat; with the result that the diseased tissue can not be exposed the proper length of time, for the skin will be destroyed. If the tube had been placed at 200 centimetres from the skin the intensity of the radiation falling on the skin would have been but slightly more powerful than that reaching the tissues below, provided the radiation was from a high-resistance tube. Therefore the treatments could have been longer and more effective, for the risk of burning the superficial tissues need not have been considered. On the other hand, if we wish to treat diseases of the skin, and place the tube far away, we expose the underlying tissue to a radiation of practically the same strength as the skin, obviously not a scientific procedure. Therefore the correct method in treating a disease of the skin or superficial tissues is to have the target (the source of X-light) as near the skin as possible. One of the arguments that has been brought forward for considering ultra-violet light superior to X-light in some affections of the skin and superficial tissues has been that the action of the former being limited to the surface, or near it, the underlying tissues are not so likely to be injured. With the forms of tube in general use (focus tubes) it is impossible to bring the source of light (which is in the middle of the tube) near the skin, as the tubes have a diameter of about sixteen centimetres. If the tubes were brought in contact with the skin the source of light would still be eight centimetres away. Even this distance is less than recommended in the text-books. For example, Williams in "Rœntgen Rays in Medicine and Surgery" says: "In cases of new growths the tube should be brought within fifteen or twenty centimetres of the part, *in skin diseases the distance should be greater.*" Pusey in "The Rœntgen Rays in Therapeutics and Diagnosis" says: "The distance at which I place my tube is, as I have said, fifteen to five centimetres from the surface." Add to these measures six or eight centimetres to get the distance of the source of X-light from the skin. I have selected these two books not because the ideas advanced differ from those of others, but because they may be supposed to be representative, for one book is now in a third edition, showing it has become a standard, while the other, from its excellent quality, seems likely to become one. Let us take twenty centimetres then as a fair average of the distance now used between the source of X-light and the skin in therapeutics. Is it not obvious that both the form of tube and the method of use can be improved upon, for with the source of X-light at this distance, when we treat a disease of the skin, we subject the underlying healthy tissues to an unnecessarily strong radiation. A tissue at a depth of a centimetre has practically as strong a radiation shining on it as the skin, taking no account of the light lost in absorption by the upper layers, which is considerable however.

We should in treating diseases of the skin and superficial tissues desire to bring the source of X-light as nearly in contact with the skin as possible and also have the radiant area large. For example, suppose we had a tube of such shape that the source of X-light could be brought within one millimetre of the skin when we wished to treat a skin disease. It is obvious that the tissues one centimetre below the surface would be subjected to X-light whose intensity would not be more than one-hundredth of that striking the skin. Certainly a better plan than the one first mentioned. I do not figure tubes enabling this to be done for the reason given in note clxvi, where the principles for producing a diffused source of X-light almost in contact with the skin were mentioned. It may, however, be well to speak of two general forms which are valuable. Cylindrical tubes, with the end opposite the cathode made flat, and funnel-shaped tubes, with the wide end of the funnel opposite the cathode and flat, for treating large areas. In these tubes the flat ends received the impact of the cathode stream particles over their whole surface, X-light in consequence arising from the whole area. It is well to cover the flat ends with thin aluminum foil to act as an anode and yet allow the X-light to pass through it. In all cases we should remember that X-light spreads as a spherical wave from every surface struck by a cathode stream particle, and therefore all X-light tubes of every kind should be enclosed in non-radiable cases. The cases used about such tubes as I have recommended for skin diseases should have handles to enable the tubes to be readily held in the hand and applied to the diseased area, or moved about over it when it is too large to be covered by the end of the tube. Such tubes may have broad targets of aluminum within the glass or the glass wall itself may be the target, the outer surface being coated opposite the cathode with aluminum foil, and connected with the position terminal of the generator; for Lodge and Rowland showed that a target which was an anode

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was more efficient. I gave the reason in note lxvi, October 25, 1899. Also in designing such tubes the experiments detailed in notes xv and cii, should be remembered as they showed, contrary to the statement of Crookes, that the position of the anode did to some extent determine the direction of the cathode stream in high vacua. For example, in designing a tube, if the anode is placed in a side arm, the cathode stream being sent directly forward past this arm to the other end of the tube, the anode will tend to deflect the stream and to retard it when it has gone beyond the side arm. This will make the cathode stream particles when they strike the glass less efficient sources of X-light, for their velocity of impact will be reduced. Consult note xviii, June 26, 1898. On the other hand, if this part of the glass is made an anode the efficiency of the tube is increased. When it is desired to cool the end of the tube in contact with the skin the method illustrated in note xli is a good one. A sheet of thin soft rubber may be tied over the flat end of the tube and stagnant or circulating water kept between it and the tube.

In determining how to use X-light in treating diseases which are to be reached by allowing the light to enter through some of the body cavities, like the mouth or rectum, we should consider how far below the surface of the membrane of the cavity the diseased tissue lies. If we wished to treat a superficial disease of the membrane of the cavity of the mouth, for example, we should use one of my diffused radiant area tubes in which the glass wall of the tube is the source of X-light, as in this way the source can be brought almost into contact with the diseased tissue, the distance may not be more than two millimetres. If, on the other hand, we wished to use the cavity as a way of approach to deeper seated tissues such a course would be unscientific for the reasons given; namely, the strength of the X-light on the healthy surface tissues of the cavity would be out of all proportion to that shining on the diseased tissue which we desire to affect. In such a case we should use the X-light concentrators and reflectors described in notes cxliv and clvi, for with these the source of X-light may be far away, therefore the healthy tissues will be subjected to a radiation but little stronger than the diseased ones. I close this note with a few more axioms.

In using X-light in therapeutics its wave-length should be such as will cause it to be absorbed by the diseased tissue. The denser the tissue the shorter the waves may be—important in treating diseases of the bones without injury to the overlying tissues.

In using X-light in therapeutics the waves should be as long as can be employed without injury to the overlying tissues—such waves are mostly absorbed.

In using X-light in therapeutics the distance of its source from the surface of the body through which the X-light enters should vary directly with the distance of the diseased tissue below that surface—the nearer the disease to the surface the nearer the source of X-light.

In using X-light in therapeutics the distance of the diseased tissue below the surface of the body through which the X-light enters should determine the form of vacuum tube to be employed—the nearer the diseased tissue to the surface through which X-light enters, the nearer the source of X-light should be to the wall of the tube.

NOTE CLXVIII—ON TREATING TWO PATIENTS AT THE SAME TIME WITH THE SAME X-LIGHT TUBE.

In hospital work the number of patients who desire to be treated by X-light is greater than can be served. I, therefore, call attention to the use of a special form of tube which was illustrated in Figs. 58 and 60, note lxv, September 20, 1899. This tube was a modification of one illustrated in note xvii, Fig. 2, January 12, 1898. The principle on which they were constructed was to send one of the cathode discharges from an alternating current against the back of the target, thus throwing the X-light arising from its impact out of the field to prevent injury to the definition. But the tube is useful in therapeutics as one patient can be placed on one side of the tube and another on the opposite, each receiving the X-light, one from the back, the other from the face of the target. The tube must be in one of my non-radiable tube-holders which must be provided with two (instead of one) diaphragm plates with adjustable openings. For these simple therapeutic purposes a less expensive tube-stand and diaphragm can be employed. The tube-box should be attached on the under side to an upright post sliding within a vertical tube to permit of adjusting the height of the source of X-light and allowing rotation in a horizontal plane. These two movements are all that are required in using such a tube in therapeutics, for only the more accessible diseased areas should be treated with this form of apparatus. As in therapeutics, the X-light need not arise from a small radiant area, the surface of the target may be prevented from melting without using the cooled target shown in the figures mentioned, by making the cathodes of such shape that the cathode streams are not brought to a focus on the target, but are caused to strike it over a large area, the surface of the platinum being made larger. A simple form of apparatus may be used for exciting these tubes, namely, one of my variable potential coils, excited by a current from an alternating dynamo without an interrupter.[1] This form of apparatus requires little attention and is satisfactory for some therapeutic work in hospitals where apparatus should be simple and cheap to enable many patients to be treated. One dynamo can be used for a number of coils.

Wireless Telegraphy for Automatic Fire-Alarm Stations.

TO THE EDITOR OF THE ELECTRICAL REVIEW:

I call your attention to an application of wireless telegraphy which, although modest, can, I believe, be of service. It is intended to inform automatically and instantaneously, without wires, fire-alarm stations of dangerous rises in temperature which may occur in buildings equipped with the apparatus.

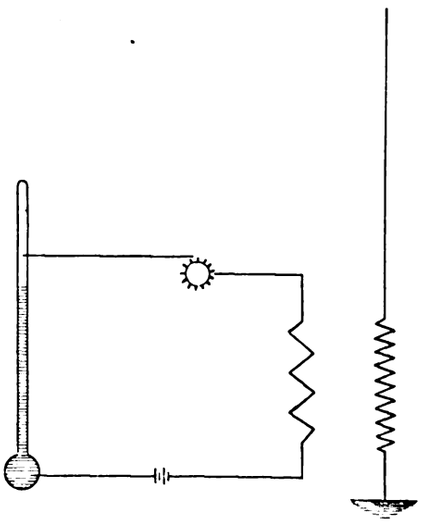

DIAGRAM OF WIRELESS FIRE-ALARM CIRCUIT.

The arrangement consists of a mercury thermometer, into which are inserted two contacts of platinum, one in the bulb and the other in the tube. These contacts are in the circuit of the ordinary wireless telegraphic apparatus. The contact in the tube is placed at the height of the critical temperature. The transmitter, consisting of a special toothed wheel, sends automatically the location of the street and the number of the threatened building.

At normal temperatures the column of mercury does not complete the circuit in the tube, and the apparatus is quiet. If the temperature attains a dangerous point the column of mercury touches the contact in the tube, and the circuit is closed. The transmitter sends automatically the necessary indications to the fire engine house. In virtue of the promptitude with which these alarms are sent, this apparatus, it seems to me, will make it possible to avoid or greatly reduce fires.

EMILE GUARINI.

Brussels, July 5.

[1] Consult note clxix.

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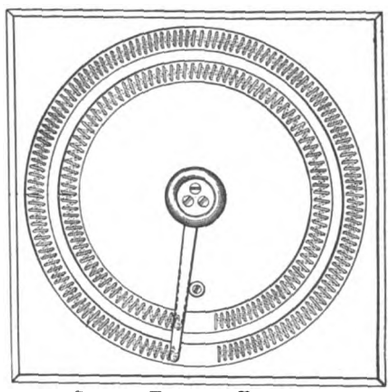
Electrical Patents.

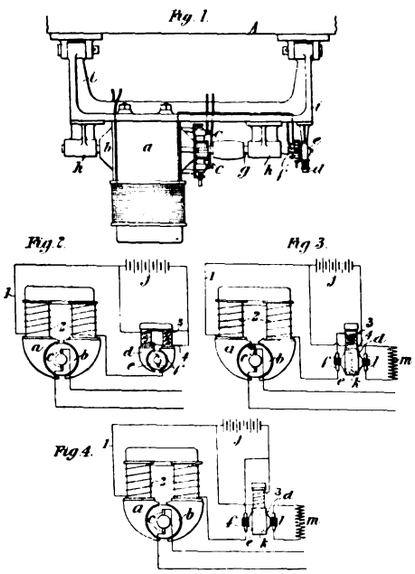
Perhaps the simplest rheostat yet produced has been invented by Mr. William C. Yates, of Schenectady, N. Y., the patent thereon being owned by the General Electric Company, of New York. The invention relates to a device for regulating the flow of current in any electric circuit in which it may be introduced by gradually cutting in and out a resistance coil which consists of numerous turns of wire partially embedded in insulating material, but exposed along the path of a switch-arm. By having the switch-arm move directly over the coils of the resistance wire contact-blocks connected to the wire at intervals are done away with, and this enables one to increase or diminish the resistance by very small steps. In fact, movement of the switch-arm can be made so slight that only one turn of the coil is cut into or out of the circuit, thereby increasing or diminishing the resistance of the circuit by only the resistance in one convolution of the wire. On the other hand, the switch can be moved over the whole length of the coil and thus connect into the circuit the entire length of the resistance wire. In carrying out the invention there is provided an electrical conductor in the form of a coil which is laid in a groove in a block of slate or other fireproof insulator, so that a side of the coil extends slightly above the face of the insulating block. The grooves are then filled, thus partially embedding the coil by pouring in such insulation as cement or any other insulating material which can be introduced in a fluid or plastic condition and which will harden and become solid either naturally or by the application of heat. Portland cement or a mixture containing the same is employed for this purpose, not only because it can be used in a plastic state and afterward hardened, but also because it is capable of withstanding a considerable degree of heat. Thus the embedding substance insulates the portion of each turn of the resistance wire below its surface from the next turn and holds the exposed portions rigidly and a sufficient distance apart to prevent accidental cross-connection, and, further, it absorbs much of the heat from the surface of the electrical conductor, thereby enabling it to carry a much greater current than it would be capable of were it not so embedded. The sides of the groove in the insulating block are undercut so as to make the cement more secure in the groove. A switch-arm is mounted to move over the exposed portion of the coil and make electrical contact therewith. In order to increase the range of the rheostat it is convenient to provide two parallel or concentric coils of wire, each embedded in insulating material, and a switch carrying a bridging contact making contact with the exposed portions of the two coils.



SIMPLE TYPE OF RHEOSTAT.

Thus any movement of the switch increases or diminishes the length of that portion of each of the two coils that is connected in the circuit, thereby giving the rheostat double the range it would have if only one coil were used.

New dynamo-electric machinery has been devised by Messrs. Henry Leitner, of Woking, and Richard N. Lucas, of London, England, who have obtained a patent on the same in this country. This invention relates to improvements in dynamo-electric machinery of the kind wherein the voltage at the terminals is kept constant by the employment of a



DYNAMO-ELECTRIC MACHINERY.

secondary dynamo, which generates a counter-excitation current through the field of the main dynamo or a counter-electromotive force as the speed of the main dynamo increases. Now in some such machinery there is a possibility of the secondary dynamo developing at high speeds so high a voltage as to endanger its burning out. According to the present invention this danger is obviated by the employment of an additional series winding in the field of a secondary dynamo. Furthermore, in such arrangements, where the secondary or demagnetizing dynamo does not supply any actual current, but merely produces an opposing electromotive force, the characteristic of the dynamo is nearly a straight line, owing to the absence of armature reaction. In practice it is necessary that the characteristic of the demagnetizing dynamo should be more or less a drooping curve, and to effect this, according to this invention, a double armature is employed from which current can be taken through a resistance adapted to be adjusted as required, thereby introducing armature reaction and causing the characteristic to assume the required form.

A Russian chemist, Professor Emanuel Goldberg, of Moscow, Russia, has patented in this country a new process of electrolytically coating iron with zinc. The invention relates to an improved process for electrolytically coating iron with zinc, the improvement consisting in adding to the electrolyte used an organic compound containing nitrogen. There is much difficulty in electrolytically coating iron with zinc, as the metal coating obtained in this manner either is apt to be deposited in a form which is not white or adheres badly to the surface to be electroplated. By the present invention, however, a pure white coating of zinc which adheres well to the surface of the iron is obtained. The invention for this purpose consists in adding to the electrolyte wherein the iron is to be coated a compound containing nitrogen bound to an organic radical. Suitable compounds are amines, amides, cyanides, nitriles, or like compounds, in which the nitrogen is attached directly or indirectly to an organic radical. The pyridine bases have given the best results. The process is illustrated by the following example: An electrolytic bath is prepared by dissolving ten grammes of zinc chloride and ten cubic centimetres or pyridine in about one litre of water and adding enough hydrochloric acid to dissolve the double salt of zinc chloride and pyridine which is formed. To separate the zinc electrolytically from this bath, a current not exceeding 0.2 ampere per square foot decimetre is required. As anode is used in zinc and as cathode the iron subject to be coated with zinc, which must be freed from fat and oxide. When the concentration of the bath is increased,

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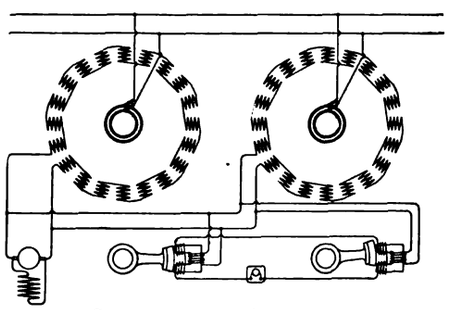
the maximum current density used may be increased. Thus far the inventor has not been able accurately to determine the chemical reasons for the industrial advantages which result from the employment of the class of compounds in which a nitrogen compound is bound to an organic radical. However, it seems that when carrying out the process the zinc is at an intermediate stage combined with the organic compounds, or there is formed an intermediate double compound of zinc chloride with an organic base, to which is due a more extensive decomposition and a more copious separation of zinc, supplying a zinc precipitate, which forms a very strong adhering coating. A simple experiment will show that when coating an object with zinc with a one per cent solution of zinc chloride and employing the current densities which are permissible in the art, a black spongy deposit is formed. If, however, one of the nitrogen compounds set forth in this description is added to the zinc salt in accordance with the invention, a pure white, dense, and, in many cases, even a shining and bright deposit of zinc is obtained.

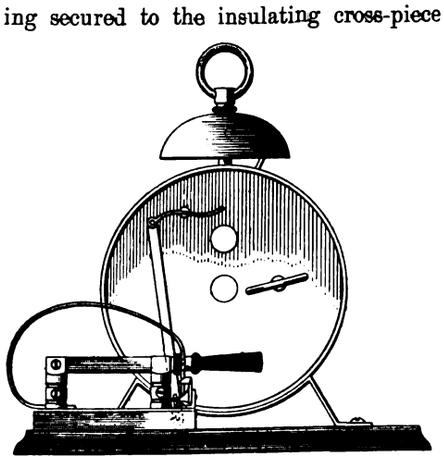
In synchronizing alternators ordinarily but little trouble exists in getting the machines in step, inasmuch as when they are operated in parallel they have a tendency to preserve synchronism or to drop into synchronism when nearly in phase, so that in general no synchronizing devices are required for the machines themselves. In the construction, however, of the larger units, which are directly coupled each to its own engine, some difficulty has been experienced with alternators of many poles, due to the lack of uniformity in the speed during each revolution, which can not be entirely overcome by flywheels. With alternators of many poles a very small fluctuation in speed may be sufficient to break the synchronism. For example, in certain eighty-pole machines a fluctuation of speed of less than one per cent is sufficient to break synchronism if the position of acceleration of one prime mover coincides with the position of retardation of the other or others. It thus becomes necessary in direct-coupled machines to synchronize the engines. A device suitable for this purpose has been patented by Mr. Charles P. Steinmetz, of Schenectady, N. Y., and assigned to the General Electric Company, of New York. The apparatus consists, essentially, of two small magnetic devices akin to transformers. Each of these has cooperating with it an arm or body of laminated material carried upon an arm or otherwise connected with the engine shaft. The magnetic part of the device consists, essentially, of a horseshoe magnet having upon its yoke a small energizing coil which may derive its energy from the exciter circuit or from any other convenient source. Upon the legs of each of these horseshoe magnets are coils in series with each other and having no external source of energy. Those upon one device are wound or connected differentially to those upon the other, and in this circuit is



SYNCHRONIZING APPARATUS.

coupled a lamp or other indicating device, an incandescent lamp being a very convenient form.

A new electric time switch which is within the reach of all storekeepers has been patented by Messrs. Ira S. Callender and Edwin F. Callender, of Galesburg, Ill. In their improved structure, an ordinary knife switch is employed, the blades of which are normally urged to open position by means of a bowed spring, one end of the spring being attached to the base of the switch, the other end being secured to the insulating cross-piece



ELECTRIC TIME SWITCH.

connecting the blades. The free terminal of the spring, which is attached to the cross-piece, has a hook adapted to be engaged by a trigger fastened to the base of the switch beneath the cross-piece and having a pivotal movement. The trigger is provided with an extension finger to which is connected a link that is fastened to the winding stem of the alarm of an ordinary clock. The operation is as follows: The alarm is set in the usual manner at the hour which it is desired that the lamps in circuit with the switch shall be extinguished. The switch is closed and locked by the trigger. As soon as the alarm is set off, the movement of the winding stem actuates the trigger through the medium of the link, thus releasing the switch blades, which are immediately and automatically thrown to open position by the spring.

British Patent Record for the Year 1902.

The twentieth report of the British comptroller-general of patents and trade marks for the year 1902 contains much interesting information. The number of applications for patents, both provisional and complete, shows, on the whole, an increase, and the number of complete specifications was only slightly surpassed by those taken out in 1897. About 2.1 per cent of the patents were taken out by women. Of the patents sealed in 1902, 49.5 per cent were granted to persons resident in the United Kingdom, 2.7 per cent to persons resident in British colonies and provinces and 47.8 per cent to foreigners—Americans accounting for nearly half of the latter. As showing the inventiveness of different countries, the following figures are of interest: One native patent is obtained in the United States for every 3,196 of the population; in Belgium, one for every 4,749; in Switzerland, one for every 5,152; in the United Kingdom, one for every 6,811; in Germany, one for every 8,525, and in Austria-Hungary, one for every 45,720. Patents for electrical appliances did not maintain the position they reached in 1901. In fact, all except two classes have decreased, although not to a great extent. These two are "electricity, conducing," and "electric telegraphs," both of which have increased slightly. The inventions relating to wireless telegraphy have decreased from thirty-one in the preceding year to twenty. In 1902 the development relating to electric traction was continued, though not to the same extent as in 1901. The principal alterations made during the year in foreign and colonial legislation with regard to patents and trade marks occurred in the following states: Belgium, Bolivia, Denmark, France, Honduras, Japan, Netherlands, Norway, Spain, Sweden, Tunis, United States, Bermuda, British Guiana, Lagos and Transvaal. The accommodation provided by the new Patent Office building in Southampton Buildings is already inadequate for the staff. It is proposed to acquire a site for building on the east end of the present offices, and notice was given in November of the intended application to Parliament for an act for the necessary compulsory power of purchase. The expenses of the Patent Office during 1902 were £114,924 10s. 1d., the receipts being £242,285 4s. 9d., leaving a surplus of £127,360 14s. 8d.

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Reviews of Current Engineering and Scientific Literature.

Electrolytic Manufacture of Vanadium and Its Alloys.

The electrolytic manufacture of vanadium and its alloys is described briefly in this article by M. Gustave Gin. The principle of the process depends upon the conducting power of the trioxide of vanadium and the ease with which the trifluoride may be obtained by decomposing trioxide of fluorine in the presence of carbon. The process is carried out by calcining vanadic acid in the presence of carbon, thus forming the trioxide of vanadium. This is mixed with a suitable proportion of bone-black and pulverized so as to obtain a homogeneous plastic mass. The paste is ground by heavy steel rollers in a special mortar externally heated, and is then forced through dies by hydraulic pressure and baked. These electrodes are good conductors, and can support seven-tenths of the current allowable in carbon. The anode is formed of a bundle of these rods, the cathode is a plate of steel or other metal which is to be alloyed with the vanadium. The electrolyte is the trioxide of fluorine, into which small pieces of the metal to be alloyed are introduced from time to time. The apparatus must be arranged to maintain a high temperature. The current density may be from two to six amperes per square centimetre. The pressure required is eleven to twelve volts. To obtain alloys with more than twenty-five per cent of vanadium, the cathode section should be considerably less than that of the anode.—*Translated and abstracted from l'Industrie Electrique (Paris), July* 10.

The Electric Tramways of Sydney, Australia.

The tramway system of Sydney, the capital city of New South Wales, dates from the early sixties. A horse line was laid down, but as the rail was laid above the level of the street, the line was soon discontinued. In 1879 a line was laid down to connect the town with the terminus of the state railway. This was operated entirely by steam for seven years. Later a cable line was put in at North Sydney, which was so successful that another cable line was laid down later on. In 1895 it was decided to build an electric line. The first section of this was opened in 1899, and has operated with such success that not only are new lines about to be built, but the steam and cable tramways are being converted to the trolley system. There are many hills in the city, some of the grades being as steep as eight and one-half per cent. On these grades a counterweight system has been adopted as a special precaution. A feature of the track construction is the adoption of eighty-pound T-rails, with a provision of milled rails and fish-plates, the rails being specially butted. The bolts make a driving fit. No expansion due to temperature rise is possible. Bonding is provided by the insertion of a thin sheet of copper between the top and bottom edges of the fish-plate and the surface of the rail. The overhead trolley system is used exclusively, with both side-pole, centre-pole and span construction. The system of distribution is direct-current supply to the immediate vicinity of the power-house, and high-tension supply by three-phase currents to the outlying districts. The harbor is crossed by two lengths of paper-insulated, lead-covered, double steel wire sheathed cables, each 2,700 feet long. The power station contains four cross-compound condensing horizontal engines of 1,250 horse-power each, direct-coupled to an 850-kilowatt compound-wound railway generator, and three cross-compound condensing engines of the vertical type, rated at 2,850 horse-power each, each direct-coupled to a 1,500-kilowatt three-phase rotating-field alternator furnishing current at 6,600 volts, twenty-five cycles. The cars are operated both singly and in pairs. Special couplers have been designed for this purpose, and four-motor controllers placed on the cars. When heavy traffic demands special accommodations, a trailer is added to the train.—*Abstracted from the Tramway and Railway World (London), July* 9.

The Brussels Electric Tramways.

This is a very complete description by MM. E. D'Hoop and J. Pedriali of the modern electric railway system of Brussels. Power is generated at a large central station and transmitted at high voltage to three substations. The main generating station contains four groups of 1,500 kilovolt-amperes each. The engines are horizontal, tandem-compound, condensing double engines, direct-connected to three-phase alternators having thirty-two poles and generating current at 6,600 volts, twenty-five alternations per second. There are three exciting groups, two driven by induction motors, the third by a small steam engine. Parallel with these is a battery of accumulators. The switchboard is of the latest high-tension type with oil-break switches enclosed in separate brick chambers. The boiler room contains twelve water-tube boilers with chain grates and automatic coal-handling apparatus. The three substations contain each five six-phase synchronous converters of 200 kilowatts, delivering current at 550 volts. Each is furnished with three transformers reducing the pressure from 6,600 to 410 volts, alternating. Each station has a motor-generator starting set consisting of a direct-current machine driven by a 6,600-volt induction motor. There is in parallel with this starting set a small storage battery for furnishing light when all of the machinery is shut down.—*Translated and abstracted from the Bulletin of the Association des Ingénieurs Electriciens (Liege), June* 30.

Induction Machines and a New Type of Polyphase Generator.

This is the second paper on this subject by Mr. A. C. Eborall, and in it are taken up the methods of winding and connecting the secondary. Transformers are not necessary, except in the case of high voltages, as the stator windings can be utilized directly for the compounding circuit. These fully compounded induction generators operate at practically synchronous speed, and it is perfectly practicable to operate such a station with compensated machines alone, provided the frequency is set by a small synchronous machine. But such a station would not be self-regulating unless the wattless component of the load had a constant value. However, a compounded induction machine in the station, in parallel with a number of over-compensated generators, will make the plant nearly self-regulating with varying loads and power-factors. The compounded machine sets the frequency and automatically takes up the variations in the wattless current. In the commercial form of this generator the rotor has a double winding, each phase consisting of two separate windings arranged side by side in the same slots. The four ends of each phase are connected up to form a six-branched star to a six-part commutator. With this arrangement there is no sparking, as the self-induction of one star is completely neutralized by the mutual induction of that parallel to it. Owing to the nature of this winding it is not necessary to short-circuit the commutator, as the winding itself performs the same

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function in an effective way. To avoid the complication of more than three brushes on the commutator of actual multipolar three-phase machines, it is usual to cross-connect the segments. Heyland has further applied his method to synchronous generators. The armatures of these machines are standard in all respects, and so is the magnet wheel proper. This magnet is given a special winding, which consists of a number of parallel circuits—usually four—connected together and to a commutator, this commutator taking the place of the usual exciter. A six-pole, twenty-kilowatt, fifty-cycle machine has a commutator of thirty-six parts. The four field windings are connected to four consecutive bars of the commutator, the bars of which are cross-connected as for a six-pole machine. Between each set of four bars there are then two idle segments. By means of three brushes, current from the armature is led into this commutator. Although the machine has but four segments per pole, the actual pulsations in the field strength are quite insignificant, due to the damping effect of those circuits which are short-circuited through the commutator. The results of a test on a machine of this kind are given. These show that this particular machine could be over-compounded ten per cent on a load with a power-factor of eleven per cent, and about four per cent on a non-inductive load, with a fixed adjustment of field-regulating resistance. A power station laid out with such machines will consequently be made nearly self-regulating for constant pressure at the receiving end of the transmission line, no matter what the magnitude or nature of the load may be. A further improvement in this machine is the use of the diverting reactance coil, in place of the diverting resistance, an idea due to Mr. E. Kolben. The advantages of this type of machine are the doing away with the exciter, and the use of standard field and armature carcases. Further, the air-gap can be reduced considerably, being limited only by mechanical considerations. Consequently, less copper is required on the field than for the older type of synchronous machine.—*Abstracted from the Electrician (London), July 10.*

The Rand Central Electric Works.

This company's central power station at Brakpan is now the largest at work in South Africa. The great difficulties met in that country in securing water and coal have been overcome by selecting a site on the borders of a large dam, and within sight of several large collieries. The frequent and severe lightning storms of that section made special protection against this danger necessary. The generating plant consists of four 1,000-horse-power, triple-expansion, condensing engines, direct-coupled to four 800-kilowatt, three-phase alternators generating electricity at a pressure of 800 volts with a frequency of fifty cycles per second. The engines are frequently called upon to develop 1,200 horse-power. They take steam at 175 pounds, and with an average vacuum of twenty-five inches the steam consumption generally runs no higher than 15.4 pounds per horse-power-hour. The switchboard is fixed in a recess off the centre of the engine room. It is fitted with Ferraris instruments. Current enters the board from the generators at 800 volts, and from the bus-bars passes to the transformer platforms which are erected at the further end of the engine room. Here are installed sixteen 200-kilowatt three-phase transformers, which raise the pressure from 800 volts to 12,000 volts. The pressure on the secondaries varies from 10,000 to 12,000, according to the load. The line consists of twenty-eight miles of conductors running along the veldt to Johannesburg, and branching off to the various mines supplied on the way. The cables are three double, bare wires, supported by steel poles twenty-eight feet high. A high line efficiency is obtained, as the loss due to leakage, resistance and in transformers is only seven per cent. Each mine is supplied with a separate transformer station, where the pressure is reduced to 120 volts for lighting and 250 volts or 500 volts for power purposes. The largest consumer is the Johannesburg municipality, which uses 800 kilowatts. The contract with the municipality stipulates that the secondary pressure shall be kept within two and one-half per cent of 2,000 volts. This regulation is obtained by two automatic regulating transformers. One of these operates by changing the transformer ratio; the other by changing the power-factor of the transformers. The highest maximum load is 2,200 kilowatts. The average maximum load is 1,600 kilowatts. The cost of generation is about three halfpence per unit.—*Abstracted from the Electrical Review (London), July 10.*

The Production of Nitric Acid by Electrical Discharges.

In this article M. de Kowalski describes a method of forming nitric acid by means of the electric arc, which has been developed by himself and M. Moscicki. The author gives, first, a brief summary of the work of previous experimenters and a short explanation of the chemical reactions, but states that he thinks the reactions due to the arc are more complex than those usually given. In 1899 he noticed that the efficiency of the reaction produced in air was increased considerably with an increase in the frequency of the alternating current used, and his work has been conducted along lines to make use of this fact. McDougall and Howells obtained an output of 33.6 grammes of nitric acid per kilowatt-hour with a current of 0.2 ampere between electrodes, while the author, with a frequency between 5,000 and 6,000 periods per second, has obtained an output of 43.5 grammes per kilowatt-hour with the same current intensity. This output is considerably increased if oxygen be added and the air treated. With a current of 0.05 ampere, a difference of potential of 50,000 volts and a frequency of between 6,000 and 10,000 cycles per second, the maximum output of fifty-two to fifty-five grammes per kilowatt-hour of nitric acid with ordinary air was obtained. This output can be nearly doubled by adding fifty per cent of oxygen. He has obtained an increase of about twenty per cent by adding only five per cent of oxygen to the air. The necessary conditions for an industrial process are to obtain the greatest output for the electrical energy used; to be able to use large amounts of power, and to obtain an apparatus which will not deteriorate. In the method developed by the author and M. Moscicki, the discharge of a condenser in an inductive circuit is used to give the high frequencies. For this purpose a twenty-five-kilowatt oil transformer is used to supply the high potential. One main of this transformer is connected to circuits, each containing a spark-gap, a condenser and a small inductance. These circuits are grouped in threes and connected through a coil having a relatively high inductance to the other lead from the transformer. When the condensers are charged, they discharge across the gap and set up through the local circuits oscillating currents. The object of the large inductance coil is to prevent these oscillations from reacting upon the transformer. In addition to these circuits a compensating coil is connected in parallel with the primary of the transformer. A special type of condenser has been developed for this work. This is constructed by silver-plating the inside and outside of suitable glass tubes. The cost of these condensers per kilovolt-ampere is about fifteen francs ($3). The loss in these condensers from accurate measurements was found to not exceed one per cent. The electrodes are enclosed in a stoneware vessel one and one-half metres in diameter, those leading directly from one lead being attached to an aluminum axle. The others are placed radially and insulated by porcelain. Back of each is an opening for the exit of the gases.—*Translated and abstracted from the Bulletin de la Société Internationale des Electriciens (Paris), June.*

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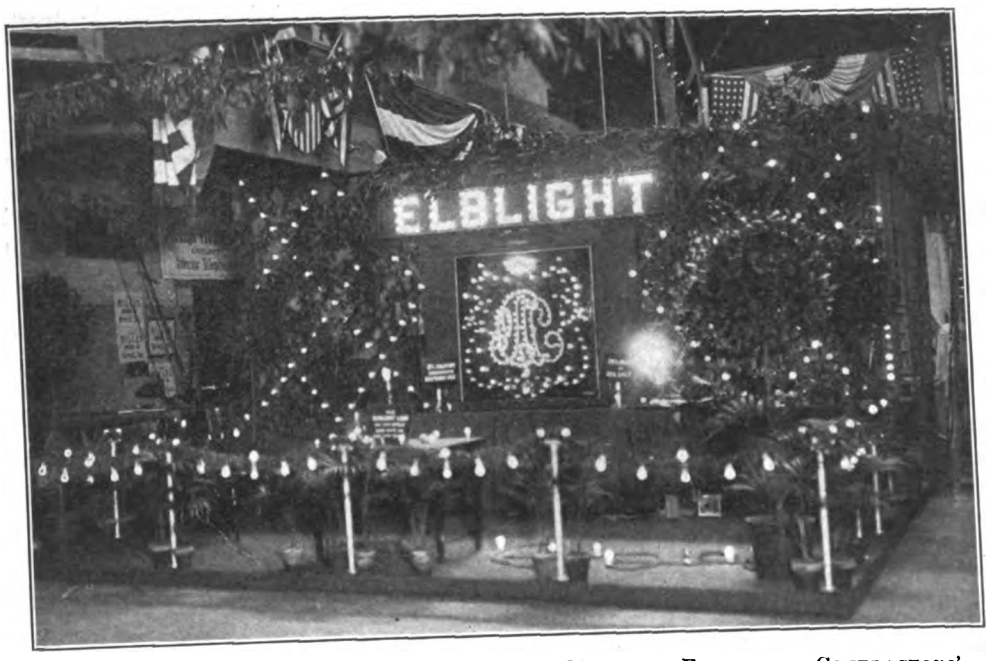
INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Effective Decoration with Incandescent Lights.

The exhibits made in conjunction with the recent convention of the National Electrical Contractors' Association were carefully arranged in the Light Guard Armory Building. The interior of this building was decorated with 5,000 Elblight lamps strung on the graceful curves of Elblight cable, which formed a trellis over all the main and side aisles between the exhibits. The aisles were also profusely decorated with greens. The lamps used were American Beauty pink, alternating with apple green. The outside of the armory was festooned with white frosted lamps, and across the street swung a flag mounted on a flexible Elblight cable, into which lamps were stuck so that they and the flag followed the undulations produced by the passing breezes.



DECORATIVE LIGHTING AT THE EXHIBIT OF THE NATIONAL ELECTRICAL CONTRACTORS' ASSOCIATION CONVENTION. THE ELBLIGHT SYSTEM.

In addition to the interior decorations mentioned, the Elblight Company had an attractive and unique exhibition in the space allotted to it, which is shown in the accompanying illustration. The chief novelty was the festooned hand rail made of silk cable into which varied colored lamps were stuck. The cordon thus formed was decorated with smilax, and the supporting iron posts were surrounded by palms.

In the back of the space, against the wall, hung an iron frame surrounding an Elblight board on which the word "Elblight" appeared. Under this a second board, four by four, was covered with a handsome monogram which was outlined by several hundred miniature lamps of various colors. An Elblight table was also shown.

An interesting technical exhibit consisted of three jars in which Elblight lamps stuck on Elblight cables were burning submerged. The centre jar contained an Elblight lamp mounted on a cable, which has been burning continuously under water for over four months. To the right was a similar lamp burning in a saturated solution of sea salt; and to the left, a third lamp was burning in a fifteen per cent solution of concentrated sulphuric acid. These exhibits show the water-proof and weather-proof qualities of the system, as well as the high grade of insulating material employed in the manufacture of Elblight material.

At the close of the convention this entire exhibit, as well as the inside and outside decorations of the hall itself, were taken down intact, labeled and shipped out of the armory in five hours, this task requiring five men.

The Elblight Company was represented by Mr. Russell Spaulding, president; Mr. Eugene H. Abadie, general manager, and Mr. J. C. Schaeffer, superintendent of construction.

Self-Ignition for Internal Combustion Motors.

A consular report states that a French patent has been taken out by the firm of De Dion-Bouton upon a self-ignition device for internal combustion motors. A small cylinder is fastened to the side of the working cylinder, with an opening connecting the two. The piston of the small cylinder reciprocates at one-half the rate of that of the larger one. An explosive mixture is drawn into the small cylinder on its down-stroke, and this is compressed to such a degree on the up-stroke that it ignites spontaneously, and fires the charge in the working cylinder, the flame communicating by the opening referred to.

The Subway and Arc Lamp System of Cincinnati, Ohio.

The accompanying illustration shows one of the street arcs which has recently been installed by the Cincinnati Gas and Electric Light Company in Cincinnati, Ohio. There are 922 of these arc lamp poles, and the subway system includes over 10,000,000 feet of conduit. This conduit was all laid by Mr. G. M. Gest, of Cincinnati and New York city. Mr. Gest has had the general contracts for a number of large undertakings, and this is one which has been finished with the usual success which has followed his work in this direction.

TYPE OF ARC LAMP POLE USED IN CINCINNATI, IN CONNECTION WITH THE SUBWAY SYSTEM.

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New Type of Incandescent Lamp.

Many classes of general illumination demand a unit of light between the arc and the incandescent lamp. Such a lamp should combine the perfect simplicity of the ordinary incandescent lamp with the high economy of the arc lamp. Its illumination should be powerful and uniformly distributed in all useful directions, brilliant in intensity, pleasant in quality and absolutely steady. These requirements are met by the Meridian lamp, a new type of incandescent lamp, which has been introduced by the General Electric Company to cover the field of lighting for which the arc light is too large and the incandescent light is too small. These lamps are now supplied by the General Electric Company from its incandescent lamp sales offices at Harrison, N. J., and are shown in the accompanying illustrations. From these illustrations it will be seen that the Meridian lamp is a neat and novel combination of a properly designed incandescent lamp with a suitable reflector and ornamental collar detachable from the lamp. The lamp filament is of special shape and accurately located in the bulb with reference to the reflector. The combinations of these features with a sand-blasted globe produce a soft brilliant white light, uniformly distributed. The lamp is very attractive in appearance and effective in results.

The Meridian lamp is as free from all complexity as the ordinary incandescent lamp. Any one can renew the lamp when burned out. Its efficiency is high, it is inexpensive in first cost and in maintenance and its renewal cost is the same as ordinary incandescent lamps. It may be operated on either alternating or continuous-current circuits, on all commercial frequencies and on any of the usual standard voltages, fits in standard sockets and requires no special connections.

The Meridian lamp is designed for interior lighting, not only where artistic effects are essential, as in residences, hotels and theatres, but also where the chief requirement is the greatest amount of evenly diffused light for the least consumption of energy, as in office buildings, libraries, studios, drafting rooms, factories and retail stores. It is especially suitable for low ceilings and window lighting, and as it is not affected by vibration or acid fumes, can be installed at any angle and in confined and inaccessible places. There is no possibility of danger from fire as the lamp is immediately extinguished when the globe is broken.

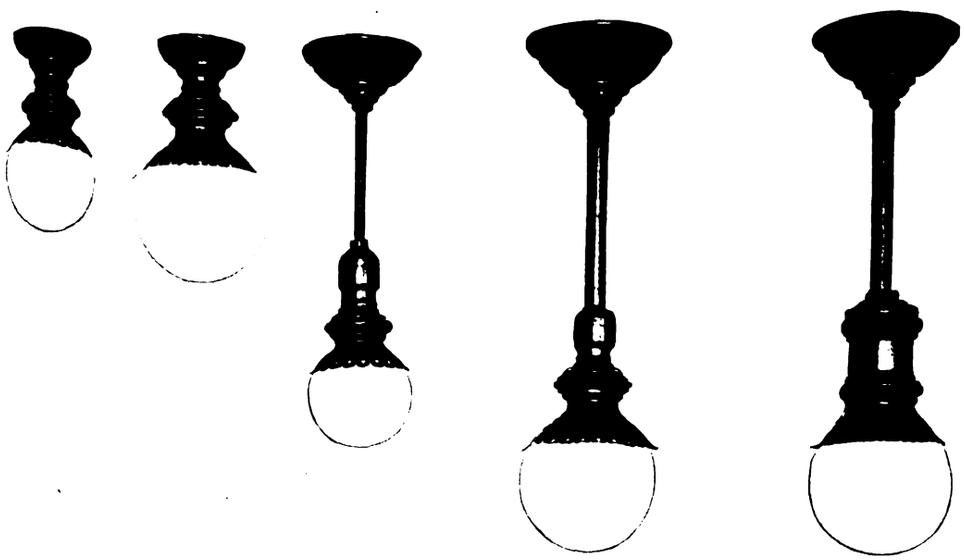
Room Lighted by Meridian Lamp, Showing Good Distribution of Light.

Each Meridian lamp when properly installed distributes a uniform candle-power over a circular area having a diameter equal to the height of the lamp above it. Thus a lamp suspended ten feet from the floor will give a uniform candle-power at all points of a circular area of the floor ten feet in diameter.

The Meridian lamp is made in two sizes.

The No. 1 lamp giving twenty-five candle-power and consuming sixty watts. The No. 2 lamp giving fifty candle-power and consuming 120 watts.

The No. 1 lamp is especially suited for residence lighting, for deck and table illumination, while the No. 2 lamp is best suited for general illumination of interiors of stores, offices, etc. Both lamps are supplied with simple collar and reflector or extension tube fitting and in various designs as shown in the accompanying illustrations. The extension tube fitting is the more desirable type as with the usual height of ceiling it suspends the lamp about eight or ten feet from the floor—a suitable height for good uniform illumination. For very low ceilings the lamp may be used with single collar and reflector, fitting the lamp directly on the ceiling in suitable wall receptacles. For very high ceilings the extension tube fitting with the extra length of tubing should be ordered.



Various Forms Ceiling and Extension Tube Fixtures Used with the Meridian Lamp.

Lamps are fitted with either Edison or T-H base and bulbs are frosted unless otherwise ordered. The General Electric Company reports that over 20,000 of these lamps have already been sold and the lamp has met with marked favor and approval. There exists a demand for a unit of light in the field between the arc and incandescent, and central stations should find it to their interests to introduce the Meridian lamp among their customers as an excellent device for this class of lighting.

An interesting bulletin has been issued by the General Electric Company on the Meridian lamp giving full illumination data. A number of central stations have placed the Meridian lamp on the free renewal list along with the regular incandescent lamps.

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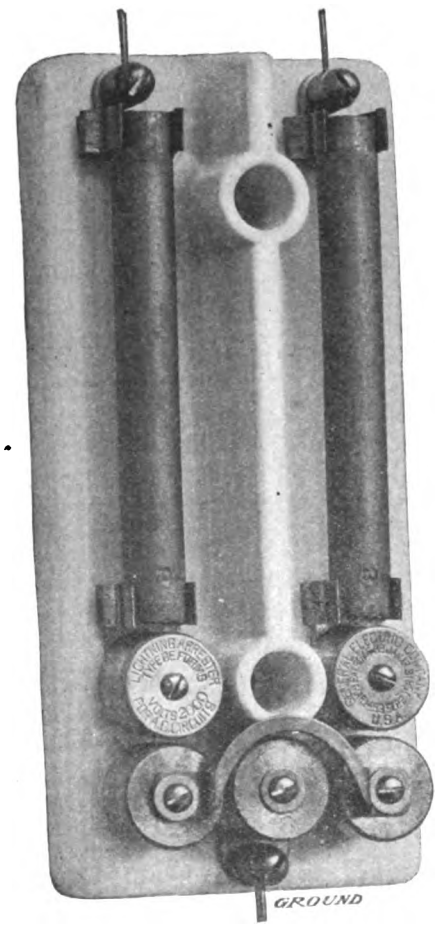
A New Development in Lightning Arresters.

Whenever alternating-current circuits contain both inductance and capacity in appreciable quantities, high voltages are likely to exist which endanger the insulation of the whole system. Such abnormal voltages are especially likely to occur in lines containing a combination of underground and overhead circuits.

The General Electric Company, Schenectady, N. Y., is now supplying alternating-current lightning arresters so designed as to protect against lightning and at the same time to act as a safety valve with reference to high voltages due to causes other than lightning. These high-voltage conditions in a great many cases may not be recognized by the central station manager unless they are brought to his attention by the frequent breaking down of insulation, and even then the troubles are often ascribed to other causes. The strains very often produce pin-hole punctures in the insulation of underground cables and thus relieve themselves temporarily; they may therefore remain unnoticed for a number of months until the insulation becomes very much impaired, ultimately resulting in a complete breakdown.



ALTERNATING-CURRENT LIGHTNING ARRESTER.

It is very difficult to detect the existence of these excessive voltages with switchboard instruments commonly in use. In the first place, most voltmeters are installed on potential transformers. When these abnormal pressures exist, the wave is of enormous high frequency and will not appear on the secondary side of the transformer, due to the fact that the eddy current set up in the iron by the high frequency is so great as to dampen out the wave and prevent its reappearance on the secondary side, but it is difficult to measure this pressure even with such instruments as electrostatic voltmeters installed directly across the high-pressure wires. This is because the wave is of short duration and its integrated value is so small and the time element of the moving mechanism of the instrument so large comparatively that the instrument will not record the disturbances. Practically it has been found that only spark-gaps or some form of wave-meter which records instantaneous value is of any service whatsoever for such measurements.

The new lightning arrester known as the "Multiplex" performs the multi-function of protecting against lightning, resonance or other high-voltage disturbances on the line. The arresters are installed directly across the lines, the centre of the arrester being connected through an additional installation of arresters, so proportioned that there are the same number of gaps from either line to line as from line to ground.

Motor-Driven Grinders.

In the accompanying illustrations are shown two types of motor-driven grinders made by the Ransom Manufacturing Company, of Oshkosh, Wis. Fig. 1 shows a motor-driven dry grinder. These machines are designed for use in grinding castings and other work of a similar nature. With the electric drive they can be placed anywhere, at any angle to the buildings, or in buildings which are covered with cranes; and with the flexibility of the electrical connector they can be placed a long distance from the power

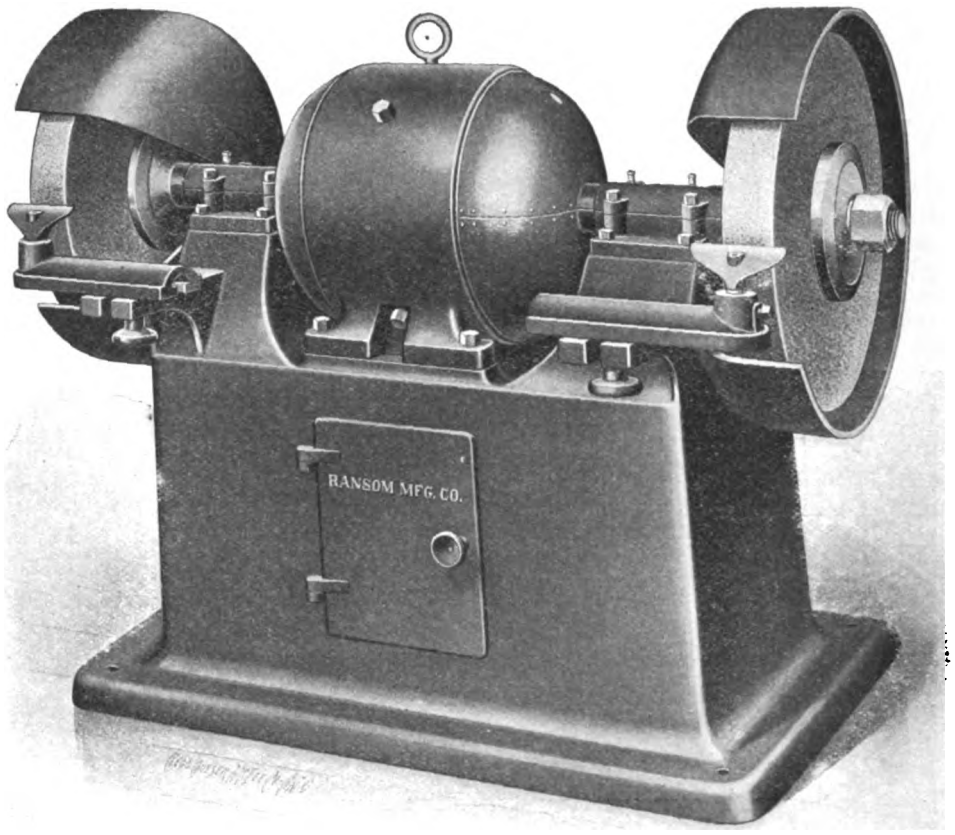


FIG. 1.—MOTOR DRIVEN GRINDERS, WITH ENCLOSED MOTOR SET BETWEEN EMERY WHEELS.

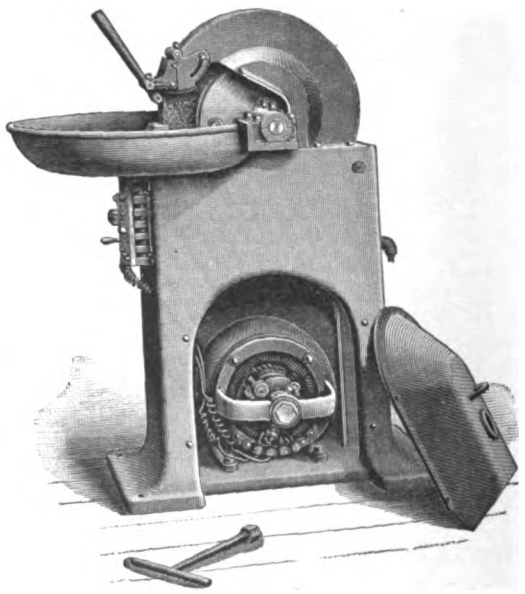


FIG. 2—WATER TOOL GRINDER, WITH MOTOR IN BASE OF MACHINE.

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plant. The advantage of a motor-driven grinder is apparent from the fact that in but a few machine shops is it necessary to keep the grinder working at all times. With the belt-drive a line shaft must be used to connect it with the other power apparatus, and, at best, a loose pulley must be kept going at all times. With the motor-drive the grinder can be entirely isolated from the other machinery, and the power cut off and only used when the motor is in positive operation.

The hoods on this machine are arranged so that exhaust pipes can be readily attached to carry off all emery dust. The machines are for direct current only. The armature is wound on the sleeve which is keyed to the same spindle that carries the emery wheels. The motors are of the mutlipolar type, compound-wound, and entirely enclosed. These are of the well-known Akron Electrical Manufacturing Company's design. Part of the shield can be removed to adjust the brushes, and the motor is absolutely dustproof.

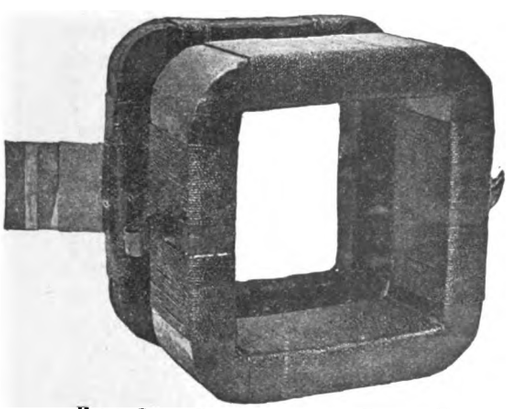
The bearings are dustproof and ring-oiling, and the dust boxes are similar in construction to engine lathe boxes. Oiling devices are so arranged that the oil can not run out of the boxes into the motor. Guards are provided to prevent any danger from bursting emery wheels.

A starting box is placed inside of the machine, and an automatic releasing starting box and switch are furnished.

Fig. 2 shows a water tool grinder, with the motor in the base of the machine, access being had by a removable door in the side of the base of the grinder. The starting box is arranged conveniently at the front of the machine, and is protected from the overhanging bowl in front.

Direct-Current Engine-Type Generators.

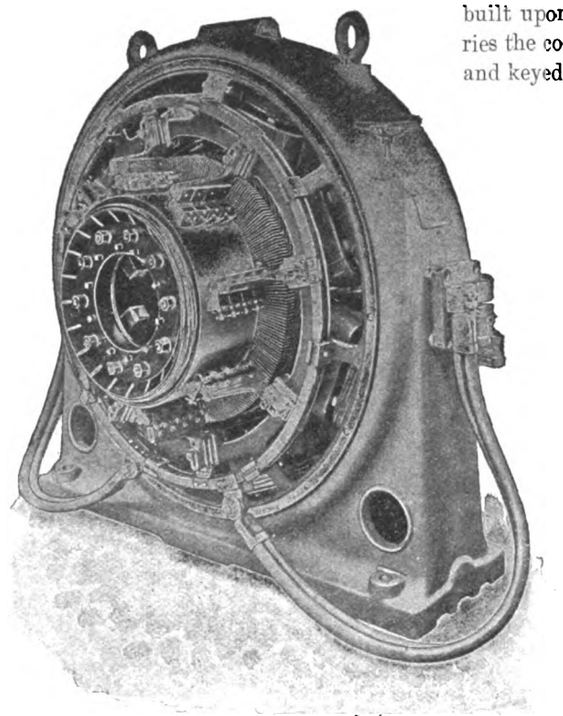
The accompanying illustrations show the field coils, armature and a direct-current engine-type generator for lighting



FIELD COILS, DIRECT-CURRENT ENGINE-TYPE GENERATOR.

and power manufactured by the Westinghouse Electric and Manufacturing Company, of Pittsburg, Pa. These direct-current engine-type generators are widely used for lighting and power service. The 125-volt generators of this type are generally used for isolated plants where the circuits are not of excessive length. Where the circuits are of great length or the generator load consists largely of motors, 250-volt generators are usually employed. These are used extensively for supplying power to motors driving machine tools of various descriptions in factories, mills and mines.

The general design of these machines consists of a circular yoke carrying inwardly projecting pole-pieces of laminated soft steel. The field castings are divided vertically and set upon a guide plate. This vertical division of the field

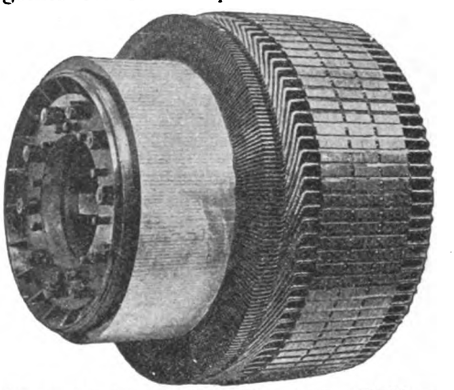


WESTINGHOUSE DIRECT-CURRENT ENGINE-TYPE GENERATOR.

affords facilities for the inspection or the removal of the armature or field coils, without the necessity of removing the outboard bearing or dismantling the engine. The opening of the field in a horizontal direction is of great convenience where head room is limited, but cranes or other devices for handling heavy castings are not available. These machines are also built with horizontally split fields.

The shunt and series coils are separately wound, and are easily removable. The series coils are composed of forged copper conductors of rectangular section. The generators are over-compounded to compensate for the drop of potential in the line. By means of a shunt on the series coils the compounding may be adjusted for different degrees of over-compounding.

The armature core consists of punchings of carefully annealed steel, held together between end-plates. This core is



COMPLETE ARMATURE, 75-KILOWATT, 125-VOLT ENGINE-TYPE GENERATOR.

built upon an iron spider, which also carries the commutator. This spider is pressed and keyed upon the extended engine shaft, and may be drawn off, should that ever be necessary, without in any way interfering with the permanent arrangement of the commutator and winding. Ventilating spaces through the spider and armature core are so arranged as to give a constant circulation of air through the commutator and winding.

The periphery of the armature is slotted. The armature winding of all machines of fifty volts and over is made from bars of drawn copper, forged into proper shape in cast-iron forms. After being thus shaped the bars are thoroughly insulated and baked to remove all moisture. The coils are held in slots by means of retaining wedges of hard fibre driven into notches near the top of the slots, parallel with the slot. These fibre wedges may be pressed out should it become necessary to remove any armature or coil. Smaller armatures have wire winding and are strongly banded.

Commutators are constructed from the best obtainable grade of hard-rolled copper, the segments being spaced by prepared mica of such corresponding hardness that an even rolling surface is presented to the brushes.

The brush-holder mechanism is carried by brackets projecting from a ring concentric with and supported by the field. The hand-wheel rocker arrangement accomplishes the adjustment of all the brushes simultaneously. The supporting ring carrying the brush-holder rod lies close to the fields, and does not project over the commutator, making the commutator brushes clear of obstructions and easy of inspection at any point.

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Annual Meeting of the Association of Edison Illuminating Companies.

The nineteenth annual meeting (twenty-fourth convention) of the Association of Edison Illuminating Companies will be held at the Frontenac, Thousand Islands, St. Lawrence River, New York, September 8, 9 and 10, 1903.

A number of valuable papers are in course of preparation on subjects pertaining to the business of the member companies, and already there are indications which point to the coming convention as probably the most valuable of a series of excellent conventions. The Edison association was organized in 1885 by companies licensed under the Edison patents. It embraces nearly all of the present licensees under these patents.

The Edison conventions are noted for their close attention to business, the absence of junketing and the higher beneficial results to its members. The place of meeting this year is selected because of the absence of outside allurements, with the expectation that this convention will exceed all others in the strict attention to business, for which the conventions of the Edison association have always been noted.

A list of the papers presented and subjects discussed will be published later.

Following is a list of officers of the association: President, Louis A. Ferguson, Chicago, Ill.; vice-president, A. W. Field, Columbus, Ohio; treasurer, Alex. Dow, Detroit, Mich.; secretary, Walter H. Johnson, Philadelphia, Pa.; assistant secretary, Wilson S. Howell, New York, N. Y.

Electrical Driving of Winding Gears.

At a recent meeting of the Mining Engineers' conference in London, Mr. F. Hird gave a sketch of the progress which had been made in the electrical driving of winding gears. The chief problem here is finding the most suitable method of control. The motor, itself, is a well-tried machine and presents no difficulty, but the controlling apparatus must be designed to meet the severe conditions of frequent starting and stopping. It must provide great accuracy of control, and must permit of steady running at slow speeds for the purpose of inspecting and repairing in the shaft. The various systems which have been used were described, and the advantages and disadvantages of each pointed out. The question of equalizing the load upon the station was then taken up, and the Siemens-Ilgner system, which accomplishes this, was described. With this system a total efficiency of sixty per cent under working conditions is expected. The author considered that the application of electricity to winding gears had developed sufficiently to be considered within the range of practical possibilities for mines and collieries in England.

A Carload of Wattmeters.

The accompanying illustration shows a car containing some 1,400 instruments of the well-known Stanley type, which were shipped by the Stanley Instrument Company, of Great Barrington, Mass., through its Pacific coast agent, Messrs. John Martin & Company, of San Francisco, to the Edison Electric Company, Los Angeles, Cal. These instruments will be used for current measurement in comparatively small installations of general house lighting. Their aggregate capacity is about 3,000 horse-power, and the total weight of the shipment is nearly 40,000 pounds.

Send This CAR LOAD of
1400
STANLEY MAGNETIC SUSPENSION ELECTRICITY WATTMETERS
STANLEY INSTRUMENT COMPANY, GREAT BARRINGTON, MASS
EDISON ELECTRIC COMPANY, LOS ANGELES, CALIFORNIA

A CARLOAD OF 1,400 WATTMETERS.

The company states that, besides shipping its product to all parts of the United States, meters have been sent to Mexico, South America, Porto Rico, etc., and since the beginning of this year, when an office was established at 25 Boulevard des Italiens, Paris, a strong demand for these wattmeters has arisen in France, Italy, Germany, Austria, Hungary, England and the British possessions. This bears out the reputation of this company for high-class goods.

Belleville Portland Cement Company.

A novel application of induction motors is to be made by the Belleville Portland Cement Company in its cement plant at Belleville, Ontario, which is to be equipped throughout with Westinghouse electrical apparatus.

A recent order placed with the Westinghouse Electric and Manufacturing Company comprises two 450-kilowatt, engine-type alternators, one 100-kilowatt, direct-current, engine-type generator, and a motor-generator set consisting of a 100-kilowatt, direct-current generator and a 150-horse-power, three-phase, type C induction motor. These two direct-current machines are to be used for exciting the fields of the alternating-current generators, for supplying lighting circuits and for the operation of a tramway locomotive.

Sixty-two induction motors will supply the motive power. These include forty-six type C constant-speed motors, ranging in capacity from ten to fifty horse-power; ten type F, variable-speed induction motors, each to be direct-geared to a rotary kiln and provided with a controller permitting the operation of the motor at any one of four speeds; two type F motors, each to be direct-connected to a hoist and provided with standard non-reversing hoist controller; also four 400-volt, type C variable-speed induction motors for the operation of two overhead traveling cranes, these being provided with reversible crane controllers.

Included in the equipment is a Baldwin-Westinghouse mining locomotive for operation on a twenty-four-inch gauge track with double trolley.

The ten-panel switchboard consists of two generator panels, three alternating-current feeder panels, a double exciter panel, a direct-current feeder panel for the control of the tramway circuit and another to control the circuits of the generator fields, and two direct-current feeder panels for the lighting circuits.

Altogether this will be a novel and interesting plant, as the operation of rotary kilns by direct-connection to variable-speed induction motors is a new departure from the usual method of supplying power to this class of machines.

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CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

LOS ANGELES TRACTION COMPANY CHANGES HANDS—H. E. Huntington has secured control of the Los Angeles Traction Company, paying $1,500,000. The authorized capital of the Huntington system is $10,000,000, of which $4,520,000 is outstanding, and it operates about 320 miles of road.

NEW OREGON POWER PLANT—Work is to be pushed on the Eagle Creek power plant, about thirty miles east of Baker City. The machinery has been contracted for, and the flume and powerhouse will be built at once. A careful survey of the water supply has demonstrated that 10,000 horse-power can be developed at the lowest stage. The transmission line for this power plant will be 110 miles long, and will include La Grande, Union and Baker City. It is expected to have the plant ready for operation by the end of the year.

COMPLETION OF LONG INTERURBAN ELECTRIC ROAD—The interurban connection between Richmond and Eaton, Ohio, has been opened, completing the line between Newark, Ohio and Indianapolis, stated to be one of the longest traction lines in existence, the distance being 250 miles. The connecting lines are the Indianapolis & Eastern, the Richmond Street and Interurban Railway Company, the Dayton & Western and the lines of the Appleyard syndicate, and some of the principal cities passed through are Eaton, Dayton, Springfield, Hamilton, Cincinnati, Columbus and Newark.

COMMERCIAL CABLE COMPANY'S PLANS—The Pacific Commercial Cable Company will, it is announced, lay a cable from Manila to Shangai, and surveys for the work will shortly be made. This company's service to Manila, P. I., is now open to the public. The rate from San Francisco to Honolulu will be reduced from fifty cents per word to thirty-five cents per word. The following rates will take effect to other points: From San Francisco to Midway Islands, 60 cents per word; to Guam, 85 cents per word; to Luzon, $1.05 per word; to all other Philippine Islands, $1.15 per word; to Hongkong, $1.10 per word; to China, $1.10 per word; to Macao, $1.15 per word; to Japan, $1.41 per word; to Chemulpo, Fusan, and Seoul in Corea, $1.41 per word; to other places in Corea, $1.49 per word; to Formosa, $1.21 per word.

TO CONSTRUCT LARGE POWER PLANT—It is reported that a strong organization of capital is being formed in Pittsburg and western Pennsylvania to supply Pittsburg and the surrounding towns with power from near-by coal fields direct at low cost. General A. J. Warner, of Marietta, Ohio, and other prominent business men are said to be interested. A large block of coal has been secured in Washington County, Pennsylvania, and Brooke and Marshall counties, West Virginia. The proposed plan of the new syndicate is to build central power plants in the coal field and distribute the power electrically. It is estimated that more than 400,000 horse-power is used annually by the manufacturing industries in the district, and that the saving to Pittsburg alone would be about $2,000,000. The project is said to be heavily capitalized.

BAY STATE GAS COMPANY TO BE REORGANIZED—A committee consisting of Titus Sheard, W. J. Arkell and C. S. Drummond, representing American interests, and the Earl of Kintore and E. Hall Craggs, representing English interests in the Bay State Gas Company of Delaware, has been formed to effect a reorganization. The new company will be the United Gas and Electric Company, organized under the laws of Delaware, with a total authorized capital of $26,000,000. Of this capital $10,000,000, par value, will be used to acquire the capital stock of the United States Light and Heating Company of New Jersey, and $15,710,000, par value, will be offered to the shareholders of the Bay State Gas Company. The remainder of the stock of the United States Gas and Electric Company will remain in the treasury for the future uses of the company.

ELECTRIC LIGHTING.

DETROIT, MICH.—Plymouth's council has accepted a proposition for an electric light plant to cost $10,538.

DAVENPORT, IOWA—Work has been commenced on the electric light plant for Guthrie Center. It will cost $20,000.

DENVER, COL.—The Loveland Light, Heat and Power Company has secured a twenty-five-year franchise from that city. Its present franchise is about to expire.

FERTILE, MINN.—At a meeting of the village council a twenty-year franchise was granted to George Kronschnabel to put in and operate an electric light plant.

CEDAR CITY, UTAH—The council has granted a twenty-five-year electric lighting franchise to Charles M. Lang, of Salt Lake City. Work on the plant is to begin within sixty days.

LEXINGTON, N. C.—The Lexington Water and Light Company has been incorporated with a capital of $75,000 by the following: W. G. Perry, J. B. Smith, G. W. Montcastle, J. M. Riley, R. L. Burkhead, of Lexington, and F. W. Siebert, of this city.

NYACK, N. Y.—As a result of negotiations which have been under way for some time, the Rockland Light and Power Company has secured control of the Haverstraw Electric Light and Power Company, and will make many improvements to the plant.

YORK, PA.—George R. Heisey, of Marietta, and Eli L. Nissley, of Florin, have bought the Marietta Light, Heat and Power Company's plant. They have also bought the Elizabethtown electric light plant. A central station will shortly be built to furnish light and power to Marietta, Mt. Joy, Florin, Elizabethtown and Maytown.

NOBLESVILLE, IND.—Articles of incorporation have been filed for the Noblesville Hydraulic Company, with a capital stock of $100,000. Noblesville, Indianapolis and Richmond parties are interested in the project. By means of a water power on the White River it is proposed to furnish Noblesville with electricity for lighting and power purposes.

MADISON, ME.—At a recent meeting of the legal voters of Madison Village Corporation it was voted that this corporation develop the water power at the French Rips on the Sandy River, building there a power-house and furnishing the same with all necessary apparatus. It was also voted to issue bonds for $50,000 to cover the expense involved.

CANNON FALLS, MINN.—A company has been organized here for the further development of the immense water power of the Cannon River at this place. A. L. Ober, of Chatfield; T. T. Comstock, of Kenyon, and F. B. Seager and E. J. Peters, of Cannon Falls, are interested, and the company will incorporate with a capital of $500,000. Work will be begun at once.

SPRINGFIELD, OHIO—W. H. Schott, of Chicago, representing a number of capitalists, has concluded a deal whereby he secures an electric lighting plant from the American Railway Company, the consideration being $350,000. The new company is to be known as the Springfield Light, Heat and Power Company, and will also secure the franchise for a new heating company which is going to install a plant here. The Springfield Light, Heat and Power Company has been incorporated in New Jersey with a capital stock of $800,000. Frank Torrence, of this city, is the president.

ST. PAUL, MINN.—The Watab Rapids Power Company has filed articles of incorporation with the Secretary of State. The business of the company will be the construction, maintenance and operation of a dam across the Mississippi, between the Sauk Rapids and the Watab Rapids, to improve or create a water supply or power for public use, with all requisite subways for supplying the public with water, electric light, heat or power. The capital stock of the company is $100,000, and the officers are: President, Arthur J. Gillette; vice-president, Albert R. Moore; secretary and treasurer, William C. Wing.

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NEW INCORPORATIONS.

ZANESVILLE, OHIO—Ohio Power Company. $125,000.

BERWICK, ILL.—The A. B. C. Telephone Company. $2,000.

KITTERY, ME.—International Electric Company. $100,000.

HARRISBURG, PA.—Coatesville Traction Company. $6,000.

CRAWFORDSVILLE, IND.—Home Telephone Company. $1,000.

SOUTH AMBOY, N. J.—Hendrum Telephone Company. $5,000.

PORTLAND, IND.—The Hoosier Telephone Company. $10,000.

KUTZTOWN, PA.—Kutztown Electric Light Company. $5,000.

NEVADA, IOWA—Slater Mutual Telephone Company. $10,000.

ZANESVILLE, OHIO—The Mt. Ephraim Telephone Company. $800.

BUTTE, MONT.—People's Electric Light and Power Company. $50,000.

NEWARK, N. J.—The Public Service Power Company. $1,125,000.

PIERRE, S. D.—Davidson County Rural Telephone Company. $10,000.

MT. VERNON, S. D.—Blendon Rural Telephone Company. $10,000.

BEATRICE, NEB.—The German Independent Telephone Company. $2,000.

INDIANAPOLIS, IND.—Deer Creek Cooperative Telephone Company. $3,000.

FREEPORT, ILL.—Freeport Electric Company. Increased from $5,000 to $350,000.

SAYVILLE, N. Y.—The Sayville Electric Company. Increased from $15,000 to $30,000.

PORTLAND, ME.—Omaha Electric Light, Heat and Power Company. $3,500,000. Incorporators: E. L. Carr and C. H. Tolman.

JERSEY CITY, N. J.—Jackson Electric Light Company. $12,000. Incorporators: L. B. Dailey, J. M. Mitchell and K. K. McLaren.

PARIS, TEX.—American Long-Distance Telephone Company. $50,000. Incorporators: R. W. Wortham, Joseph Timmons and A. H. O'Neill.

DUNDEE, N. Y.—Dundee Telephone and Telegraph Company. $2,500. Incorporators: Charles J. Watson, Arthur Besemer and James M. Ovenshire.

CAVETT, OHIO—Cavett Telephone Company. $5,000. Incorporators: W. Bronan, W. M. McQuown, J. W. Meyers, C. H. Hyman, H. M. Hoaglin, Earnest Kohn.

RALEIGH, N. C.—The American Despatch Telegraph Company. $25,000. Incorporators: James A. Egerton, Raleigh; George H. Fearons, West End, N. J.; Belvidere Brooks, New York city.

RUTLAND, VT.—The Rutland Power Company. $10,000. Incorporators: W. W. Nichols, Newman K. Chaffee, H. L. Hoag and Henry O. Carpenter, of Rutland, and F. D. Proctor, of Proctor.

JERSEY CITY, N. J.—The Southern Kansas Electric Railroad Company. $325,000. Incorporators: Thomas H. Hyde, E. S. Slough, Charles H. Ebert, L. L. Northrup and L. P. Stover, all of Iola, Kan.

CHARLESTOWN, W. VA.—The Simpson Electrical Company. $25,000. Incorporators: Melville D. Post, of Grafton, W. Va.; Louis B. Bryden, W. M. Drainer, Thomas Wyckoff, Walter C. Feeley, Simpson, W. Va.

SOUTH BETHLEHEM, PA.—Hanover Central Electric Railway Company. $48,000. Incorporators: Clarence A. Wolle, of Bethlehem; Charles A. Walbert, Lemuel H. Woddrop, Edmund C. Crain and John T. Bacon, of Philadelphia.

EAST ST. LOUIS, ILL.—Springfield & Jacksonville Rapid Transit Company. $500,000. Incorporators: Edmund C. Donk, Edwin H. Conrads, James W. Buel, St. Louis; Tobert Bethmann, East St. Louis, Ill.; L. H. Coleman, Springfield; E. S. Greenleaf, Jacksonville, and William Brown, New Berlin.

TELEPHONE AND TELEGRAPH.

BELLEVILLE, KAN.—A telephone line will be built from Laton to Riverdale.

ITHACA, N. Y.—A telephone line has been established from Newark to Port Gibson.

COHOES, N. Y.—The Hudson River Telephone Company is extending its lines to Crescent.

COLUMBUS, OHIO—The Cecil Telephone Company, of Cecil, has been incorporated with a capital of $10,000.

STEUBENVILLE, OHIO—The Bergholz Telephone Company will install an exchange in Carrollton in the near future.

BEDFORD, PA.—The Bedford County Telephone Company is erecting a new line between Bedford and Fishertown.

WILKESBARRE, PA.—The United Telephone and Telegraph Company will erect a line through the Nippenose Valley.

KINGWOOD, W. VA.—The citizens of Beech Hill have organized a telephone company and have erected a line from Albrightsville to Brockville.

ZANESVILLE, OHIO—The directors of the Newark Independent Telephone Company are preparing to build county lines on the Granville and Mount Vernon roads.

VANCOUVER, B. C.—The Great Northwestern Telegraph Company is to build a line from Dawson to the boundary, and connect with the projected Northern American lines.

MARION, OHIO—The La Rue Telephone Company has been incorporated with a capital of $50,000, and J. H. Leonard, F. Johnson, C. F. Stahl and M. A. Taylor as incorporators.

JACKSON, MICH.—At a meeting of the Citizens' Telephone Company the following officers were elected: J. C. Richardson, Z. C. Eldred, E. B. Fisher, C. E. Tarte and H. A. Douglas.

MEREDITH, N. H.—The Citizens' Telephone Company has elected the following officers: A. W. Abbott, W. B. Fellows, H. J Odell, J. H. Dow, V. Hazerick, H. Bickford and T. Prescott.

WHEELING, W. VA.—A charter was issued to-day to the Buchannon Telephone Company to build and operate telephone and telegraph lines. The company has a capital of $25,000.

MADISON, WIS.—The Amherst Telephone Company, of the village of Amherst, has been incorporated with a capital of $2,500. C. J. Iverson, A. O. Anderson, T. Howen and F. E. Webster are the incorporators.

MOLINE, ILL.—The stockholders of the new Independent Telephone Company have authorized the issuing of $15,000 additional stock, part of the proceeds to be spent in extending the lines in the Tri-cities.

MARION, IND.—The Swayzoo Telephone Company has filed articles of incorporation with a capital of $6,000. E. Ireland, H. Mark, R. P. Henley, W. Ammons, C. I. Goble, Z. Hamblin and L. C Pence are the incorporators.

ST. JOSEPH, MO.—It is stated that $100,000 will be expended in St. Joseph within the next few months by the Missouri & Kansas Telephone Company for the improvement and enlargement of the company's property in this city.

LAWRENCE, IND.—The Union Home Telephone Company has been incorporated with a capital of $2,500, to do business in this town. The incorporators are: J. C. Monteith, W. H. Brim, G. C. Dudley, F. M. Vance and J. A. Hartmon.

COOPERSTOWN, N. Y.—Articles of incorporation have been drawn for the organization of a new telephone company, to be known as the Hartwick Telephone Company, with E. Sergeant, G. Schoolcraft, M. Fields and H. O. Branch as the projectors.

JAMESTOWN, N. Y.—At a meeting of the stockholders of the Home Telephone Company, held for the purpose of considering the matter of increasing the number of directors, the following new directors were elected: T. S. Lane, W. J. Maddox, B. D. Phillips, R. T. Izant and C. C. Clawson.

NEW YORK, N. Y.—The new telegraph and telephone cable between the mainland and Ellis Island has been laid by the Western Union Telegraph Company. The new cable will not touch at Governor's Island, as the old one did, but will connect the Immigration Bureau direct with the Barge Office.

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ELECTRICAL SECURITIES.

There has been no improvements in stock market conditions during the past week. Prices have continued to sag, and, due to the steady declines of the past ten months, two failures were announced the latter part of the week. It is not thought, however, that these will have any particular influence in shaping future developments. Indeed, the more optimistic do not hesitate to express the belief that the worst is now over and that much better things may be looked for shortly.

The main features of speculation continued to be the heavy forced liquidation and the absence of buying by the local public; but the latter condition has been somewhat offset by the large investments of foreign buyers, who secured some 80,000 shares during the week. The money situation continues to be an important factor, and from the present outlook it appears that firm and at times stringent money markets will be the rule this fall, unless unexpected developments occur.

ELECTRICAL SECURITIES FOR THE WEEK ENDING JULY 25.

New York:	*Closing.*
Brooklyn Rapid Transit	41½
Consolidated Gas	182½
General Electric	157
Kings County Electric	190
Manhattan Elevated	132⅜
Metropolitan Street Railway	113
New York & New Jersey Telephone	150
Westinghouse Manufacturing Company	175
Boston:	*Closing.*
American Telephone and Telegraph	130
Edison Electric Illuminating	225
Massachusetts Electric	85
New England Telephone	120
Western Telephone & Telegraph preferred	83
Philadelphia:	*Closing.*
Electric Company of America	7⅞
Electric Storage Battery common	54
Electric Storage Battery preferred	54
Philadelphia Electric	5½
Union Traction	42⅞
United Gas Improvement	82
Chicago:	*Closing.*
Chicago Telephone	115
Chicago Edison Light	142
Metropolitan Elevated preferred	55
National Carbon common	22
National Carbon preferred	90
Union Traction common	4
Union Traction preferred	30

National Carbon directors have declared the regular quarterly dividend of 1¾ per cent on the preferred stock, payable August 15. Books close August 5 and reopen August 17.

PERSONAL MENTION.

MR. BAILEY WHIPPLE, who has been prominent for many years in electric lighting circles, has been appointed sales manager for the Nernst Lamp Company.

MR. U. N. BETHELL has been elected president of the Bell Telephone Company, of Philadelphia, and of the Delaware & Atlantic Telegraph and Telephone Company, the election occurring on Tuesday of last week. Mr. Bethell succeeds Mr. James E. Mitchell, who becomes chairman of the board. In addition to holding these offices, Mr. Bethell is now first vice-president and general manager of the New York Telephone Company, and president and general manager of the Chesapeake & Potomac Telephone Company.

PROFESSOR W. E. GOLDSBOROUGH, chief of the Bureau of Electricity of the Louisiana Purchase Exposition, visited the convention of the National Electrical Contractors' Association at Detroit. Professor Goldsborough says that he is receiving an unexpected amount of cooperation and sympathy from the electrical industries of the United States and foreign countries, in the making of the electrical features of the fair a great success. He also says that the plans for the "Electrical Week" are progressing finely and that the plan means the greatest gathering of electrical people ever brought together.

MR. MELVILLE E. STONE, the able general manager of the Associated Press, is receiving many congratulations over his brilliant handling of the news from Rome respecting the illness and death of the Pope. So promptly did Mr. Stone's great news association, through its comprehensive cable facilities and special arrangements for the occasion, get the fact of the Pope's death that New York actually became the distributing point of the news, giving it to London several minutes ahead of all other sources. The correspondent of the Associated Press at Rome is to be felicitated, too, over the graphic pictures he cabled to headquarters here.

MR. EDWIN R. WEEKS, of Kansas City, Mo., was a visitor to New York city recently. Mr. Weeks had some very interesting stories to tell with regard to the recent floods in and about Kansas City. He was one of the organizers of a party which made a specialty of rescuing those unfortunate creatures which the ordinary rescue parties were failing to assist. In this manner hundreds of dogs, horses, cats, cows and other animals were rescued, and, as Mr. Weeks said, "incidentally, some two or three dozen children." One of the remarkable conditions which was brought about during this time was the very good behavior of the electrical machinery, some of which was submerged entirely for a considerable time. Mr. Weeks is a member of the firm of Weeks, Kendall & Newkirk, consulting engineers.

THE DEPARTMENT OF PHYSICS AND ELECTRICAL ENGINEERING at Lehigh University has been reorganized, with Professor W. S. Franklin in charge of physics, and Professor William Esty in charge of electrical engineering. Professor Franklin is a graduate of the University of Kansas. He has pursued graduate study in physics at the University of Kansas, at the University of Berlin, at Harvard University, and at Cornell University. He was five years in charge of physics and electrical engineering at Iowa State College, and he has been six years in charge of physics and electrical engineering at Lehigh University. Professor Esty is a graduate of Amherst College and of the Massachusetts Institute of Technology. He was one year with the General Electric Company, at Lynn, Mass., eight years at the University of Illinois, as instructor and assistant professor of electrical engineering, and he has been for two years assistant professor of electrical engineering at Lehigh University.

ELECTRIC RAILWAYS.

YORK, PA.—An electric railway will be built from Hanover to Littlestown and thence to Westminster, Md. Another road will connect Chambersburg and Gettysburg.

NEW CASTLE, PA.—Work is being pushed on the trolley road from Jamestown to Warren. It will run between the two places *via* Sugar Grove, Youngsville and Allegheny Springs.

NORFOLK, VA.—The Chesapeake Transit Company will make additional improvements to its line. The capital stock of the company has been increased from $500,000 to $630,000 for this purpose.

FALL RIVER, MASS.—The Tiverton & Seaconnet Street Railway Company has been incorporated to build an electric road from New Bedford to Horse Neck, and thence through Little Compton and Tiverton to Fall River.

COLUMBUS, OHIO—The Columbus Railway and Light Company, which holds leases of the Edison and Columbus Railway properties, will expend between $300,000 and $500,000 before January 1 in making improvements.

SHEBOYGAN, WIS.—A trust deed to cover the issue of $700,000 bonds issued by the Sheboygan & Elkhart Lake Line has been filed in the register of deed's office. The trust deed is given to the Newark Loan and Trust Company.

SHARON, PA.—Philadelphia capitalists are interested in the construction of a trolley line to connect Sharon, Greenville, Mercer and Franklin. The line will be about forty miles long, and it will cost about $1,000,000 to build and equip it.

COLUMBUS, OHIO—The Newark, Martinsburg & Mount Vernon Traction Company, of Newark, has been incorporated with a capital of $25,000 to operate an electric line from Newark to Martinsburg, Gambier and Mount Vernon in Knox County.

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INDUSTRIAL ITEMS.

THE COUNTRY CLUB, of Newton, Mass., has installed a large number of single-glower Nernst lamps for lighting the club-house throughout, and great satisfaction is expressed with the results obtained by this innovation.

THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, of Rochester, N. Y., and Chicago, Ill., has recently sold a 400-capacity new style generator call visual signal switchboard with complete protective apparatus to the Celger Telephone Company, Churubusco, Ind.

THE EMERSON ELECTRIC MANUFACTURING COMPANY, St. Louis and New York, will be pleased to distribute to prospective buyers and interested customers a leaflet entitled "A Few of the Facts about Emerson Fans." This leaflet tells in a concise way all the features characterizing the Emerson desk fan and ceiling fan.

THE ELECTRIC APPLIANCE COMPANY, Chicago, selling agent for Packard lamps and transformers, has just received from the printers a complete catalogue of the new Zenith lamps. These lamps, which are designed to fill an intermediate place between the arc and incandescent, are meeting with much success. The catalogue will be mailed upon application.

THE NERNST LAMP COMPANY, through its Chicago office, reports that the Illinois Steel Company, of South Chicago, has recently illuminated its drafting room exclusively with the three-glower Nernst lamps, doing away with all desk lights, thereby gaining a superior distribution as well as a superior quality of light for the use of its employés in the exacting work of tracing and drafting.

THE ISAAC LEISY BREWING COMPANY, of Cleveland, is making an interesting installation by replacing an old equipment consisting of 125-volt generators with a 100-kilowatt and a fifty-kilowatt, Westinghouse 125 to 250-volt, three-wire engine-type generators. The change is being made to effect the double purpose of obtaining 220 volts for running the motors and 110 volts for use in connection with its arc and incandescent lighting.

THE VARLEY DUPLEX MAGNET COMPANY is calling attention to the fact that its post office address is Providence, R. I. The company, at one time, used the address Phillipsdale, which is a suburb of Providence, but this resulted in a good deal of the mail going to Philadelphia and in some instances even to the Philippine Islands because of the similarity in the names. The address of the company hereafter will be Providence, R. I.

THE NATIONAL MINING COMPANY, Pittsburg, Pa., has recently added to its electrical equipment one thirteen-ton Baldwin-Westinghouse locomotive; two Westinghouse 200-kilowatt, 500-volt, 200 revolutions per minute, engine-type generators, connected to Buckeye engine; one Westinghouse twenty-kilowatt, 125-volt, 390 revolutions per minute, engine-type generator, connected to Westinghouse standard engine, and the usual switchboard and detail apparatus.

THE COMMERCIAL INTELLIGENCE BUREAU, LIMITED, London, E. C., has supplied a cabinet containing the names of the leading British manufacturers to the British consul in New York. This is intended for public reference. The cards in this cabinet are arranged and indexed so that the buyer can immediately find the name of the manufacturer of the particular article in which he is interested. It is stated that these cabinets have been greatly appreciated wherever they have been supplied, as they give information for which the consuls are frequently sought.

LUNA PARK, Coney Island, N. Y., is to have a carnival of nations on Wednesday, August 5. A magnificent display and entertainment are promised and all railroads are arranging for special excursions. Luna Park has been a surprise to New Yorkers ever since its opening. From the advance accounts it had been expected that Luna was to be something better than had ever been known here; but the two hundred and odd thousand lights with the two-hundred-foot high electric tower and a hundred and sixty-four smaller towers around the grounds make a far grander spectacle than any one had conceived. It is a very interesting place.

THE WESTINGHOUSE TRACTION BRAKE COMPANY reports among recent sales of street railway apparatus, an order from the Los Angeles Railway Company, Los Angeles, Cal., for eighty street car air-brake equipments with motor-driven compressors. These equipments are to be fitted to new high-speed cars which are being built by the St. Louis Car Company. The Westinghouse Traction Brake Company has also lately closed contracts for the following motor-driven compressor air-brake outfits: Sixteen to Oakland Transit Company, Cal.; seventeen to North Shore Railroad Company, San Francisco, Cal.; twelve to Indianapolis & Northwestern Traction Company; sixteen to Indiana Railway Company, South Bend, Ind.

THE ROBBINS & MYERS COMPANY, Springfield, Ohio, has adopted the name "Standard" as the designation for its line of protected direct-current motors and dynamos. Some years ago there was a demand for a type of motor midway between the open, unprotected motor and the fully enclosed motor. In the former there was little protection for the armature and field windings, while the latter required much more material per horse-power output in order to run within a safe temperature limit. This demand was met by a line of machinery put out by the Robbins & Myers Company, which up to this time has been called the "protected type;" but as it has been pointed out that this title is no longer sufficiently distinctive, it has been changed to that stated above. These machines have been on the market for about six years, and are made in sizes from fifteen horse-power down.

MR. S. G. BOOKER, of St. Louis, who was for many years prominently identified with the manufacture of carbon products, has been appointed manager of the National Light, Heat and Power Company, of St. Louis, Mo. The company is incorporated under the laws of Missouri, with a capital stock of $1,500,000. It has acquired the eight-acre tract at the intersection of the Oak Hill branch of the Missouri-Pacific Railroad and Chippewa street for a manufacturing plant. This is the same property that was bought some years ago by Mr. Booker for the Phœnix Battery Manufacturing Company. The National company will at once take possession and begin work which will be on a large scale. It will manufacture oil burners, gas machines, carbides, etc. It is the intention of the company to have one of the largest and best equipped factories in the West, and under the active management of Colonel Booker a pronounced success is undoubtedly assured.

THE WESTINGHOUSE TRACTION BRAKE COMPANY reports the following sales of street-car air-brake equipments. All of these equipments are provided with motor-driven compressors: five equipments to Evansville & Princeton Traction Company, seven equipments to Wooster & Southbridge Street Railway Company, eight equipments to Concord & Manchester Street Railway Company, twelve equipments to Concord Street Railway Company, one equipment to Holland Palace Car Company for use on electric sleeper. The Westinghouse Traction Brake Company has also recently equipped a number of cars with its magnetic brake and car-heating apparatus. The following is a list of some of the roads to whom this apparatus has been sold: Pennsylvania & Mahoning Valley Railway Company, of New Castle, Pa., equipments for sixteen cars; Morgantown Electric and Traction Company, equipments for twelve cars; Washington & Canonsburg Railway Company, Washington, Pa., equipments for fifteen cars; Altoona & Logan Valley Electric Railway Company, equipments for eight cars.

THE HELENA LIGHT AND TRACTION COMPANY is building a new power-house at Helena, Mon., which will be equipped with Westinghouse apparatus throughout, a portion of which has recently been ordered from the Westinghouse Electric and Manufacturing Company, the remainder having been in use for some time. The electrical equipment consists of two seventy-five-kilowatt, direct-current generators, each to be direct coupled to a 100-horse-power, type C induction motor; two 15-horse-power motor-generator sets; nine 10,000-volt transformers—six of 150 kilowatts and three of 125 kilowatts capacity; also two 175-kilowatt rotaries. Three 150-kilowatt and three 125-kilowatt transformers will be equipped with a face-plate for obtaining different voltages from the transformers, this dial being connected to the low-tension circuit in such a manner as to give variation of voltage between 2,400 and 2,050. Seventeen low-tension leads are brought out from the secondary winding, one lead directly connected into the line and another lead connected to the spark-gap, the remaining fifteen connected to the regulator face-plate outside of the transformer case. This allows the purchaser to secure proper voltage regulation for extreme variation in load without changing the voltage at the Missouri River Company's station, fourteen miles distant.

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CHARLES W. PRICE . . . . PRESIDENT and EDITOR
STEPHEN H. GODDARD . SECRETARY and MANAGER
RUSSELL HOWLAND . GENERAL REPRESENTATIVE
WM. HAND BROWNE, JR. . . . TECHNICAL EDITOR
AINSLIE A. GRAY . . . . . ASSISTANT EDITOR

WESTERN OFFICE — 40 Dearborn Street, Chicago, Ill. CHARLES FRENCH, Manager.

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THE MIDSUMMER NUMBER.

There probably never was a summer time in the history of the comparatively new electrical industry in which commercial work continued so actively as during 1903. In many branches it has kept ahead of possible supply and, notwithstanding numerous delays due to strikes and lack of raw material, the general development is evident in all directions. Advance orders and proposed installations for the fall are to be noted already, and it is believed that the usual autumn activity will be fully one month ahead of former seasons. The electrical industry is enjoying an undoubted boom in nearly every one of its numerous branches.

Manufacturers are eagerly grasping good opportunities to exploit standard products, and modifications of old and developments of new apparatus. The consulting and constructing engineer, the professor and the student are preparing for the opening of a new campaign with every faculty alert and with ambitions keyed to do even greater things if this be possible. Contemporaneous with this condition is the present issue, the Midsummer Number, of the ELECTRICAL REVIEW. This issue will reach an extensive territory, both at home and abroad, where its diversified contents will be read with appreciation, as reflecting the influence of modern views in working up to future events.

THE INTERNATIONAL ELECTRICAL CONGRESS.

We are impressed by the plan and scope of the International Electrical Congress which will convene in St. Louis in September, 1904. A plan which contemplates an organization embracing the active working participation of all of our national electrical associations and an official co-operative representation by the national electrical societies of all the great nations which have accepted the invitation of the United States to participate in the Louisiana Purchase Exposition, is a plan that should have the united support of every electrical interest. It marks a movement along right lines, and better still the committee of organization that has conceived the plan is made up of men whom we know in the perspective of their achievements.

In spite, then, of the broad scope of the Electrical Congress of 1904, we believe it will have great success and mark a distinct step in our progress.

Professor Elihu Thomson, the president, has long ago won the esteem of his countrymen and the admiration of the whole electrical fraternity.

Mr. Arnold, the chairman of the executive committee and the newly elected president of the American Institute of Electrical Engineers, is a type of the well-balanced American electrical engineer of the younger generation; a type that is attracting attention the world over. It is excellent that he should be in an authoritative position at this international gathering.

As we look back and review the work of the previous electrical congresses, we find that they have left a strong impress upon the electrical activities of the world. The coming electrical congress can be of greater benefit than any of these, as the topics which are now open for the consideration of the chamber of official delegates of the countries to be represented have greatly broadened. Our electrotechnical nomenclature needs to be rounded out to the extent of fully meeting the demands of our work in the university, in the research laboratory and in the practical field. International standards of electromotive force, current and illumination should receive deliberate attention, be revised and, if possible, recommended for international adoption.

More than this, can not this electrical congress make the record of bringing about, if not the realization, at least the initiation of an international code for the standardization of electrical apparatus and appliances?

THE PROBABILITIES OF WIRELESS TELEPHONY.

The unceasing interest in methods of communication without wires must include what is being currently done in "wireless telephony." Of the many systems that have come up, that of Ruhmer, with his extension of the old photophone of Professor Bell, has reached the greatest success to date. In his hands, the Teutonic capacity for taking infinite pains has resulted, as it often does in experimental work, in reaching kilometres with a very dependable apparatus, where the best American results known, using a burnt cork receiver and a parabolic reflector for arc light or sunlight, have only reached furlongs. It only needs a further degree of perfection to make Ruhmer's apparatus of immense value in military and naval signaling; unless, indeed, conservatism should step in in defence of the time-honored signal flag and wig-wag systems, just as "Morse" has held its own in railway train despatching in spite of the thoroughly demonstrable superiority of the telephone. Such use need take no account of any inferiority for general use to the present telephone employing a wire line; there is no reason why the wireless system should not find for itself quite as

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many special uses, all independent of a "central office," as space telegraphy itself is finding to-day.

High-Frequency Wave Telephony Difficult.

Coming now to the methods employing high-frequency electric waves, we find ourselves at once upon ground where, at this writing, angels and stock companies may well fear to tread. To any one who has ever worked in the more understandable and positive field of space telegraphy, wherein the very necessity for making new precedents and special instruments bearing no relation to old telegraph methods has itself facilitated experimental development, the necessity of adapting existing telephone instruments to the handling of frequencies comparatively very high, even at their lowest obtainable rate of vibration, presents formidable difficulties involving, in the last analysis, not mere improvement in present apparatus but the employment of entirely new methods of working that will probably bear little resemblance to present-day telephone communication.

Problems to Be Solved.

Another point is that a pair of telephones working over a wire line of any length comprises a singularly inefficient example of "power transmission;" it is only the classic sensitiveness of the telephone receiver that makes communication practicable. Now, remembering that electric waves distributed from a sending antenna proceed in all directions, normal to the antenna, inventors in this field would do well to figure for themselves, in advance of any great expenditure of brains or money, the enormous losses that must take place before a receiving station can be reached. A practical method of superposing the slow vibrations of articulate speech upon the more rapid Hertzian vibrations in a sufficiently powerful sending apparatus, together with a sensitive and dependable detector possessing the property of complete and instantaneous auto-decoherence, will go a long way toward a success comparable or even perhaps surpassing the present limits of space telegraphy.

TRACING ALTERNATING-CURRENT WAVES.

The electromotive force generated in an alternating-current apparatus is, of course, an alternating one. That is to say, an alternating current flows, according to the usual method of describing this phenomenon, first in one direction and then in the other, through the conducting wire. This alternating current, then, varies in intensity from instant to instant and it becomes desirable to learn just in what way this variation is taking place.

Methods of Tracing Waves.

There are two general methods of tracing the form of an alternating-current wave. The first method to be used is due to Joubert. This has been modified and improved in a number of ways by various experimenters. In principle, it consists in determining the difference of potential existing at some particular instant. If this is done for a sufficient number of points sufficiently close together in time, the values may be plotted in the form of a curve, and in this way the general character of the wave is shown. In the second method an apparatus is used, which is so delicate that it will follow accurately all variations in the current flowing through a small magnetizing coil. The motion of the apparatus being used to produce a permanent record of the current variations.

The Contact Method.

In the first method some form of contact maker is used. A contact maker is merely a device, which, for a very brief instant, closes an electrical circuit, and the closing of this contact is made to produce a reading by means of suitable apparatus, which is proportional to the difference of potential existing in the circuit at the instant it is closed. In Joubert's method, the closing of the circuit by the contact maker is made to charge a condenser, which is then discharged through a ballistic galvanometer, the throw of the galvanometer being proportional to the electromotive force at the instant of closing the circuit. The first contact makers were very crude, but later experimenters brought this apparatus to a high degree of perfection.

Modifications of the Contact Method.

The ballistic galvanometer is tedious and unsatisfactory for work of this kind, but it may be replaced by a suitable direct-reading dead-beat instrument. A pretty modification of this method consists in adapting to it the principle of the potentiometer. In this method the instantaneous alternating electromotive force is balanced by a direct but variable electromotive force, which is easily measured. The point of balance may be determined by connecting in series in the circuit, which is made and broken by the contact maker, the variable direct electromotive force and a telephone receiver in series with the electromotive force to be studied. When the direct electromotive force is equal but in opposition to the instantaneous alternating electromotive force at that instant when the circuit is closed, no current will flow through the circuit and the telephone receiver will be silent. A slight change in either the alternating or the direct motive forces will send a current through the circuit and will produce a click in the telephone receiver every time the circuit is closed by the contact maker. Of course, if desirable, a telephone receiver may be replaced by any sensitive connecting instrument.

The Oscillograph Method.

In the second method of tracing alternating-current waves an apparatus is used which has so little inertia that it is able to follow every variation in the current passing through its magnetizing coil. In the early types of the apparatus, the so-called oscillograph, a very small needle delicately suspended and carrying a tiny mirror is hung in the field, set up by a small coil. A strong beam of light is thrown upon the mirror and reflected from that to a sensitive photographic film. The needle follows every variation of current sent through the coil, so that if the sensitive paper be moved quickly but at the uniform rate across the line where the beam of light from the vibrating mirror plays, a trace will be left upon the film, which shows the variations in the current flowing through the coil. In this type of apparatus the great difficulty is

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to obtain a needle so small that its inertia and its own period of vibration will not distort the form of the wave to be traced. This difficulty, however, has been prettily overcome recently by Professor Harris J. Ryan. The cathode rays thrown out from an exhausted tube when electrical oscillations are set up in it are deflected by a magnetic field. These rays are, of course, without inertia. By passing a ray through the magnetic field set up by the wave to be traced, the ray will vibrate through a path, its deflection at any instant being proportional to the intensity of the current in the coil. This gives an inertialess lever, which may be used to produce a permanent record of the form of the wave. The ray from this tube is allowed to impinge on a sensitive film if a record is desired, or upon a screen of some material which will respond to the excitation of the ray and become luminous when a visual image is sufficient. In the first case, since the photographic action of tubes which as yet have been used is small, an exposure lasting a few minutes is necessary. This, of course, gives a somewhat broader record than would be secured were there but one or two cycles recorded. However, it is a question whether the average curve secured when conditions are fairly constant is not as valuable as a record of a single cycle, which shows merely the conditions existing at the moment when that record was taken and not the average behavior of the circuit.

Value of Cathode-Ray Indicator.

The apparatus developed by Professor Ryan is suitable as well for commercial use as for laboratory experimentation, and its adaptability to high-frequency phenomena should make it of invaluable assistance in the study of telephone apparatus and the phenomena occurring during commutation in direct-current machinery, as we have here in general a frequency high compared to that of commercial alternating currents. The indicator itself is of such a nature that it can be used effectively even under commercial conditions, as it does not require the great refinements of location and protection to be found only in research laboratories. There seems to be no doubt that this instrument will find a most useful application in the study of electrical phenomena.

Tracing Current Waves.

When an electromotive-force wave is to be traced this electromotive force is generally used to cause a small current to flow through a circuit containing a high resistance, and the wave-form of this small current is traced and taken to be the same as that of the electromotive force. If a current wave is to be traced this is most conveniently done by sending the current through a simple resistance and the varying difference of potential across this resistance is traced, the curve being taken as similar to that of the current wave.

GROUNDED AND UNGROUNDED TRANSMISSION CIRCUITS.

The paper presented by Mr. J. S. Peck at a recent meeting of the American Institute of Electrical Engineers on "Grounded Transmission Circuits," should be of great value to engineers engaged in transmission work. Mr. Peck discusses the effect of grounding the line with various systems of transmission, showing where danger may arise and when this practice brings additional protection. The system offering the greatest number of ways of combining apparatus is the three-phase system, and it also happens that this is the one most generally used for power transmission for long distances at high voltages. In Mr. Peck's paper the effects of grounding the neutral with the various grouping of transformers are clearly shown, and the cases when danger may arise due to an accidental grounding or short-circuiting are pointed out.

Subject One of Real Importance.

During the discussion of this paper, several engineers who have had much experience with high-tension circuits took occasion to emphasize the fact that the possible dangers introduced by grounding pointed out by Mr. Peck were not imaginary, but were very real—a fact which shows that the paper deserves the study and attention of those interested in work of this character.

Danger to the Telephone Line.

Mr. Peck also points out the danger to the telephone system introduced by grounding any part of the line, a danger which is entirely distinct from that which may threaten transformers. The telephone system is to-day an essential part of every transmission line, and any construction which may jeopardize this should receive careful consideration before being adopted.

MODERN VIEWS ON MATTER—THE REALIZATION OF A DREAM.[1]

BY SIR WILLIAM CROOKES.

(Concluded.)

Many lines of argument and research tending toward the same point give trustworthy data by which to calculate the masses and velocities of these different particles. I must deal with big figures, but big and little are relative, and are only of importance in relation to the limitations of our senses. I will take as the standard the atom of hydrogen gas—the smallest material body hitherto recognized. The mass of an electron is 1/700th of an atom of hydrogen, or 3×10^{-26} grammes, according to J. J. Thomson, and its velocity is 2×10^{9} centimetres per second, or two-thirds that of light. The kinetic energy per milligramme is 10^{17} ergs, about 3,500,000 foot-tons. Becquerel has calculated that one square centimetre of radioactive surface would radiate into space one gramme of matter in 1,000,000,000 years.

The positively electrified masses or ions are enormously great in comparison with the size of the electron. Sir Oliver Lodge illustrates it thus: If we imagine an ordinary sized church to be an atom of hydrogen, the electrons constituting it will be represented by about 700 grains of sand, each the size of an ordinary full-stop (350 positive and 350 negative) dashing in all directions inside, or, according to Lord Kelvin, rotating with inconceivable velocity. Put in another way, the sun's diameter is about 1,500,000 kilometres, and that of the smallest planetoid about twenty-four kilometres. If an atom of hydrogen be magnified to the size of the sun, an electron will be about two-thirds the diameter of the planetoid.

The extreme minuteness and sparseness of the electrons in the atom account for their penetration. While the more

[1] An address delivered before the Congress of Applied Chemistry at Berlin, June 5, 1903.

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massive ions are stopped by intercollisions in passing among atoms, so that they are almost completely arrested by the thinnest sheet of matter, electrons will pass almost unobstructed through ordinary opaque bodies.

The action of these emanations on phosphorescent screens is different. The electrons strongly affect a screen of barium platinocyanide, but only slightly one of Sidot's zinc sulphide. On the other hand, the heavy, massive, non-deflectable positive ions affect the zinc sulphide screen strongly, and the barium platinocyanide screen in a much less degree.

Both Rœntgen rays and electrons act on a photographic plate and produce images of metal and other substances enclosed in wood and leather, and throw shadows of bodies on a barium platinocyanide screen. Electrons are much less penetrating than Rœntgen rays, and will not, for instance, show easily the bones of the hand. A photograph of a closed case of instruments is taken by radium emanations in three days, and by Rœntgen rays in three minutes. The resemblance between the two pictures is slight, and the differences great.

The power with which radium emanations are endowed of discharging electrified bodies is due to the ionization of the gas through which they pass. This can be effected in many other ways; thus, ionization is communicated to gases faintly by the splashing water, by flames and red-hot bodies, by ultra-violet light falling on negatively electrified metals, and strongly by the passage of Rœntgen rays.

According to Sir Oliver Lodge's electronic theory of matter, a chemical atom or ion has a few extra negative electrons in addition to the ordinary neutral atom, and if these negative electrons are removed it thereby becomes positively charged. The free electron portion of the atom is small in comparison with the main bulk, in the proportion in hydrogen of about 1 to 700. The negative charge consists of super-added or unbalanced electrons—one, two, three, etc., according to the chemical valency of the body—whereas the main bulk of the atom consists of paired groups, equal positive and negative. As soon as the excess electrons are removed, the rest of the atom, or ion, acts as a massive positively charged body, hanging tightly together. In a high vacuum the induction spark tears the components of a rarefied gas apart; the positively charged ions, having great comparative density, are soon slowed down by collisions, while the electrons are driven from the negative pole with an enormous velocity depending on the initial electromotive force and the pressure of gas inside the tube, but approaching, at the highest exhaustions, half that of light.

It is recognized that electrons have the one property which has been regarded as inseparable from matter—nay; almost impossible to separate from our conception of matter—I mean inertia. Now, in that remarkable paper of J. J. Thomson's published in 1881, he developed the idea of electric inertia (self-induction) as a reality due to a moving charge. The electron therefore appears only as an apparent mass by reason of its electro-dynamic properties, and if we consider all forms of matter to be merely congeries of electrons, the inertia of matter would be explained without any material basis. On this view the electron would be the "protyle" of 1886, whose different groupings cause the genesis of the elements.

There is one more property of the emanations of radium to bring before your notice. I have shown that the electrons produce phosphorescence of a sensitive screen of barium platinocyanide, and the positive ions of radium produce phosphorescence of a screen of zinc blende.

If a few minute grains of radium salt fall on the zinc sulphide screen the surface is immediately dotted with brilliant specks of green light. In a dark room, under a microscope with a two-third-inch objective, each luminous spot shows a dull centre surrounded by a diffused luminous halo. Outside the halo the dark surface of the screen scintillates with sparks of light. No two flashes succeed on the same spot, but are scattered over the surface, coming and going instantaneously, no movement of translation being seen.

If a solid piece of a radium salt is brought near the screen, and the surface examined with a pocket lens magnifying about twenty diameters, scintillating spots are sparsely scattered over the surface. Bringing the radium nearer the screen the scintillations become more numerous and brighter, until when close together the flashes follow so quickly that the surface looks like a turbulent luminous sea. When the scintillating points are few there is no visible residual phosphorescence, and the successive sparks appear "atoms of intensest light," like stars on a black sky. What to the naked eye seems like a uniform "milky way," under the lens becomes a multitude of steller points, flashing over the whole surface.

In a vacuum the scintillations are as bright as in air, and being due to interatomic motion they are not affected by extremes of low temperature; in liquid hydrogen they are as brilliant as at the ordinary temperature.

A convenient way to show these scintillations is to fit the blende screen at the end of a brass tube with a speck of radium salt in front about a millimetre off, and to have a lens at the other end. I propose to call this little instrument the "spinthariscope," from the Greek word σπινθαρίς, a scintillation.

It is probable that in these phenomena we actually witness the bombardment of the screen by the positive ions hurled off by radium with a velocity of the order of that of light. Each particle is rendered apparent only by the enormous extent of lateral disturbance produced by its impact on the sensitive surface, just as individual drops of rain falling on a still pool are not seen as such, but by reason of the splash they make on impact, and the ripples and waves they produce in ever-widening circles.

Indulging in a "scientific use of the imagination," and pushing the hypothesis of the electronic constitution of matter to what I consider its logical limit, we may be, in fact, witnessing a spontaneous dissociation of radium—and we begin to doubt the permanent stability of matter. The chemical atom may be actually suffering a katabolic transformation; but at so slow a rate that supposing a million atoms fly off every second, it would take a century for weight to diminish by one milligramme.

It must never be forgotten that theories are only useful so long as they admit of the harmonious correlation of facts into a reasonable system. Directly a fact refuses to be pigeon-holed and will not be explained on theoretic grounds, the theory must go, or it must be revised to admit the new fact. The nineteenth century saw the birth of new views of atoms, electricity and ether. Our views to-day of the constitution of matter may appear satisfactory to us, but how will it be at the close of the twentieth century? Are we not incessantly learning the lesson that our researches have only a provisional value? A hundred years hence shall we acquiesce in the resolution of the material universe into a swarm of rushing electrons?

This fatal quality of atomic dissociation appears to be universal and operates whenever we brush a piece of glass with silk: it works in the sunshine and rain-drops, and in the lightnings and flame; it prevails in the waterfall and the stormy sea. And although the whole range of human experience is all too short to afford a parallax whereby the date of the extinction of matter can be calculated, protyle, the "formless mist," once again may reign supreme, and the hour hand of eternity will have completed one revolution.

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The Use of Electric Power in Plowing.

Some New Applications of Electricity to Cultivating Farms.

By Emile Guarini.

ANIMAL and steam power no longer suffice for agriculture. There is a need for an agent assuring more rapid working and greater economy and efficiency, a need which is supplied by electricity. The practical application of electricity to tilling has not come about without many trials and tests of various methods. The most simple system is that in which the plow is provided with wheels driven by a motor, but it was quickly found that this system was not free from serious objections. The first of these is the placing of heavy apparatus upon a plow which must travel over a field offering great resistance. The second, and the principal objection to this method, is the difficulty of supplying power to the motor, as the feeding cables must be displaced continually to follow the motion of the plow.

These disadvantages are met also in another system, although in this they are not as serious. In this system the motor draws the plow across the field by means of a chain, Fig. 1, and not by driving the wheels of the carriage. The chain is stretched across the field, and is displaced little by little parallel to the furrows. The mechanical efficiency of these systems is not satisfactory, and a better arrangement has been sought. This has resulted in placing the motor on a carriage provided with a drum, on which is wound up the cable or chain which draws the plow. There are two varieties of this system—that having one motor and that having two. The first, Fig. 2, B. C. D.,—that with one motor—is the most economical, but it can work only in soft ground. In this system the motor carriage is placed on one side of the field, and draws the plow by means of a cable passing over a pulley which is anchored at the other side of the field. The other end of this cable is carried back to the motor carriage and wound upon a second drum which serves to move the plow in the opposite direction.

In the second variety of this system, Fig. 2, A, two motor carriages are employed. This system is more rapid than the one just described, and is capable of working difficult, compact earth. In this system the second motor carriage replaces the anchor of the first, and the plow is drawn across the field, first by one motor and then by the other.

Having explained the differences between the methods, it will be well to examine the details of application which have been made, and to note the intrinsic value of each system. In order to appreciate that value it will be necessary to examine carefully the results. Attention should also be paid to the time necessary for operation, to the weight of earth

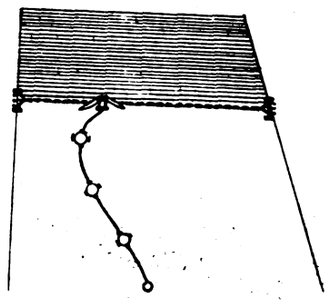

FIG. 1.—ELECTRIC PLOWING BY MEANS OF CHAIN.

cultivated, to the consumption of coal and loss of energy, the cost of operation, including that of coal, water, oil, attendance, repairs, interest on the capital and depreciation of the material. Figures can rarely be obtained on all these points, and therefore this article will cover the performance of each system without entering into a discussion of the comparative merits.

One system developed in Chicago deserves mention. An electric automobile was used to draw an ordinary plow, or any other apparatus. The second invention of that kind was the apparatus constructed by M. P. Taillade, the engineer of Arts and Métiers. This plow or cultivator consisted simply of an ordinary plow, on which was mounted an electric motor driving wheels. The motor operated, in addition, a series of knives on an axle, which worked the earth. The objections inherent with this type of apparatus have been indicated above, and it will not be necessary to return to it.

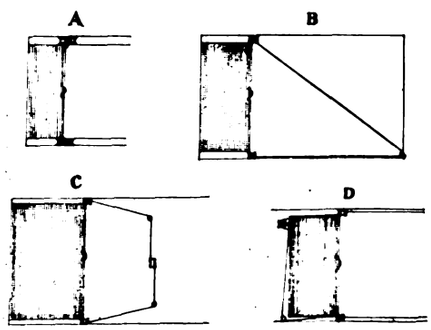

FIG. 2.—ONE AND TWO MOTOR SYSTEMS OF ELECTRIC PLOWING.

The house of Zimmermann, of Halle-sur-Saale, has owned a towing system for some time. The motor is mounted on the frame of the plow, and carries fixed to its shaft a toothed drum, the teeth of which gear in the links of a chain. The latter is fixed at each end of the field, Fig. 1, by anchors which can be disengaged by one man and moved for each furrow. The anchors are mounted on wheels, and are raised from the ground by a lever. Their weight is thirty-five kilogrammes only. When the end of a furrow is reached the plow is raised, turned and restarted by the action of a switch which controls the current in the motor. This instrument is regulated by the apparatus for carrying the conductor. To feed the current to the motor there are two cables mounted on small carriages similar to those employed for irrigating pipes. The two cables are insulated, and wind and unwind on a drum placed on the plow. There are a number of models of this plow, differing in the number of plowshares. The least expensive (7,500 francs) has two shares. It is suitable particularly for small work, and requires a current of 110 volts and sixty to eighty amperes. The furrows thus made are from twenty-five to twenty-eight centimetres deep, and sixty centimetres wide. This apparatus can also work the subsoil plows which follow the plow and penetrate to a depth of forty centimetres. In tests made in 1895, in a heavy, tough clay, the furrows had a total width of sixty centimetres and a depth of twenty-four centimetres. The dynamometer showed a pull of 600 to 700 kilogrammes, giving about forty-five kilogrammes per square decimetre. The speed was at no time less than ninety metres per minute. The energy consumed was eight horse-power, and the loss was four horse-power.

For large work a model with four plows is most suitable. It requires more energy, but makes it possible to cultivate from four to five hectares to a depth of thirty-five centimetres in ten hours. The cost of the work is 25.65 francs per hectare cultivated, while it is 62.50 when oxen are used. The inconveniences due to the weight of the cable have been mentioned above.

Turning now to apparatus of more in-

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terest from the practical viewpoint, one of the best known in France has been developed by M. Felix Prat. In his arrangement an electric motor drives, through gearing, two drums turning in opposite directions, one for taking the plow out and the other for returning it. Brakes regulate the speed of the drums, and prevent the cable from unrolling without maintaining a certain tension. The system, while interesting, has not given entirely satisfactory results.

Another model of the electric plow operated from a drum has been developed by the house of Eckert. In this the drum is placed perpendicularly to the position it usually occupies, in order that the pulley which carries the cable from the upper makes use of the rotation of the pulley during the period when the plow is returning toward the windlass to shift the anchor. When the cable passes over the pulley, without exerting much tension, the anchor is raised by means of a chain and the carriage displaced a certain distance automatically. Immediately the anchor sinks to the ground, and when the cable reverses the increased pull on the latter forces the anchor into the ground. The Brutschke apparatus has been used at Grotz-Behnitz and at Sillium, Germany.

The house of A. Borsig, Berlin, builds a type of plowing apparatus which is worth examination. The motor is fed by movable connections branched from fixed conductors. A conductor 300 metres long moving toward the motor, the slack side of the traction cable drives a gear which lifts the anchors and moves the anchor carriage into the position necessary for the following furrow.

The towing system due to Colonel Brussiere has been used at Cureyras, in Algeria. An advantage of this system is that the towing cables are wound only to the depth of one layer, which causes less wear; but this advantage is at the expense of a weight of 20,000 kilogrammes.

La Société Helios, of Cologne, also builds electric plows equipped both with one motor and an anchoring carriage or with two motors. The one-motor system includes a motor carriage and an anchoring carriage. It is interesting to remark

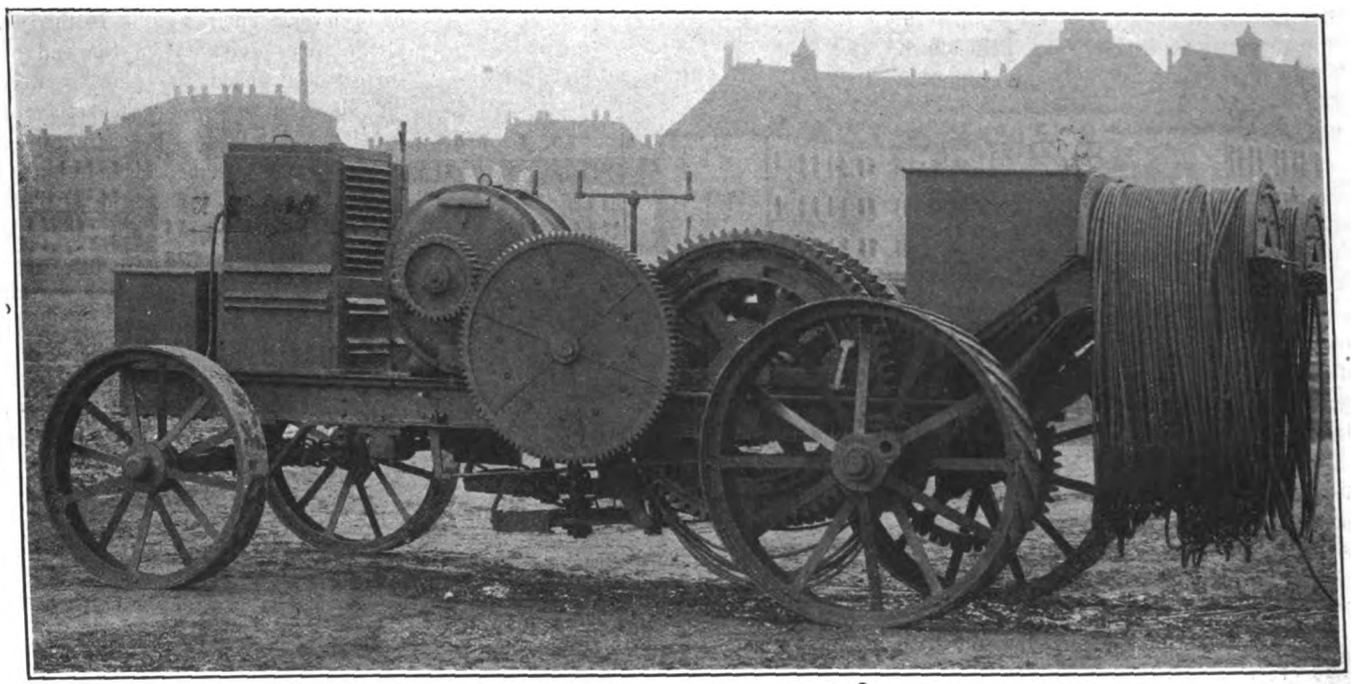

Fig. 3.—Brutschke Apparatus for Plowing. The Motor Is Double-Acting and also Shifts the Carriage for a New Set of Furrows.

to the lower part of the windlass may be done away with.

The windlass plows considered up to this point are single-acting. Those due to Herr Brutschke, of Berlin, Fig. 3, are double-acting—that is to say, they work going and returning. The great difficulty in this system is that the cable for going, as well as that for returning, is subjected to the same pull. For this reason it is necessary that the return pulley be solidly fixed, while, on the other hand, for quick working it should be relatively movable. This pulley is placed on a four-wheeled carriage, the wheels of which are furnished with a cutting flange for the purpose of increasing the lateral thrust on the ground. To this carriage is attached a sort of prong anchor which penetrates deeply into the ground. Herr Brutschke and a cable of the same length enable the machine to cultivate 300 hectares. The apparatus includes a controlling carriage, an anchor carriage and a plow which travels between the two carriages, turning five furrows at a time. The controlling carriage is provided with an alternating-current motor of forty horsepower, switches, interrupters and gearing which enables the motor to shift the carriage. The anchoring carriage carries an anchor and a drum about which is coiled the drawing cable. This carriage has a grooved pulley, over which passes the traction cable. This pulley is mounted on a guide and connected to the anchors by a chain. There are four anchors suspended from a small windlass which allows them to be raised completely for shifting the carriage. When the plow is

that electrical tillage began with the use of two motors. Thus, the first tests—those of Chrétien and Félix, at Sermaize, in 1879—were made by this means. In spite of the defective construction of the apparatus employed the efficiency was fifty per cent. The power used was eight horse-power at the generator and four horse-power at the receivers. The plow traversed from fifty to seventy metres per minute, and worked twenty square metres with a width of furrow of twenty-seven and one-half centimetres, and a depth of twenty centimetres.

Some years later, in 1885, a double trailing system was again used in the Proforiano tests in Frioul, the estate of Comte Vittorio Asarta. Three hectares were cultivated in ten hours, making six furrows twenty-two centimetres deep.

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The plow traveled at the rate of seventy metres per minute. It was provided with three shares and cultivated a total width of ninety centimetres.

In addition to the tilling the electricity is used to drive various mines and to light the farms and streets of the village.

An interesting installation is that on the Diedrichshagen farm. As the fields are distant three and one-half kilometres from the farmhouse, it is necessary to use alternating currents for transmission. The overhead line is composed of three wires of four millimetres cross-section. The power transmitted is thirty-seven horse-power. The voltage is 2,200, but this is transformed on the ground to 220. The work was done with two electrical windlasses and a metallic cable. The efficiency is about seventy-five per cent, each windlass representing a power of twenty-eight horse-power. The plow has four shares and makes 300 metres in six minutes. The furrows have a total width of 1.8 metres and a depth of thirty centimetres. At the end of the furrow the plow is reversed in not more than 1.5 minutes. In one hour the plow makes eight journeys and cultivates 4,350 square metres. The cost is only 0.09 mark per horse-power, making for thirty-seven horse-power, during ten hours, thirty-three marks. All expenses included, the saving realized is fifty per cent.

The Dolberg apparatus makes use of a metallic cable and a windlass separated from the motor. It is placed on two large metal beams carrying the slide rails of the motor, and is driven from the motor by means of a belt. This apparatus is, unfortunately, not easily shifted about. The Forster apparatus is faulty, since the windlass is placed too high up. The Siemens & Halske apparatus makes use of a motor fed by an insulated cable which it unwinds from a drum. The motor drives the wheels of the windlass or the cable drum and shifts the carriage. This has the advantage that with only three men—one at each windlass and one on the plow—the work can go on with speed and regularity, due to the fact that, without stopping, the man at the windlass can manipulate the plow or shift the windlass. The disadvantages of the system are the great weight of the apparatus (ten and one-half tons) and the deterioration of the cable, due to irregular winding and unwinding.

The two motor models have the disadvantage over those with one motor of being more costly and of requiring two windlasses and a double feeding system; but the amount of work accomplished in the same time is considerably more. This expense is diminished by Forster's arrangement in Fig. 4, which eliminates half of the feeding system. The current in this arrangement is supplied by a copper cable carried on special poles. This is connected to one of the motors. From here the current is passed along the towing cable to the second motor, when it returns to the generator by a second feeder, requiring two feeding cables only in place of four.

As we have seen above, these electric plows, though some are more perfect than others, all have the advantage of easy displacement, of regular and rapid operation, of easy setting up, and of operating at a great distance from the source of supply (Fig. 5), giving at the same time a mean efficiency of fifty per cent.

Specialists are not in agreement on the cost of plowing in this way. Thus, agriculturist Brutschke estimates that it is possible to cultivate four hectares in ten hours, with furrows thirty-five centimetres deep, and using only ninety kilowatt-hours. The cost of the kilowatt-hour is given as 0.29 franc. At this rate, electrical tilling should cost, everything included, 25.89 francs per hectare. Mr. Ringelmann, a French agriculturist, questions this figure, because the kilowatt-hour should be estimated, according to him, at 0.36 franc. This would increase the expense to 38.62 francs per hectare. If it is possible to cultivate sixty hectares per day, instead of four, the expense would be only 25.75 francs per hectare.

Whatever the expense, it is certain that the saving effected is considerable, and that there are practical advantages in electrical tilling, particularly for large estates.

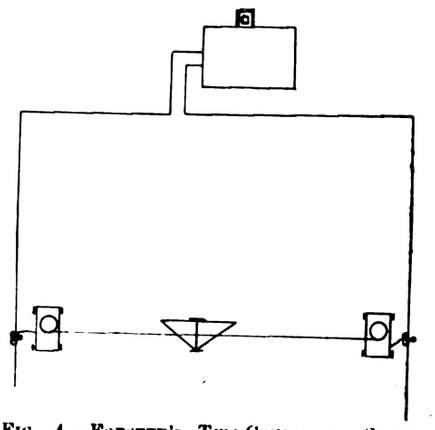

FIG. 4.—FORSTER'S TWO-CONDUCTOR SYSTEM OF ELECTRIC PLOWING.

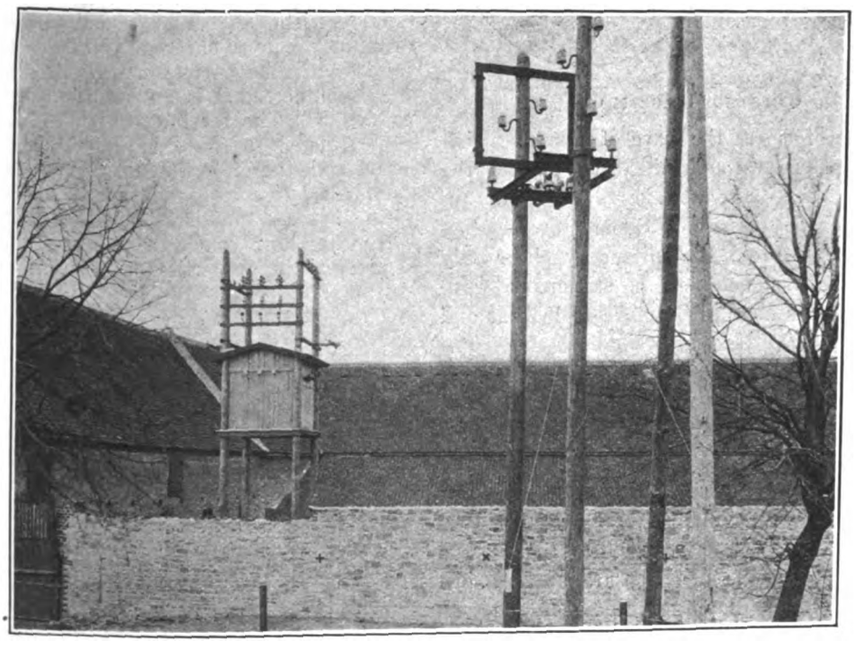

FIG. 5.—TRANSFORMER SUBSTATION AT CROTTORF, SUPPLYING POWER FOR ELECTRIC PLOWING.

State Laws Affecting Automobiles.

The American Automobile Association has issued a most useful little book giving the text of the laws affecting automobiles in the state of New York, New Jersey, Pennsylvania, Connecticut, Massachusetts, Rhode Island, Vermont, Maine and Delaware. In addition to the text of the laws a valuable feature of the pamphlet is the digests of the various state laws. This makes it an easy matter to reach an understanding of the purposes of the laws and the restrictions imposed by the different state authorities. The book is of convenient size for carrying in the pocket, and every owner of an automobile should possess one. The American Automobile Association is distributing these books to the various club members of the association, as well as to individual members. It is proposed at a later date to issue a second pamphlet embracing the automobile laws of the western states.

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THE CATHODE-RAY ALTERNATING-CURRENT WAVE INDICATOR.[1]

BY HARRIS J. RYAN.

During the past three years I have had considerable experience in the use of the Braun type of cathode-ray tube to determine the character of rapidly changing electric currents. In this experience I developed the following

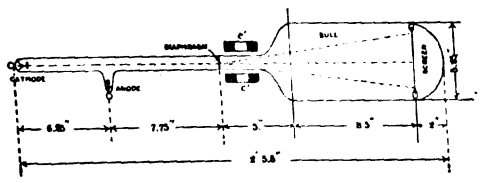


FIG. 1.—TUBE, SHOWING POSITION OF ONE PAIR OF COILS.

method for using this form of tube as an alternating-current wave indicator. By means of the method this instrument fills much the same sort of a want in the detail study of many alternating-current phenomena as does the indicator in the study of the cyclic performance of steam in the steam engine.

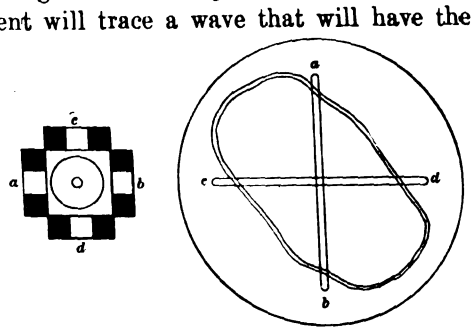
I have found the method so convenient and satisfactory in a large class of work compared with other and more usual methods that I am confident that many members of the Institute will find its employment often convenient and most useful in their own work.

DESCRIPTION OF THE METHOD.

The usual form of cathode-ray tube employed for indicating alternating currents is shown in Fig. 1. The cathode and anode are connected to the negative and positive conductors respectively of a motor-driven Wimshurst electrostatic machine. A current of about 0.0005 ampere is set up in so doing and the cathode rays are driven forward through the tube, striking the glass diaphragm which is opaque to them. All of the rays are stopped at this diaphragm except those which pass through a small aperture at its centre. This pencil of rays continues until they strike the screen where they cause a brilliant spot of fluorescent light. The screen is of mica spread with white powder that powerfully fluoresces when struck by the cathode ray.

Comparatively weak magnetic fields will cause large deflections to the ray. Thus if a continuous current be passed through the coils, c' c'', mounted just beyond the diaphragm as shown in Fig. 1, of sufficient strength in regard to the number of turns in the coils so as to produce a magneto-motive force of about fifty ampere-turns, the ray will be deflected well to one side of the centre of the tube, causing a corresponding displacement of the spot of light on the screen to the point marked +. Such deflection is due to the magnetic field set up across the cathode ray by the current in the coils. When the current ceases the spot of light produced by the ray returns to its normal position at 0. If the current is set up in an opposite direction, the spot of light will shift on the screen to the point marked —. When an alternating current having the same maximum value is substituted for the continuous current, the spot of light will vibrate between the + and — positions, and owing to the persistence of vision will appear as a band of light.

By looking at the screen as seen reflected from a revolving mirror, the spot of light actuated by an alternating current will trace a wave that will have the



FIGS. 2 AND 3.—SHOWING ARRANGEMENT OF COILS AND DIAGRAM OF CARD.

same form as the wave of current which is passed through the coils due to the fact that the cathode ray has no appreciable inertia. Some investigators have revolved the mirror synchronously and thus obtained a stationary wave which is most satisfactory to look at and which may be readily photographed. The synchronous driving and satisfactory adjustment of the revolving mirror involve expensive apparatus that is cumbersome and tedious in manipulation; to avoid the use of this apparatus I have devised the following method:

Reference is here made to Figs. 2 and 3. Two sets of coils are applied just beyond the diaphragm and mounted with their axes at right angles and in the same plane as shown in Fig. 2. The coils having the axis a b set up a horizontal field and which when established with alternating currents will produce the vertical motion of the spot of light producing a luminous band on the screen shown at a b in Fig. 3. Similarly, the coils having the axis c d produce the horizontal motion of the spot and the band c d. When the alternating currents are set up simultaneously through both sets of coil, the spot of light will be subject to both motions tracing the card shown by the broken line.

In order that definite results may be obtained, only one of the wave-forms of the two currents may be unknown; the other must be of known form. The most suitable known form is that of a true sine wave. To secure a true sine wave of current with ample accuracy for all practical purposes, I have employed the following arrangement of inductance and capacity. Referring to Fig. 4, AC are leads from an alternating source of unknown pressure wave-form supplying the current to an apparatus at M that is to be observed. The circuit through M leads through one set of coils mounted at c_1 c_1, so as to give a motion of the cathode ray that is proportional to the instantaneous values of the current through M. The current that produces the standard sine wave motion of the cathode-ray tube passes through the coils c_2 c_2 with their axes at right angles and in the same plane of the axis of the coils c_1 c_1. This current is obtained from the source having an unknown pressure wave-form at a' c'. It passes from c' through the single path L′ and the paths C and L″ in multiple, and finally to the source at a'. The coils c_2 c_2 are connected in the branch L″. L′ and L″ are inductive reactions made by mounting coils on straight laminated iron cores. The ohmic resistances are made as low as is ordinarily convenient and possible compared with the corresponding values of the reactances. C is an ordinary paper condenser. The reactances of C and L″ are adjusted so as to be approximately equal and, therefore, so that resonance is established to some extent due to the exciting current that is set up through L′. All who have made a study of the characteristic properties or behaviors of

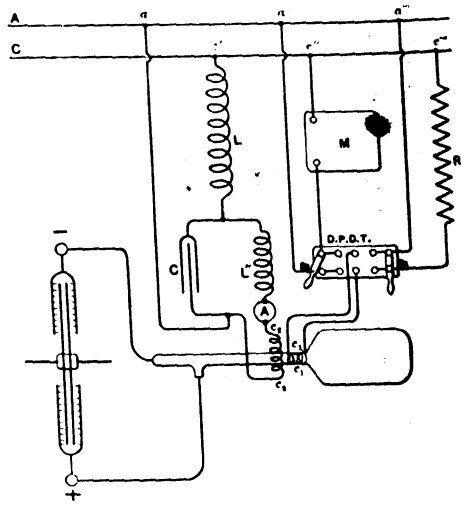


FIG. 4.—ARRANGEMENT OF CIRCUITS FOR AN ARC CATHODE-RAY INDICATOR.

the harmonic elements or component irregularities in relation to inductance and capacity will note at a glance the powerful action that this circuit will exert in expurgating the current that passes the branch L″ A c_2 c_2 of all irregularities causing it to have a simple sine wave-form.

(To be concluded.)

[1] A paper presented at the twentieth annual convention of the American Institute of Electrical Engineers, Niagara Falls, N. Y., July 2, 1903.

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GROUNDED AND UNGROUNDED TRANSMISSION CIRCUITS.[1]

BY J. S. PECK.

The question of grounding or not grounding the neutral and of the best method of connecting transformers is one of great importance, and it is the object of this paper to point out some of the conditions, both normal and abnormal, which arise with different systems of connections with and without grounded neutral.

By the grounding of the neutral point of a transmission system it is sought:

1. To limit the strain from line wires to ground.

2. To limit the strain between high-tension and low-tension windings of the transformers, also between high-tension windings and iron core.

Consider first the case of a single-phase transformer ungrounded, with high-tension and low-tension voltages taken for convenience as 10,000 and 1,000, respectively. There is evidently a maximum strain of 10,000 volts from one high-tension line wire to the other. If the circuits are insulated and symmetrical there will be a strain of 5,000 volts from each line wire to ground, and from each extremity of the high-tension winding to the low-tension winding and to the iron core.

If, however, the circuits are not symmetrical, the full strain will not be equally divided, and if in an extreme case one high-tension wire is grounded there will be a strain of 10,000 volts from the other line wire to ground; similarly, if one extremity of the high-tension winding be connected to the low-tension winding or to the core, there will be a strain of 10,000 volts from the other extremity of the high-tension winding to the low-tension winding or to the core.

The actual strain between adjacent high-tension and low-tension windings is equal to the high-tension voltage plus or minus the low-tension voltage, depending upon the arrangement and connection of the coils; but as the low-tension voltage is usually a small percentage of that of the high-tension, it is customary to assume that the strain between windings is equal to that of the high-tension voltage alone.

If the middle or neutral points of high-tension and low-tension windings are grounded, the iron core being also grounded, then as long as the circuits are in balance the voltage strains will be the same as with the windings ungrounded and balanced; but in case of a ground on either high-tension or low-tension line, or in case of a connection between high-tension and low-tension windings, a portion of the windings will be short-circuited. This will, in general, blow fuses or circuit-breakers, thus cutting the transformer out of service; or the voltage of the system will be lowered to such an extent as to call attention to the trouble.

Thus, on a single-phase transmission system, the grounding of the neutral point of primary and secondary windings will limit the strain from line to ground, and from either extremity of high-tension to low-tension and iron to approximately one-half the normal voltage of the system. If the neutral of only one winding is grounded, the strain from this winding to ground will be limited to approximately one-half of its normal voltage, but the strain from the ungrounded winding to ground and to iron and to the grounded winding will not be thus limited.

In considering other systems, the voltage strains between primary and secondary will not be mentioned, as these strains are easily calculated when the voltage on the transformers and the strain to ground is known. A short-circuit on a system will be assumed to cut out the transformers.

TWO-PHASE, FOUR-WIRE SYSTEM.

The two-phase, four-wire system is practically a double single-phase system, and the conditions for grounded and ungrounded neutral will be the same as for single-phase.

TWO-PHASE, THREE-WIRE SYSTEM.

The voltage across the two outside wires is 1.4 that between the middle and either outside wire. A ground on the middle wire will give a strain of 10,000 volts between each outside wire and ground, while a ground upon an outside wire will give a strain of 10,000 volts from middle wire to ground, and of 14,000 volts from the other outside wire to ground.

The neutral point for this system may be obtained from the middle point of an auto-transformer connected across the transformer windings. In this case, a ground upon any line wire will cause a short-circuit on the transformers, thus limiting the strain to ground to approximately 0.7 normal line voltage.

In general, the method of obtaining the neutral point by means of auto-transformers is not feasible on high-tension systems on account of the comparatively great cost of an auto-transformer wound for the high-tension voltage, and it will not be further considered in this discussion.

THREE-PHASE, DELTA SYSTEM.

With this system the strain from any line wire to ground is, with the system in perfect balance, fifty-eight per cent of the line voltage. In case of a ground on any line wire, the two remaining wires are raised to full line potential above the ground.

With this connection one transformer may be cut out, leaving two connected in V, and the above conditions will not be changed.

THREE-PHASE "V" SYSTEM.

With transformers connected in V, the strains will be the same as when connected in delta.

THREE-PHASE, "T" AND TWO-PHASE, THREE-PHASE SYSTEM.

With either the T or two-phase-three-phase connection the voltage strains with ungrounded neutral are the same as for the delta system. The neutral point may, however, be obtained from the teaser winding, in which case a ground upon any line wire will short-circuit portions of the windings.

With the three-phase T and two-phase-three-phase connection the grounding of the neutral limits the voltage between line and ground to fifty-eight per cent of normal.

STAR SYSTEM.

With transformers connected in star the conditions are very similar to those where two transformers are connected with primary windings in series and also the secondaries in series.

The total line voltage will divide with approximate equality between the two transformers. Between line wires and ground there will exist the same strain as with a single transformer, having the same total voltage; but if one transformer be short-circuited, the full voltage will be concentrated upon the other transformer so that the internal voltage strains on this transformer will be doubled and its iron loss greatly increased, though the strain from line wires to ground may be the same as before.

If the series connection between the two transformers be grounded, and a ground occur on either line wire, the transformer connected to this wire will be short-circuited and the other transformer will take the full voltage of the circuit and the ungrounded wire will be raised to full line voltage above ground.

Unless the leakage current of the transformer working at double voltage is suffi-

[1] Abstract of paper read at annual convention of the American Institute of Electrical Engineers, Niagara Falls, July 1, 1903.

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cient to open the circuit, the transformer may continue to operate indefinitely under the above conditions provided it does not break down, due to excessive heating or to the double voltage strains to which it is subjected.

In the case of a star-connected group of transformers with the neutral point of the primary and of the secondary, and also that of the generator, grounded, no excessive voltage can occur on any transformer, and the strain from any line wire to ground is limited to fifty-eight per cent of full line voltage, for a ground on any line or a short-circuit in any transformer will short-circuit the generator.

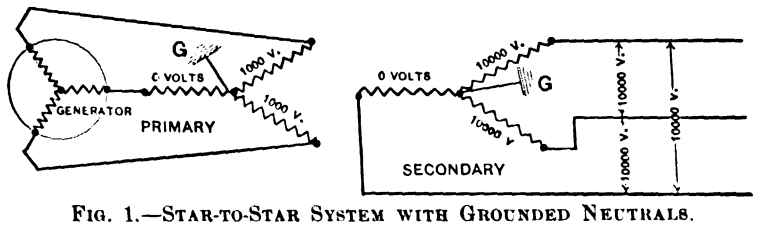

FIG. 1.—STAR-TO-STAR SYSTEM WITH GROUNDED NEUTRALS.

Fig. 1 shows the same system of connections but with the generator ground omitted. In this case a ground upon the primary or secondary line will short-circuit one transformer of the group and the two remaining ones will be operated at seventy-three per cent above normal potential; also the strain between the ungrounded wires and the line will be that due to the full line voltage.

Thus for a star-connected system the grounding of the neutral points is of no value in limiting the voltage strains on the system unless the neutral point of the generator be also grounded; in fact, the grounding of the transformers without the grounding of the generator increases the chance for trouble, since a ground upon any line wire increases by seventy-three per cent the voltage of two of the transformers.

STAR-TO-DELTA SYSTEM.

With a star-to-delta system no excess voltage can be obtained on any transformer, and not more than full voltage strain to ground, provided the delta remains closed; but with the delta open at one point and a short-circuit on one transformer (Fig. 2), the voltage on the two remaining ones will be increased seventy-three per cent and across two sides of the delta there will be three times normal voltage. Thus, on a 10,000-volt circuit, 30,000 volts may be obtained in case a transformer is short-circuited and cut out of the delta.

This excess voltage across the two sides of the delta is due to the fact that a short-circuit on the star changes the angular position of the voltages from 120 degrees to sixty degrees, which in turn changes the angular position in the delta from sixty degrees to 120 degrees.

DELTA-TO-STAR SYSTEM.

With this system it is impossible to obtain voltages higher than normal upon any transformer or between any two line wires. A short-circuit in one transformer may, however, cut it out of the delta but leave the star-connection intact. Two of the transformers operate at normal potential, with normal potential between two of the line wires, but with fifty-eight per cent of normal between the other wires.

STAR-TO-DELTA, RAISING. DELTA-TO-STAR, LOWERING.

In Fig. 3 is shown a transmission system with raising transformers connected star-to-delta, and lowering transformers connected delta-to-star. The neutral points of the low-tension windings of both raising and lowering transformers are grounded, and there is a ground on one low-tension lead which short-circuits one transformer. The high-tension side of this transformer is cut out of the delta. The voltage across the other transformer is increased seventy-three per cent, and the phase relation changed from 120 degrees to sixty degrees, the voltages being as shown in Fig. 2. On the lowering delta, three times normal voltage is impressed on one transformer and seventy-three per cent above normal voltage on the other two. The voltages obtainable across the star on the lowering transformers are readily understood from the figure. It will be noted that across one phase there is normal voltage and across the other two phases 2.7 times normal voltage. It is probable that a transformer subjected to three times normal voltage would take so large a leakage current as to blow fuses.

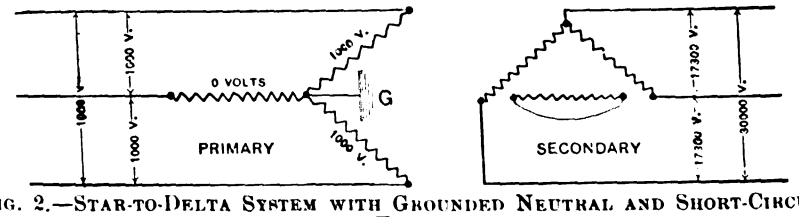

FIG. 2.—STAR-TO-DELTA SYSTEM WITH GROUNDED NEUTRAL AND SHORT-CIRCUIT ON ONE TRANSFORMER.

With this system of connection, grounding the neutral point of the star without a ground upon the neutral point of the generator is of no use in preventing unequal and excessive strains on the transformers and from line wires to ground. Should the delta on the raising transformers be kept closed, it is obvious that a short-circuit on any raising transformer would short-circuit the generator, but the above condition is one which might very possibly occur where switches or fuses are placed inside the delta.

DELTA-TO-STAR, RAISING. STAR-TO-DELTA, LOWERING.

Fig. 4 shows approximately the voltages and phase angles obtained when one raising transformer is short-circuited and cut out of the delta, but with the star-connection intact. The voltages obtained on the lowering delta will be approximately those shown. It will be noted that this delta has been twisted far out of its normal form, though the voltage on no transformer has been raised above normal and on the lowering transformer all voltages are below normal.

Fig. 5 shows the same connection but with one transformer short-circuited and cut out of the delta. The voltage across one of the remaining transformers is increased seventy-three per cent, while that across the other remains normal. The voltage across the open side of the secondary delta is increased 165 per cent above normal; that on one, seventy-three per cent above normal and on the other it is normal.

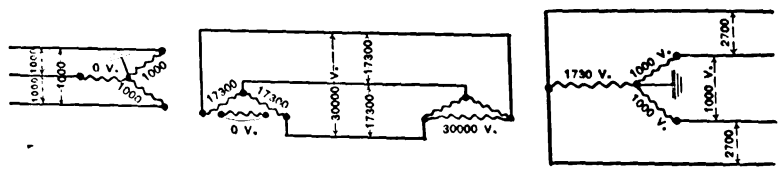

FIG. 3.—STAR-TO-DELTA, RAISING. DELTA-TO-STAR, LOWERING, GROUNDED NEUTRALS.

If the neutral points of raising and lowering transformers are grounded the abnormal conditions shown in Figs. 4 and 5 can not be obtained, for in this case, with the lowering delta closed, as in Fig. 4, the fuses will be blown when a lowering transformer is short-circuited; and with the delta open, as shown in Fig. 5,

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a short-circuit in the lowering transformer will short-circuit the generator.

It is obvious that a large number of combinations of raising and lowering transformers in addition to those given above may be obtained.

Resonance — The abnormal voltages given above are those which are obtained from the generator pressure through direct transformation. Mr. Blackwell, in his paper, "Star or Delta-Connection of Transformers," has called attention to another cause which may produce abnormal voltages, *i. e.*, resonance. This is particularly liable to occur when a high inductance, such as the winding of an idle transformer, is in series with a large capacity, such as that of a transmission line.

In addition to the combinations given above there are the two-phase-three-phase, three-phase V and three-phase T-connections which may be used at either the raising or lowering ends. When used for raising transformers, these combinations will deliver their proper voltages to the line provided the proper voltages are impressed on their primary terminals, as it is impossible by short-circuiting one transformer to raise the voltage of the other.

When used as lowering transformers these combinations will supply to the secondary circuits, voltages of proper amount and bearing the proper phase relation to each other, provided the voltages impressed on the primary side are of proper amount and proper phase relation to each other. If, however, the voltages applied to the primary are distorted then the voltages delivered by the secondaries will be correspondingly distorted.

Grounded Neutrals—It will be noted that in many cases the grounding of the neutral points of a transmission system limits the voltage strain to ground and the voltage which may be obtained across any transformer, and in such cases grounding would seem advisable. This is notable in the case of the star-system with grounds on transformer and generator neutrals. There is, however, a danger arising from this grounding which should be carefully considered. In case of trouble on the circuits, current may flow through the ground to the neutral; in thus flowing it will naturally take the path of least resistance, so that if telephone or telegraph lines, which have normally low resistance to ground, parallel the transmission circuit, the current will flow along these wires, often with disastrous results to the circuits.

Two cases of trouble are particularly liable to give these conditions:

1. Where the neutral points of the high-tension windings of raising and lowering transformers are grounded, the opening of one or two of the three transmission wires will cause currents to flow through the ground.

2. A high-resistance ground on a transmission wire will partially short-circuit a transformer and cause current to flow through the ground to the neutral.

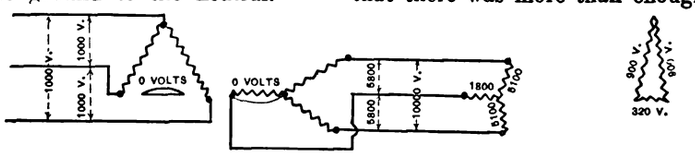

FIG. 4.—DELTA-TO-STAR, RAISING. STAR-TO-DELTA, LOWERING. ONE SIDE OF RAISING DELTA CUT OUT.

While grounding of neutrals may be permissible in certain localities it may not be allowable in others; and in laying out a plant it would seem to be advisable so to arrange the apparatus that it may be safely operated without grounding the neutrals.

The delta system is the one giving the minimum chance of trouble. Under certain conditions, however, the star and star-delta systems will give satisfactory service.

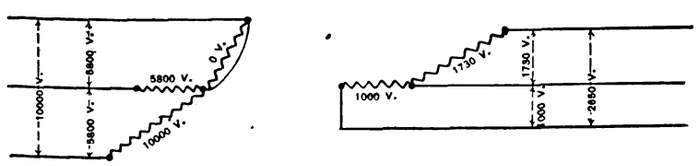

FIG. 5.—STAR-TO-DELTA, LOWERING. ONE SIDE OF DELTA CUT OUT.

Forthcoming High-Speed Travel Experiments in Germany.

The promised high-speed competition tests between steam and electrically hauled trains between Hamburg, Hanover and Berlin, will be made in the course of the next few weeks. These tests are to be a continuation of the high-speed electric train trials on the Berlin-Zossen military line. Speeds of 100 miles per hour at light load, and ninety miles per hour at heavy load, will be attempted. Both electric locomotives and motor cars will be tried.

The German Reichstag has made an appropriation for heavier rails and ties for the Berlin-Zossen line, and tests will be commenced upon this when the new material has been put down. In the tests made on this line about a year ago it was found that the high speed obtainable was limited by the light track construction, so that the full capabilities of the electric trains could not be determined.

Meeting of the Faraday Society.

The first ordinary meeting of the Faraday Society, a British organization devoted to the interests of electrochemistry and electrometallurgy, was held June 30, 1903, at the rooms of the Chemical Society, London. The membership of the society is 238, but as few of the members live in London, there were only fifty present. The president, Dr. J. W. Swan, was unable to be present, and the chair was occupied by Mr. James Swinburne, one of the vice-presidents. An address from Dr. Swan was read, explaining the purposes of the society, and expressing the view that there was more than enough of useful and necessary work to be done on grounds now unoccupied by other organizations. The next business was the passing of rules which had been drawn up by the council.

Mr. W. C. Dampier Whetham gave a short account of his paper on "The Present Position of the Theory of Electrolysis." This sketched the development of the dissociation theory and showed how it explained electrolytic conduction of aqueous solutions. The author, however, did not think that sufficient data were at hand to warrant the extension of this theory to non-aqueous media.

Communications were read from Dr. Swan and Professor H. E. Armstrong, severely criticising the dissociation theory. The discussion was continued by Dr. Lehfeldt and Dr. Lowry, and a brief reply was made by Mr. Whetham.

Mr. James Swinburne then read his paper on "Chlorine Smelting with Electrolysis." Contributions from Dr. Swan and Mr. J. C. Richardson, discussing this paper, were read, and the paper was discussed by Mr. B. Blount, Dr. Steinhart, Professor William Thomson, Mr. R. H. Hutton, Dr. Mullineux Walmsley and Mr. Whetham. A brief reply was made by Mr. Swinburne. Papers by Dr. Lehfeldt, on "The Total and Free Energy of the Lead Accumulator," and by Dr. Perkin, on "Electrolytic Apparatus," were read by title. These will be discussed at the next meeting of the society. An exhibition was given of Dr. Perkin's apparatus.

The society then adjourned, to meet early in the autumn. After the adjournment refreshments were served in the library of the Chemical Society.

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Mediterranean System of Electric Traction in the Neighborhood of Nice and Hydraulic Plant of Mescla.

By C. L. Durand.

ONE of the most extensive systems of electric traction in Europe is that which has been recently installed along the Mediterranean coast in the vicinity of Nice. It includes a number of lines within the city of Nice itself which use both underground conduit and trolley, as well as a line which runs for over thirty miles along the coast from Cagnes to Menton, taking in a portion of the Riviera, which besides being well populated is so largely frequented by visitors during the winter. The power for the system of traction lines is obtained from a hydraulic plant in the vicinity and is transmitted over a high-tension line to three substations. The whole installation has been carried out by the Compagnie Française Thomson-Houston.

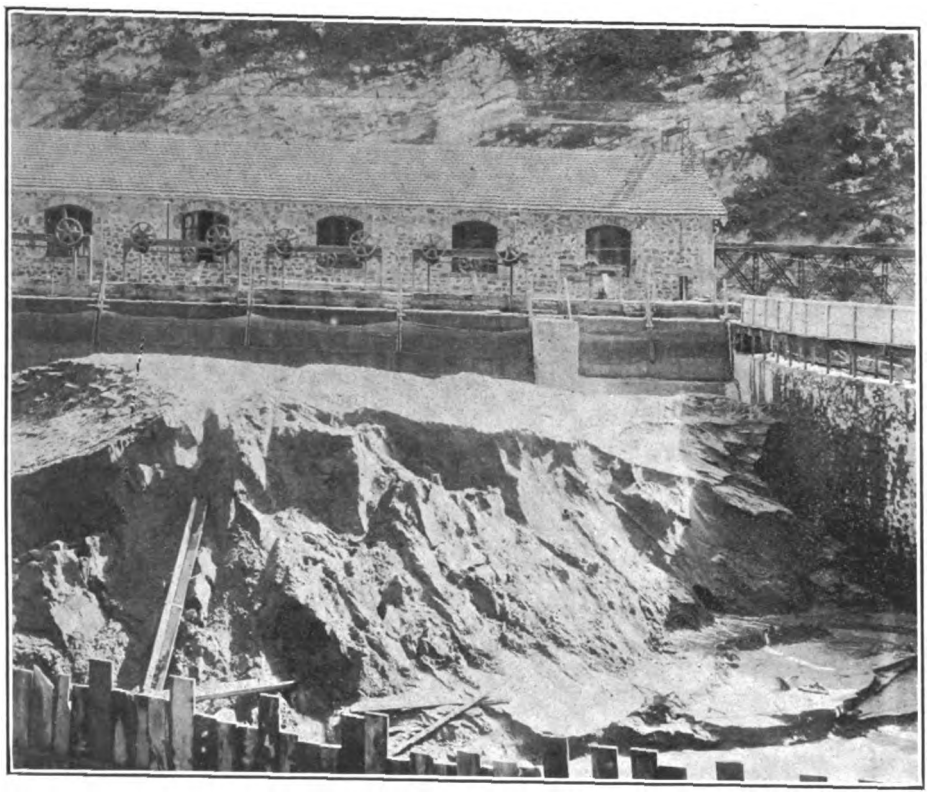

FIG. 1.—HYDRAULIC POWER STATION AT MESCLA, SUPPLYING POWER FOR THE NICE ELECTRIC RAILWAY SYSTEM.

The main hydraulic plant is located in the mountainous region in the neighborhood of Nice, and uses the power of the Var River to generate three-phase current at 10,000 volts for the main transmission line which runs to the principal substation at Nice and from there to two other substations located on the coast, at Californie and Beaulieu. These three substations are designed to transform the high-tension three-phase current produced at Mescla into direct current at 500 to 550 volts for the different traction circuits. The principal substation of Sainte Agathe, which is located at Nice, has also a steam generating plant which assures the working of the system in case of accident to the transmission line from Mescla. It contains the steam engines and dynamos which can supply the same current as received from the hydraulic plant. The high-tension line from Mescla to Nice, at 10,000 volts, is overhead throughout, while the lines from Nice to the two substations of Beaulieu and Californie are formed of underground cables.

At the point known as "La Mescla" in the valley of the Var, the river after receiving the Tinée makes a circuit around the mountain, and by connecting the two extremities of the loop a difference of level of thirty-five to forty feet is obtained, and as the output of the stream is about ten cubic metres per second, this gives the plant an available force of 2,000 horsepower. To carry this out a tunnel was pierced through the mountain which enabled the whole or a part of the waters of the Var to be brought to the turbines, which are located near the mouth of the tunnel. The photograph, Fig. 1, shows a view of the hydraulic station which is erected at this point. In the foreground is the settling basin with the water drawn off in order to clear out the large amount

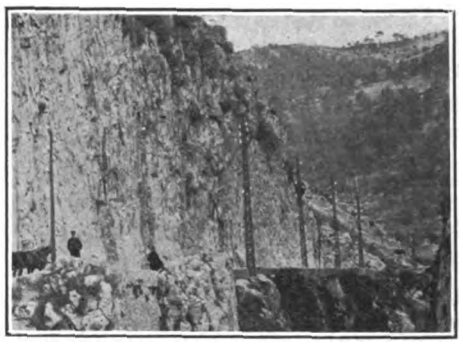

FIG. 2.—IRON POLES USED IN MOUNTAINOUS SECTIONS OF MESCLA-NICE TRANSMISSION LINE.

of sand which the stream draws down with it. The water upon leaving the turbines is not sent at once into the river below, but as there is still a considerable difference of level it is taken off by a tail-race which later on will supply a second hydraulic plant located a few miles from the first. The main turbines, which are three in number, can each take 7,500 litres per second. They are of the centripetal type, formed by a pair of conical

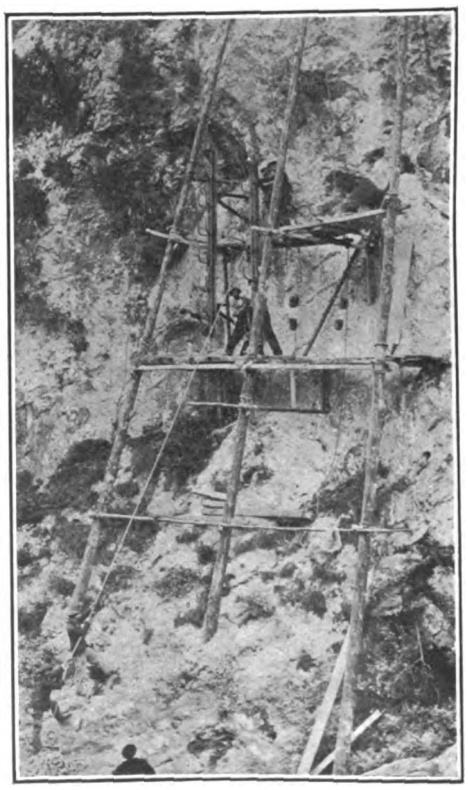

FIG. 3.—BRACKETS FOR HIGH-TENSION TRANSMISSION LINE, NICE ELECTRIC RAILWAY SYSTEM.

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wheels, and receive the water from two distributors whose vanes are articulated and are operated by the mechanism which regulates the speed. The turbines are each lodged in a separate water-chamber built in masonry and the chambers can be closed by a movable gate in front of the entry. Each of the main turbines is

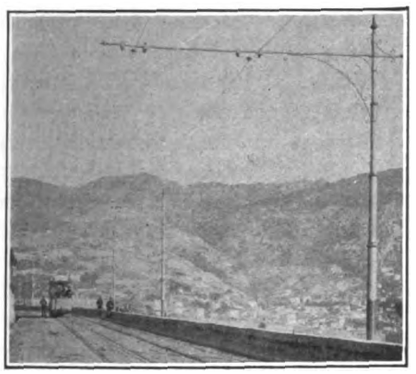

FIG. 4.—CONSTRUCTION ON COAST LINE SECTION OF NICE ELECTRIC RAILWAYS.

supplied with an oil-pressure governor of the Escher-Wyss pattern, which controls a small electric motor for regulating the turbine vanes. A pump worked by a special ten-horse-power turbine with horizontal shaft supplies the oil under pressure for operating the governors.

with a frequency of twenty-five cycles and furnish a tension of 10,000 volts which is sent directly into the line without using transformers. The exciting current for the alternators is supplied by two four-pole dynamos which are operated separately by two sixty-horse-power turbines. The high-tension switchboard is made up of standard apparatus and has three panels for the alternators, one station panel and two panels for the overhead lines, besides an exciter panel. All the parts carrying the high voltage are placed in the rear of the panels.

The construction of the overhead line across the mountainous region, which lies between Mescla and Nice, has been one of the most difficult parts of the work. The different engravings show the general character of the country traversed by the line. The high-tension circuit is formed of six copper wires of 7.25 millimetres diameter which form two separate three-phase lines. These two lines are designed to work in parallel under normal operation, but if an accident should disable one of them the other has a sufficient capacity to operate the plant. For this reason each line has a separate switchboard panel both at the start and finish. The line which is established in a rocky district over nearly the whole length is supported on porcelain insulators upon specially built trellis-work poles of considerable height, measuring from thirty-five to forty-two feet. The poles are planted in a bed of cement beton from five to six feet deep, according to the nature of the ground, and are spaced 115 to 125 feet apart. Where the line passes over the roads or in inhabited places it is protected by a network of wires which is designed to catch the broken line and also connect it to ground. Six galvanized iron wires are stretched above and below the line and are cross-connected every fifteen feet by a transverse wire, the whole system being connected to ground, forming a sort of cage inside of which passes the line wire. In this way a very efficient protection is secured. Besides the lightning arresters at each end of the line, the poles are provided with lightning-rods. Special measures had to be taken to avoid disturbances to the telephone and telegraph lines which often run parallel to the high-tension circuit. In some cases, where the lines run near together, a protecting network is placed between them, connected to ground, which also acts to some extent as a magnetic screen for cutting off the induction effects. The rocky nature of the country occasioned

FIG. 5.—CONDUIT CONSTRUCTION FOR NICE ELECTRIC RAILWAYS.

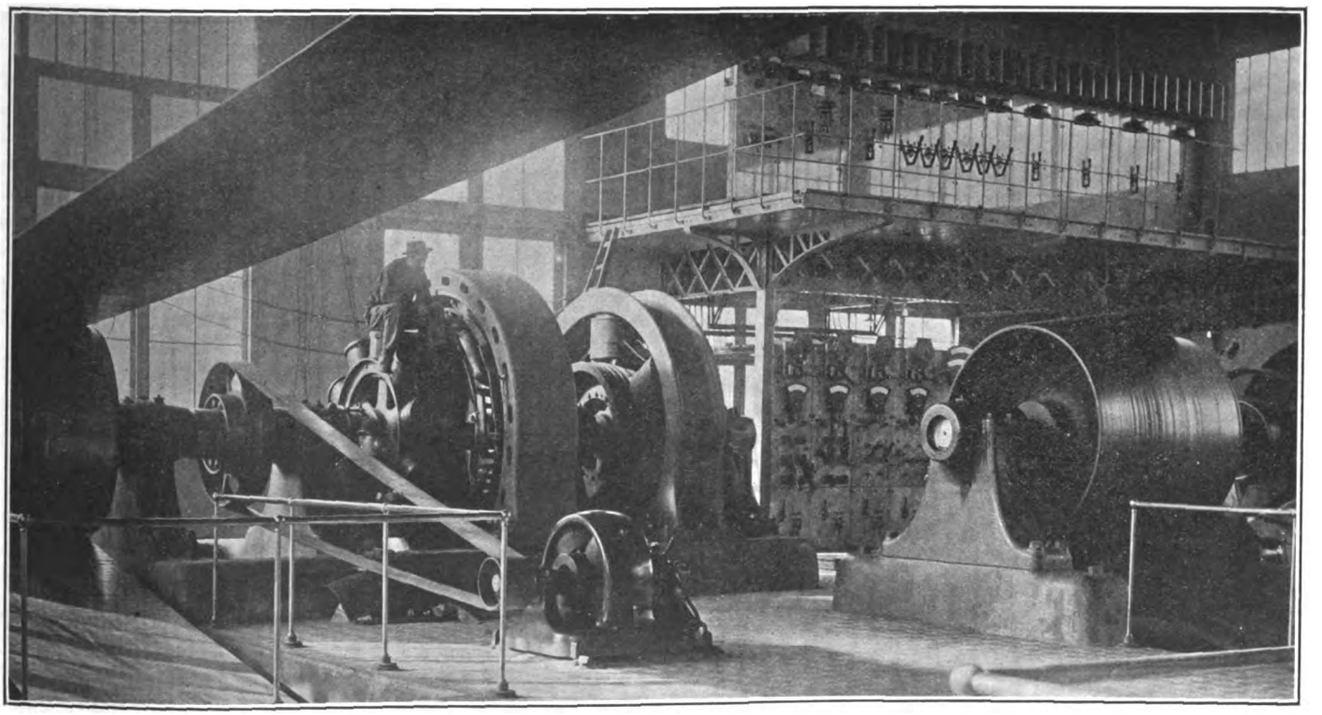

FIG. 6.—SUBSTATION AT SAINTE AGATHE, SHOWING GROUP CONSISTING OF THREE-PHASE 530-KILOWATT ALTERNATOR AND 500-KILOWATT RAILWAY GENERATOR MOUNTED ON ONE SHAFT AND THE HIGH AND LOW-TENSION SWITCHBOARDS, NICE ELECTRIC RAILWAY SYSTEM.

Each of the main turbines is directly connected by an elastic coupling to a twenty-pole three-phase alternator with an external fixed armature ring and revolving field mounted on a flywheel. These alternators are built for 500 kilowatts

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considerable trouble in running the line. In the Gorges of Balmes, for instance, most of the construction material had to be brought to the spot on the backs of mules, over the narrow mountain roads, and not only were the iron pieces for the poles, which were assembled on the spot, brought in this way, but all the other material and even the water for mixing the beton. The line where it passes through the Gorges of Clues along the mountain road will be observed in Fig. 2; in some places the line is mounted along the side of the rock upon iron brackets, as noticed in Fig. 3. The line passes through the mountain region for nearly all its length, coming out not far from Nice, where it follows the Paillon River, and finally reaches the substation of Sainte Agathe, within the city.

The system of lines which is now in operation and controlled by the Compagnie des Tramways de Nice et du Littoral has a total development of nearly 100 miles of single track. It includes two distinct parts, the urban system of Nice and the coast line which runs along the whole of the coast from Cagnes on the west of Nice to Menton on the east, passing by Villefranche and Monte Carlo, and thus running through many of the stations of the Riviera which are so largely frequented during the winter season.

The city of Nice had two lines which used animal traction, and these were transformed and six new lines added, making a very extensive system. Two forms of traction are used within the city. In the central portions the underground conduit has been installed, while the remainder uses the trolley. The underground conduit system has been carried out on the same lines as the system which is now in use at Paris on the Bastille—Montparnasse and other lines. The central slot has been adopted, with a contact plow of the standard pattern. The engravings show the construction of the conduit and the overhead system. The trolley wires are supported either upon poles formed of steel tube or in most cases by rosettes fixed to the houses, as the use of poles has been avoided as much as possible.

The greater part of the Nice lines has been laid in double track with one metre gauge, while the coast line runs partly in double track and at other places in single track with switches.

All these lines are supplied with power either from the Mescla hydraulic station or by a steam plant which has been installed in the same building as the main substation of Sainte Agathe. The system is designed to be operated from the hydraulic plant under ordinary conditions, while the steam plant acts as a reserve. A view of the latter portion is shown in the engraving Fig. 5. It is equipped with engines, boilers and accessory apparatus to use normally 45,000 pounds of steam per hour. The engines, of which there are two of 700 horse-power each, are of the horizontal type with two twenty-inch cylinders provided with Corliss valves, with a twenty-six-inch piston stroke and running at 100 revolutions per minute. The steam is furnished by two batteries of four semi-tubular boilers each, having 185 square metres heating surface. Each of the steam engines drives by belt a group consisting of a triphase alternator and a direct-current generator. Both of these machines are mounted side by side upon the same shaft, as will be noticed. The alternator is a ten-pole machine of 530 kilowatts, giving 900 volts and running at 300 revolutions per minute, with a frequency of twenty-five cycles. The six-pole direct-current machine has a capacity of 500 kilowatts and is compounded so as to give a tension of 500 volts at no load and 550 volts at full load. Each of the alternators is excited by a small twenty-five-kilowatt machine driven by belt from the main shaft at 1,100 revolutions per minute and giving sixty volts. The alternating current at 9,000 volts is lowered by a set of step-down transformers to 340 volts, then changed to direct current at 500 to 550 volts by a group of rotary converters. For the feeder which supplies the Contes traction line a booster is used which is formed of a four-pole fifty-horse-power induction motor coupled direct to a thirty-five-horse-power generator running at 750 revolutions per minute and delivering continuous current at seventy-five volts. The station contains also six oil transformers of fifty-five kilowatts each which lower the tension of 9,000 volts to 5,000 volts for supplying the two substations of Californie and Beaulieu. Three smaller oil transformers of twenty kilowatts lower the tension from 9,000 to 110 volts for the motor of the booster set. The rotary converters use six transformers of the same type. The switchboard, which will be noticed to the right of the engraving, is provided with twenty-five panels in all for the high and low-tension circuits, and is made up of standard apparatus. The station is lighted by a twenty-kilowatt group consisting of a twenty-kilowatt 500-volt motor which drives a 120-volt generator at 875 revolutions.

The two substations of Beaulieu and Californie are similar in construction. They are fed by three-phase current generated at the Sainte Agathe plant and are connected to it by an underground circuit formed of lead-covered cables with iron sheathing. The cables contain three conductors of thirty square millimetres section each. The distance to the Californie substation is 4.8 miles and to the Beaulieu six miles. Each of these substations contains two rotary converters of the four-pole type, giving 150 kilowatts at 750 revolutions per minute. These machines deliver current for the traction lines at 500 volts no load and 550 volts full load. The plant includes six stationary transformers of fifty-five kilowatts which lower the tension from 4,300 to 340 volts for supplying the rotary converters, besides a switchboard of six panels for the alternating and the direct-current side.

The system of feeders for the line has a total development of twenty-three miles. It is generally laid underground; of the two overhead portions one is used for the Contes line and the second for the section which is fed by the Beaulieu substation, and these two have a total development of six miles. The overhead feeders are formed of cables of 125 square millimetres section and are mounted upon insulators on the same poles as the trolley wire. The system of underground feeders starting from the Sainte Agathe station is formed of armored cable of 200 or 400 square millimetres section, and runs for the most part through the city of Nice. An extensive system of pilot wires has been specially designed to connect the station with the main points of the system and thus observe the drop of voltage in the return circuits in order to avoid danger from electrolysis.

The motor cars, of which there are over a hundred, are each equipped with two G. E.-58 motors and the usual standard apparatus, besides carrying a special apparatus with contact plow in order to pass from the trolley to the underground conduit parts of the road, and inversely.

A New Automobile Record.

The world's record of flying kilometre was lowered in the motor speed trials which took place at Phœnix Park, Dublin, on July 4. This feat was accomplished by Baron De Forest on a seventy-horse-power Paris-Madrid Mors machine, who brought the record—which previously stood at twenty-nine seconds—down to 26.6 seconds. This represents traveling at the rate of eighty-six miles an hour. In other tests, held the same day, previous records were also reduced, including those for motor cycles and tourist cars.

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ELECTRICAL MINING NOTES.

BY SIDNEY F. WALKER.

At the recent meeting of the British Institution of Mining Engineers in London, a paper upon the breakdowns of electrical plants was read by the electrical engineer to a boiler insurance company which has taken up the insurance of dynamo machines. The author strongly condemned the present practice of working plant up to its full output. The question is a somewhat difficult one, where supply generating stations are concerned, as there is always a staff of skilled men at hand which can put things right at small cost and in a short time, and the difference in coal and accessories may be considerable between working at low load and working near full load. But the case where electrical apparatus is used in mining work is quite different. Stoppage means considerable loss, and efficiency is to be measured, not by the immediate return of work for power expended, but the cost of doing the work required, and in this the repairs bill may bulk very largely, if plant is worked up to its full capacity; while stoppages, if frequent, will discount any good effects produced by the improved apparatus. The author of the paper pointed out correctly, that an insulation test was of little service as a test of reliability, though a temperature test might be of service. As in all apparatus which is to do continuous work, there is only one test which is of any real value, and that is the work itself. A guarantee by a good firm, to make good any part of the apparatus that fails within a certain time, coupled with satisfactory enquiries as to the behavior of similar apparatus, is probably the very best safeguard that a user of electrical apparatus can have. He may have assistance from genuine experts, from men who have practical experience in the particular class of apparatus in question, and who will be able to judge at a glance whether the wire, for instance, on the armature is likely to stand the heat to which it will be subjected, whether the spindle is large enough or the brush-holders are satisfactory, etc. Further, there is no doubt that if some one connected with the user of the apparatus, an expert who really understands his work, could see the progress of the apparatus from time to time, it would probably save many breakdowns. There are of course difficulties in the way of carrying out a suggestion of this kind. Manufacturers do not want experts about their works who are going into other works, and may take with them little wrinkles which they wish to keep to themselves. Again, colliery owners and colliery managers are very much in the position of spoilt children. They have had the commercial workers who wish to do business with them at their feet for a very long time, and it is almost against their religion to pay a consulting fee. The plan adopted is too often, for the engineer at the colliery, who rarely knows much about electricity, to pump the would-be contractors until he thinks that he has got hold of the subject sufficiently, and he then makes a report advising that so and so's tender be accepted, he having previously secured himself with this firm.

The author of the paper on plant failures also strongly recommended periodical inspection of plants. The table given by the writer, with the paper, is very instructive, but is strictly in accordance with the present writer's experience and, he believes, that of others. Of the total number of breakdowns which occurred, armatures were responsible for seventy-eight per cent, and of these commutators for thirty-three per cent. Mechanical portions are given at twenty-five per cent, brush gear at seven per cent, field magnet coils at ten per cent. It will be noticed that the percentages do not quite agree. There are more parts than make up the whole, but this is explained by the fact that some of the faults had to be classed under two heads. Of the mechanical failures, shafts come out very well. Bearings are responsible for a good proportion of failures, some 8.6 per cent, binders of armature coils for 9.4 per cent. Of the electrical faults, armature coils short-circuited account for twenty-nine per cent, and armature coils earthed for 19.5 per cent, breakage of wires of armature coils to 15.6 per cent. The author also appends a table showing to what causes failures may be attributed generally, and he assigns eighteen per cent to bad design, 13.6 per cent to bad workmanship, 1.56 per cent to overrating, a very small percentage considering the usual practice, 7.4 per cent to dust and damp, and 2.5 per cent to want of attention; thirteen per cent is classed as unknown, and 5.5 per cent as due to faults in accessories. In the discussion which followed, it was complained by some contractors and manufacturers present, that the number of failures had not been stated. In his reply, the author of the papers gave seven and one-half per cent as the percentage of failures which had occurred, taken over four years. This was the percentage per annum of the total machines insured with the National Boiler Insurance Company, whom the author represented. He also gave as the average life of electrical plant, four years. This included all kinds of machines, new and old, and all classes of work, largely mining.

Coal-cutting came up for discussion in this paper, and a member suggested that a committee of the institute should investigate coal-cutting. One contractor who spoke stated that of sixty-five machines which he had working at different collieries, the average life was eight and one-half years, and the percentage of failures only two per cent, and this included a case where a motor had been drowned for two months by an inrush of water at a colliery, and was burnt on starting. Another maker complained very strongly that electrical apparatus was often put into the hands of incompetent men to look after, and thought that the motor of a coal-cutting machine was often blamed when it was the machine itself which was at fault.

Another manufacturer thought that electrical apparatus was subjected to fewer breakdowns than any other apparatus, and when specifying for apparatus, the time during which the apparatus would be running continuously should be stated.

The paper on electric driving of winding gears, or hoists as they are called in America, was very interesting. It was read by one of the staff of Messrs. Siemens Brothers. Messrs. Siemens have not done a great deal of mining work in the United Kingdom, but the firm of Siemens & Halske, of Berlin, with which they are connected, has done a good deal in Germany. Some twenty years ago they fitted up an electric locomotive in a coal mine in Westphalia, the Zankeroda, where the current was taken from an angle iron placed at a convenient height, with a little carriage running on it connected to the locomotive. Mr. Hird, the writer of the paper, detailed the work which had been done in this country and on the Continent previously to his firm taking the matter in hand, which was practically the adoption to one or two electric motors to winding, by attachment to the winding engine, through gearing, with the usual starting resistance; and the paper then went on to explain that this arrangement was very wasteful. Winding or hoisting is very different from any other work which an engine or a motor is likely to be called upon to perform. At a colliery, for winding, there are two wire ropes coiled up on a drum, one attached to each cage.

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Each rope is made long enough to allow its cage to descend to the bottom of the shaft, and each cage descends and ascends alternately, so that its rope is alternately being run out from the winding drum and being coiled up on it. Winding, or hoisting, is accomplished simply by revolving the winding drum, and coiling the rope up which happens to be run out, the other rope unwinding in the process. It will be noticed that when the cage, usually loaded either with coal or men, is first started off its supports at the pit bottom, a very heavy strain is brought upon the engine or motor which is revolving the winding drum, but as the cage ascends the rope attached to it becomes shorter and shorter, while that attached to the descending cage becomes longer and longer, and at a certain point in the shaft the work to be done upon the ascending cage is balanced by the work being done by the descending cage, and from that time forward till the end of the wind, till the ascending cage is landed upon its props, the energy delivered to the winding drum by the descending cage is greater than that demanded by the ascending cage. Evidently this is a case where electricity should come in at its best, but not with the old plan of simply adding a resistance to the motor, to be used for starting. It is at starting that the consumption of energy is usually greatest and to add to this consumption by wasting energy in heating resistances means to lower the efficiency very considerably. Added to this, the arrangement does not provide for taking advantage of the excess of energy delivered by the descending cage during the latter portion of the wind. After a good deal of experimenting, the plan almost universally adopted has resolved itself into the provision of a special generator for the winding current, the excitation of which is controlled in place of controlling the current passing through the armature, the control being effected by the engine driver himself by a succession of contacts upon his lever. Various methods of controlling the excitation of the generator for the winding current were explained by the author, but the final form, up to the present, according to the experience of Messrs. Siemens & Halske, is that known as the Siemens-Ilgner system. Mr. Ilgner is the engineer of some mines in Germany, and he has worked the system out in conjunction with Messrs. Siemens. The system is a very pretty one. A separate generator is provided for the winding current. It is usually not driven by a steam engine, but by the electrical supply service. It is a motor-generator, and the supply service may be whatever is convenient. Usually it is three-phase in the installations which have been put down. To the axle of the motor-generator is attached a heavy flywheel, whose office is to absorb the surplus energy which is given out by the descending cage. The field current of the generator of the motor-generator is supplied by a small generator driven by the motor which is in connection with the supply service. The current from the motor-generator is taken directly to the armature of the motor which drives the winding drum, and the field circuit of the motor which drives the winding drum is also supplied by the small auxiliary generator which supplies the field of the motor-generator. The resistances necessary for controlling the two field circuits are brought to contacts which are worked over by the engineman's winding lever. When the winding first commences, and a large supply of energy is demanded, it is furnished by the motor-generator; the motor taking what it requires from the supply service and handing it on to the winding plant. When the descending cage is giving up more energy than is required to lift the ascending cage, and in fact from the moment when the strain upon the winding motor is relieved, the flywheel of the motor-generator takes up the surplus energy and stores it, to assist the supply current at the next wind. It is stated that with this method only forty pounds of steam per brake-horse-power actually exerted is consumed, while with the best forms of steam-driven winding plants ninety pounds is the rule; and with the majority of winding plants it is very much more. The author of the paper also describes an arrangement for electric winding which was exhibited at the Dusseldorf Exhibition, in which a somewhat similar arrangement ruled, but the surplus energy of the descending cage was taken up by a storage battery accumulator. This is stated not to be so good for the purpose as the flywheel, and with this the present writer agrees. Electrical accumulators are hardly the things to use about a coal-pit at present. At the same time the rivalry between the two aptly illustrates that between the two systems of storage. The mechanical method of storage by means of a heavy flywheel has much to recommend it, but it has also drawbacks, and it is doubtful if it will hold its own in face of a really good and reliable storage battery, when colliery people have acquired more knowledge of electricity.

The other paper presented to the Institution described a small hydraulic electrical plant which the author of the paper had fitted up in North Wales in connection with some of the slate quarries at Bala Festiniog. The object of the author, he stated, was not so much to describe his plant, as to call attention to the restrictions which the British Board of Trade exercised over developments of the kind. The English Board of Trade is a government department to which is entrusted the regulation of all sorts of matters, but in particular the supply of electricity for lighting and power. The result of the reading of the paper was that a committee of the institute was appointed to approach the Board of Trade on the matter. The present writer and others have been constantly urging upon colliery owners the advantages, where there are several collieries under one management, of putting down a central station to generate electrical energy to supply light and power to all the machines at all the collieries, but if they are to be regulated at every step, the gain will be very doubtful.

Journal of the British Institution of Electrical Engineers.

The June issue of the *Journal* of the British Institution of Electrical Engineers contains the following papers, with discussions: "A Study of the Phenomenon of Resonance in Electric Circuits by the Aid of Oscillograms," by M. B. Field; "Distribution Losses in Electric Systems," by A. D. Constable; "Divided Multiple Switchboards; an Efficient Telephone System for the World's Capitals," by W. Aitken; "Methods of Supporting and Protecting Inside Conductors," by O. L. Falconar; "Some Notes on Continental Power-House Equipment," by H. L. Riseley; "Network Tests and Station Earthing," by A. M. Taylor; and "The Arrangement and Control of Long-Distance Transmission Lines," by E. W. Cowan. There is also given an abstract of a discussion on "Electric Wiring Up to Date," which was held at the meeting of the Glasgow local section.

Accumulator Cars in Wales.

Another trial of electric accumulator cars is being made on the Swansea & Mumbles Railway, South Wales. Two vehicles are being employed, each accommodating about eighty passengers. The cars were built by the Brush Electrical Engineering Company.

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The Edison Interests at West Orange, N. J.

A Description of the Extensive Works Manufacturing Some of the Inventions of Thomas A. Edison.

THE manufacturing plant for the production of a number of the inventions of Mr. Thomas A. Edison, at West Orange, N. J., contains many features of more than ordinary interest to the trained mechanic and engineer, and of instruction and profit to the visitor not so familiar with mechanical apparatus. The works are pleasantly situated in a country locality which, while being far removed from the city environment, is easily accessible by both steam and electric trolley service. Passing through the office of the gatekeeper, which commands the front entrance to the works on the Valley Road, the first point of interest is the private laboratory, reception room and experimental department of Mr. Edison. The experimental plant is located in a large brick structure, three stories high, and the mechanical outfit has the appearance more of a heavy machine shop than of an experimental mechanical laboratory.

LIBRARY AND RECEPTION ROOM, LABORATORY OF THOMAS A. EDISON, WEST ORANGE, N. J.

The reception room is situated in the extreme front of the experimental building, and this is invitingly fitted up with easy-chairs and accommodations for the visitor. It is here where Mr. Edison receives most of his visitors, as this is where his desk is situated and the room is of convenient access to the experimental stockroom and machine rooms beyond. This reception room has two galleries which follow three sides of the room, the northern wall being of a more or less ornamental nature, as may be seen from the accompanying illustration. On the ground level of the reception room is a number of models of various kinds, and an extensive technical library which is for the use of the laboratory staff of experimenters. In the first gallery is located one of the most remarkable and complete mineral collections which is on exhibition to-day. This is the collection which Mr. Edison secured from the Tiffany Company, and had largely been gathered by Mr. George F. Kunz, who has attained a great deal of prominence in the field of mineralogy. The second gallery is used for storing various materials and for the filing of records.

Immediately to the east of the reception room in the experimental building is the stockroom, wherein are stored all chemicals and the finer apparatus necessary for the work of the experimental staff. Beyond this are the machine rooms for the building of experimental tools and the heavy pieces of apparatus necessary for the manufacturing of special products. This machine room is thoroughly equipped with milling machines, planers, radial drills, lathes, boring machines, slotters, punch-presses and various other machines of this nature. On the floor above are lighter machines for special experimental purposes. On this floor, and also on the floor above, are testing rooms and different departments for work along special lines.

Continuing to the east in this building, along Lakeside avenue, is the boiler room, and beyond this the dynamo room for supplying the light to the experimental building and electric current for the motor drive in several of the other factories.

Beyond this building, and extending to the tracks of the Erie Railroad, are the executive offices of the works. Here are located the managers of the different departments and a large force of clerks attending to the clerical details of the various organizations.

The whole plant occupies quite a large plot of ground, the buildings being placed very much after the order of a hollow rectangle.

Adjoining the Erie Railroad tracks, a spur of which runs into the ground of the Edison works, is the main machine room. Here are manufactured nearly all of the parts of the various machines turned out for the different selling companies which represent the Edison interests. In this machine room are made the stampings and turnings for the Bates and Edison numbering machines, fittings and appurtenances for the Edison phonograph, the Edison kinetoscope apparatus, and some of the material which goes into the assembly of the Edison primary battery and the Edison primary battery fan motor.

At this point it might be well to state that while the Edison primary battery is assembled at the works at West Orange, the manufacturing of the parts is mostly all done at Silver Lake, N. J. There is still some experimenting being done on Mr. Edison's storage battery at the West Orange works, but the machinery, outside of the experimental machinery, is being put up and placed in operation at Glen Ridge, N. J. Some of the experimental machines for the Edison Portland cement works are still made at the experimental department at West Orange, but the heavy machinery and manufacturing apparatus are practically all in place at Stewartsville, N. J.

The accompanying illustrations show views of the main machine room; one illustration showing a double row of automatic screw machines. The operation of

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the machines is remarkable in many ways, as long, straight pieces of metal are fed into the machines, coming out either finished as screws or as shafting of greater or less dimensions, with one or more flanges cut in in one operation. In this room there are also the punch-presses for stamping a number of the fittings for the different classes of apparatus, the engraving department for cutting the figures in the steel dies for the numbering machines, the gear-cutting machines for cutting the different gears and segments which operate the phonograph machines and the projecting kinetoscopes; and one end of the building is given up to the sapphire department exclusively. Here are prepared the sapphires which are used in the registering and reproducing apparatus connected with the phonograph, and also in preparing the tools for shaving the record blanks.

A special line of screw-cutting machines is installed in this building, the working of which has to be very carefully and accurately manipulated. These are particularly for cutting the threads on the main shaft of the phonograph machines, these threads being cut to a pitch which has a ratio of one hundred to the inch. On this thread is fitted a mandrel nut which engages with the screw cut inside of the record, this causing the record to travel from right to left during the operation of the phonograph machine. In the main machine room is the raw material stockroom and the machine tool stockroom.

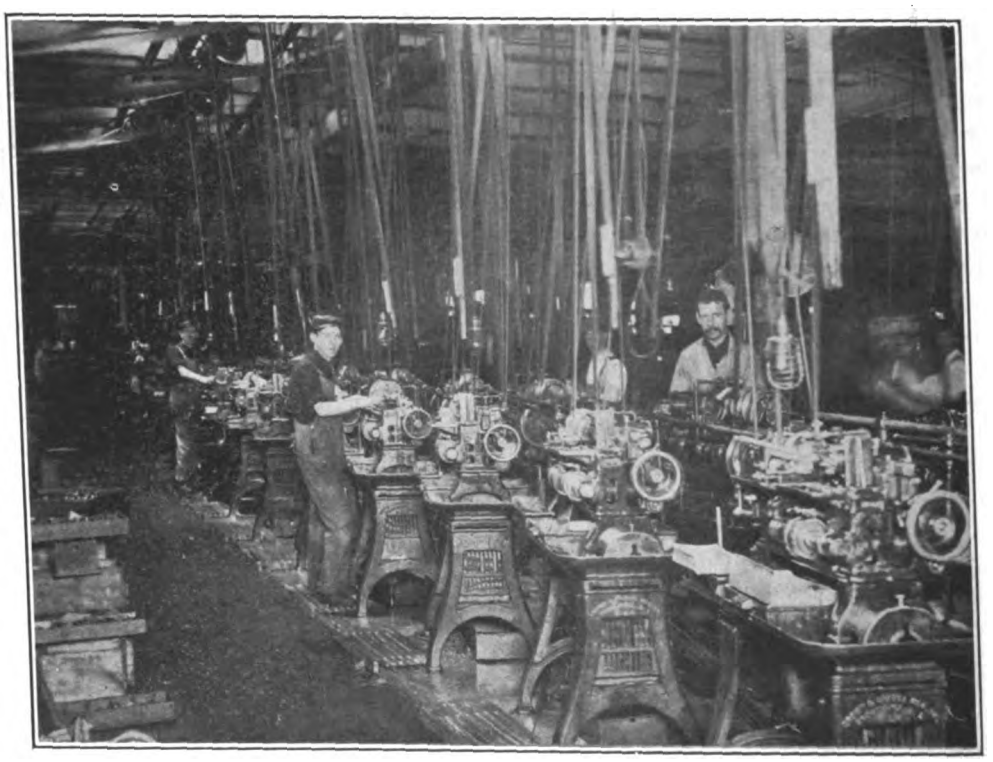
Adjoining the main machine room there is a smaller machine department which is used principally for making the parts for the Edison battery fan motor and assembling this apparatus. In this room is also the tool-making department, which makes up the tools for the various operations throughout the factories.

The next building on the trip around the rectangle is the shipping department and the assembly room for the phonograph apparatus. Here the different materials which go to make up the phonograph apparatus are brought together, and the phonographs assembled.

On the second floor of this building is the testing department, where the phonograph machines are tested for mechanical efficiency and perfection.

Beyond this, the next building is the planing mill and box-making and cabinet-making department. Here packing boxes for shipping the finished product, and also the cabinets for the phonographs and for the kinetoscopes are made up from the raw material to a finished state, the varnishing and lettering being completed in this department. A number of ingenious machines in the way of planers, wood-cutters and nail-drivers are to be seen in this department; and it is here, with the exception of the record-moulding department, that there is the evidence of the greatest utility of the labor-saving machinery installed.

The building in which the records are made is one of the most interesting departments of the Edison plant. Here the master records are produced for reproduction which runs into the thousands and sometimes into higher figures than this. The making of a master record is attended with more difficulty than is ordinarily understood. There has to be exercised a great deal of ingenuity in so bring-



AUTOMATIC SCREW MACHINES IN THE MAIN MACHINE SHOP, AT THE WORKS OF THOMAS A. EDISON, WEST ORANGE, N. J.

ing out the characteristics of any selection spoken, sung, or played to the master instrument that in reproduction the delicate registrations may not be so flattened out that they will be either harsh or indistinct in rendition. While the theory of the operation of the phonograph may be very well understood, it may not be out of place here to sketch briefly the essential points in the phonographic reproduction of sound. When a human voice tone is articulated or a musical note is struck, the air immediately surrounding the seat of such a disturbance is set into vibration more or less rapid, according to the character of the disturbance caused by such a sound. If we take the note produced by rubbing a string which is of such a length that it vibrates 256 times per second, we get what is commonly known as the concert C pitch. If the string is composed of such material that its vibrations are of greater amplitude than those of some other material, the volume of the sound will be greater. With a greater amplitude of vibration there is consequently a greater condensation and rarefaction of the air surrounding the sound-producing apparatus. These condensations and rarefactions radiate in a spherical manner from the point of disturbance, and striking on a diaphragm or membrane stretched across any opening will cause it to vibrate at the same frequency as the initial period.

The master phonograph instrument is fitted with a wide-mouthed horn which terminates in a narrow neck closed by a membrane or diaphragm, to which is attached a sapphire stylus. Rotating at a rate which causes it to travel one inch laterally while rotating 100 times, a specially prepared record is cut by the stylus as the vibrations of different frequency and amplitude impinge on the diaphragm. Sometimes it is necessary for the master record to be made over and over again until a perfect result is secured. These master records are thoroughly tested by musical and mechanical inspectors. The former test is made by running them through a phonograph, and such as satisfy all requirements under this inspection are tested again. An examination is then made with a microscope to determine if the surface of the cylinder is satisfactory in all particulars. When

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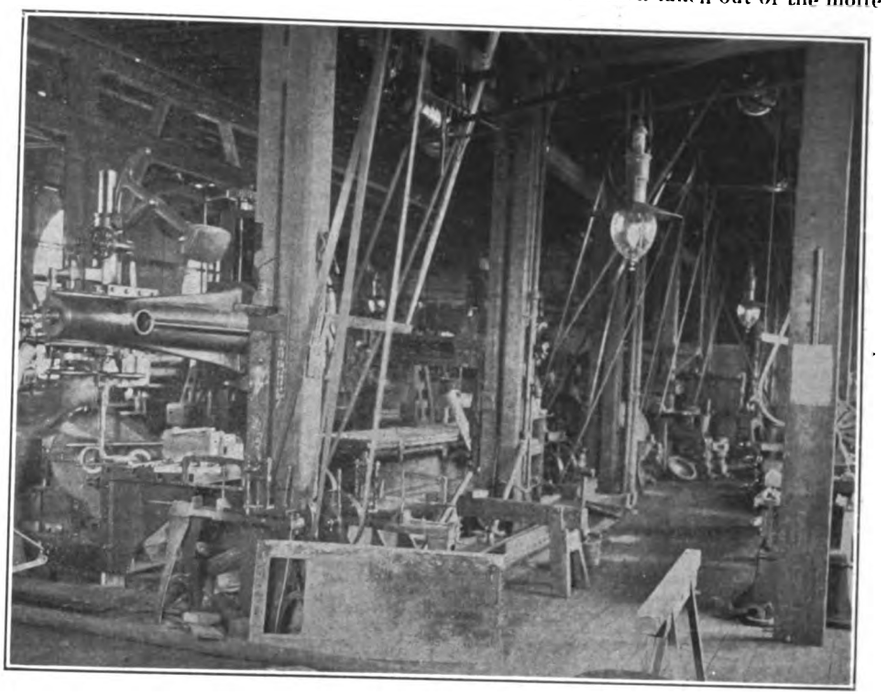
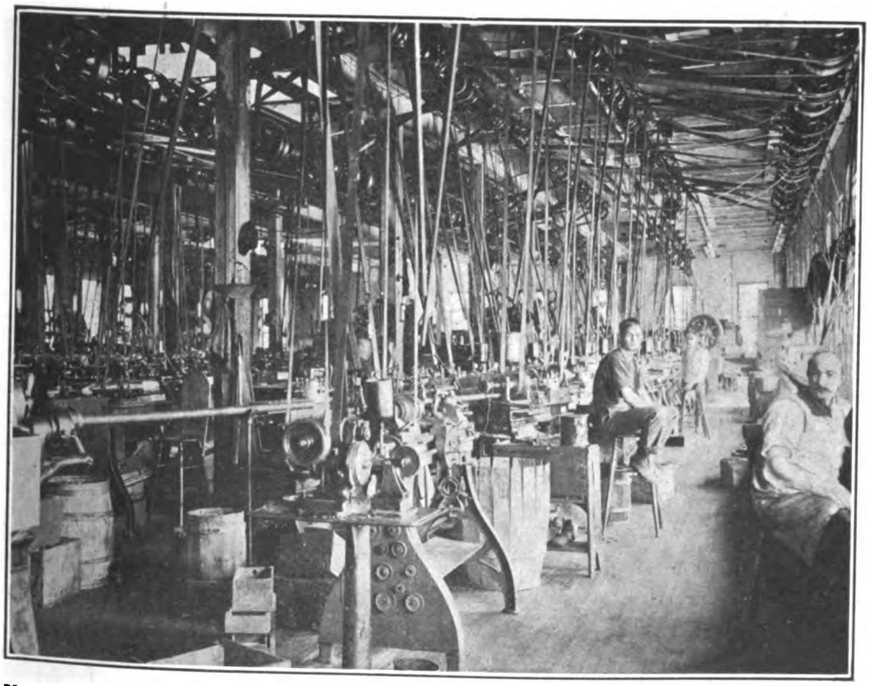
a good record has been secured this is used for forming the mould.

The first step in forming the mould is to electroplate the master record. Into one end of the record is thrust a metal plate, to which is attached an iron armature. This head rests on a conical pivot and thus supports the record. Close to and parallel with the sides of the record are suspended two strips of gold leaf attached to two electrodes. Over the whole is placed a glass bell jar, and by means of a pipe connected to the base of the stand the jar is exhausted. Just without the glass jar, and at the same height as the iron armature mentioned above, is a magnet which revolves around the jar and thus sets the record in rotation. An arc is passed between the gold plates, which vaporizes the gold and deposits it upon the record as it spins. In this way a thin, uniform coating of gold is obtained over the outer surface of the master record. The record is then removed and placed in a copper-plating solution, and a deposit of copper of one-sixteenth of an inch made, this process requiring several days. When a sufficient thickness has been secured the mould is taken out and the copper turned off to a true cylindrical surface with the master still in it. This is then fitted into a brass shell, which forms the body of the mould, and the record is complete and ready for moulding after the master has been removed.



THE MECHANICAL PLANT OF THE EXPERIMENTAL LABORATORY OF THOMAS A. EDISON, WEST ORANGE, N. J.



A VIEW IN THE MAIN MACHINE ROOM AT THE WORKS OF THOMAS A. EDISON, WEST ORANGE, N. J.

After the gold-plated shell has been properly seated inside of the hollow brass mould the mould is placed in a proper receptacle, and it then becomes the work of the moulding crew to carry out the next process of manufacture. The moulding room is divided into a number of what are technically termed "kettles." To each kettle there is a crew, each member of which has his special work to do. The first step in the process of manufacture after the matrix has been perfected is to place the mould into a proper receptacle, which lowers it into a vat of molten composition, whereupon the molten material being at a much higher temperature than the metal mould, a thick film of composition congeals around the interior of the mould, the periphery of the film taking on the impressions of the gold-plated matrix. The mould is then taken out of the molten bath and placed on a forming machine, when it goes through several operations which turn upon the inside of the record a thread which fits the mandrel which carries the record from right to left in the phonograph machine. After this thread has been properly made the mould is plunged into a chilling solution which causes the record to contract sufficiently to drop out of the mould. The record is then taken to another machine which simultaneously trims and finishes the rough ends of the record. Following this process the records are next placed upon a slowly rotating mandrel, where they are judged for accuracy as to roundness, trueness to gauge and general perfection. The records are next taken to the department where they are sorted as to selection, and finally are carried upstairs, where they are wrapped and packed for delivery to the shipping department.

The phonographs in use are mostly all operated by a spring motor. While the machine, as completed, is apparently a simple piece of apparatus, still there are quite a number of parts going into the building up of a perfect machine, and several of these parts have as many as twenty-five operations performed before they are completed. After the records are properly made, they are placed upon a mandrel which is rotated by means of a spring and clockwork. A sapphire button or ball, of such diameter that it will engage the indentations which were made by the registering stylus on the master record, is fitted to a diaphragm or membrane which covers the neck of the phonograph horn. As the sapphire button or ball is thrown into vibration by engaging

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with these indentations on the rotating record, the diaphragm is thrown into vibration of a similar frequency, which, in turn, causes the condensations and rarefactions in the air which affect the sensitive organ of hearing, completing the cycle of operation. As the record is rotated it is moved from left to right by the mandrel nut which fits over the thread on the main shaft.

There is everywhere apparent in each of the several departments which are utilized in the production of the Edison apparatus the evident great demand for each article. The Bates and Edison numbering machines are used in every city in the world, and the output annually has increased far beyond the most generous expectations. The Edison battery fan motor is a most popular piece of apparatus, and a large number of operators are kept continually busy supplying the demand. The kinetoscope still holds its own as an amusement feature in numberless resorts; but it is as regards the phonograph that one is particularly impressed with the extent to which the general public will patronize a legitimate amusement feature. Within the past few years the demand and output have increased fourfold, and the factory is now working twenty hours out of the twenty-four to supply the market for this scientific amusement device.

British Engineering Standards Committee.

The British Engineering Standards Committee has already begun work, the result of which it is hoped will simplify and cheapen the manufacture of electrical machinery in England. In addition to the Electrical Plant Committee there are several subcommittees now sitting. The government is supporting the work, and has appropriated $15,000 toward defraying expenses. It has also appointed members to represent the different government departments on the main Electrical Plant Committee and on the several subcommittees.

The main Electrical Plant Committee met in July, 1902, and divided the work into four heads—physical standards, mechanical standards, telegraphs and telephones, and power. The last heading has been subdivided into generation and transformation, transmission and distribution, and utilization; and the subhead of utilization has been further divided into light, traction, power, heat and electrochemics.

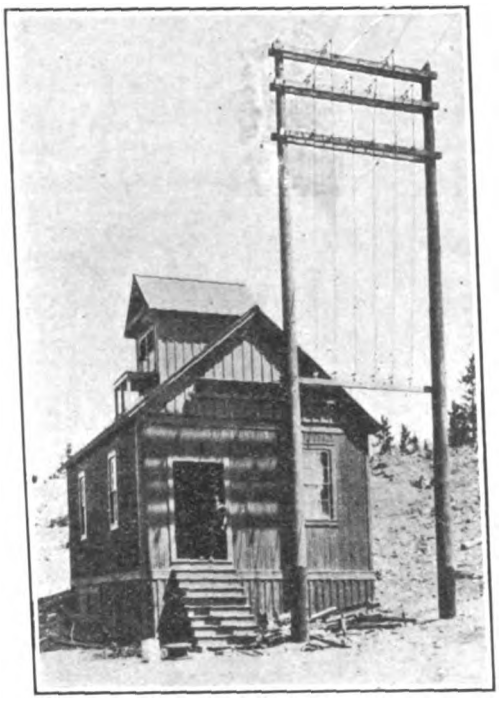
The following are the chairmen of the various committees: Electrical Plant Committee, Sir William Preece; subcommittee on motors, generators and transformers, Colonel R. E. Crompton; subcommittee on cables, R. Kaye Gray; subcommittee on telegraphs and telephones, John Gavey; subcommittee on electric tramways, A. P. Trotter; subcommittee on central station rules, C. H. Wordingham. A small committee has also been formed under the title of subcommittee on the temperatures of insulating materials, Dr. R. T. Glazebrook, chairman.

ELECTRICITY IN PLACER MINING.

PLANT OF THE GOLDPAN ENGINEERING AND MINE SUPPLY COMPANY, BRECKENRIDGE, COL.

BY JAMES E. JOHNSTON.

The development of the vast mineral resources of Colorado has been very materially aided in many instances by the ultilization of the energy of her mountain streams, electricity being the main medium of application. The intermittent character of the flow of these streams, however, has been the most serious drawback to the extended use of water power in this section of the Rocky Mountains. Still for some purposes, this is not as great an obstacle as might at first seem. This is especially so in the case of placer mining,



SUBSTATION OF GOLDPAN ENGINEERING AND MINE SUPPLY COMPANY.

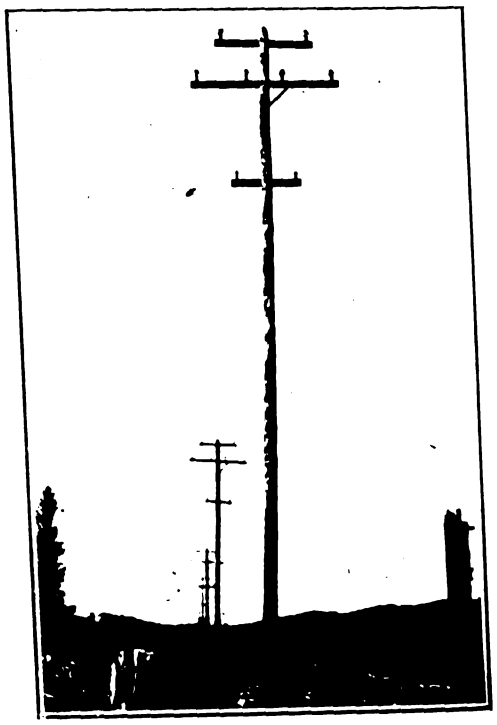
which can only be prosecuted during the summer months, at which time, even the most insignificant of these streams, becomes a veritable torrent.

The Goldpan Mining Company, of Breckenridge, Col., has the largest placer mining plant in the state, if not in the United States. This plant, outside of the direct application of water under pressure to the washing of the gravel and elevating same from the pit, is largely operated by electricity.

Spruce Creek, some five miles above the present scene of operations, is the source of power. This is diverted from its natural channel and conveyed to the pressure box by means of a ditch some two miles long. From the pressure box to the generating station the water is conveyed in a steel pipe of varying diameter and thickness to suit requirements. The total effective head is 425 feet and the working pressure about 206 pounds.

The generating plant consists of two 200-kilowatt, alternating-current Westinghouse generators, delivering two-phase current at 440 volts, and direct-connected to two Pelton water-wheels.

The arrangement of these generators and wheels is novel and deserves mention. The wheels are set as closely together as possible to allow their extended shafts to pass each other. The shafts are thus parallel and of the same length and some four feet apart. On each end of each shaft is mounted one-half of a flexible coupling of the leather link type. At each end of this arrangement is placed



POLE LINE OF THE GOLDPAN ENGINEERING AND MINE SUPPLY COMPANY.

a generator which by a tension screw and guides can be placed so that its half coupling can engage with either shaft. Normally one generator will be used on each wheel, but the plan allows either wheel to be operated with either generator and provides for emergencies that otherwise could not be met.

Two exciters, each of capacity sufficient to excite both generators, are provided. They are direct-connected, each to a suitable Pelton wheel.

As a portion of the current generated is used in lighting the town of Breckenridge and the remainder is applied to motor work of an intermittent nature, the switchboard is provided with two sets of busbars which allow of either multiple or separate running. This board is of

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blue Vermont marble provided with a full line of measuring instruments of the long scale type.

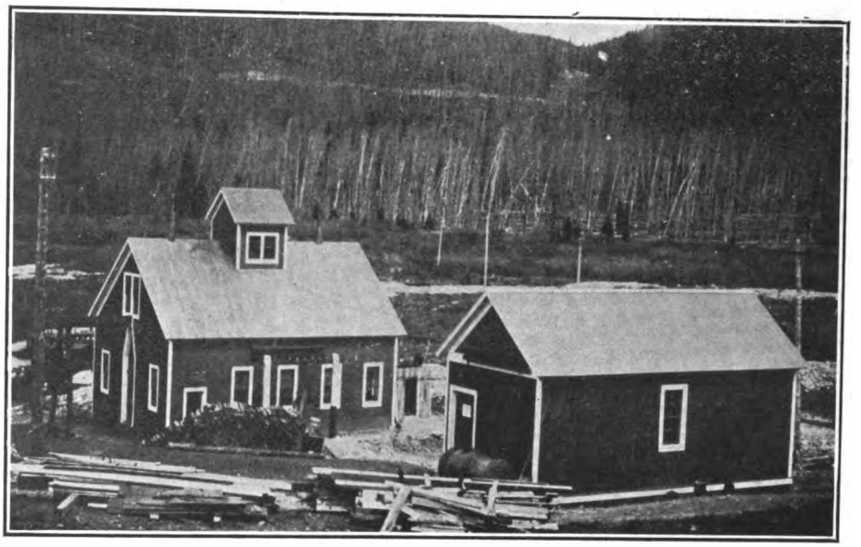
The raising transformers are located in a separate building and are of the Westinghouse oil-cooled type. The line pressure is 10,000 volts, three-phase, it being the intention ultimately to cover greater transmission distances than is now done.

The line is of No. 5 copper, two circuits of three wires each of one set of poles. Glass insulators are used.

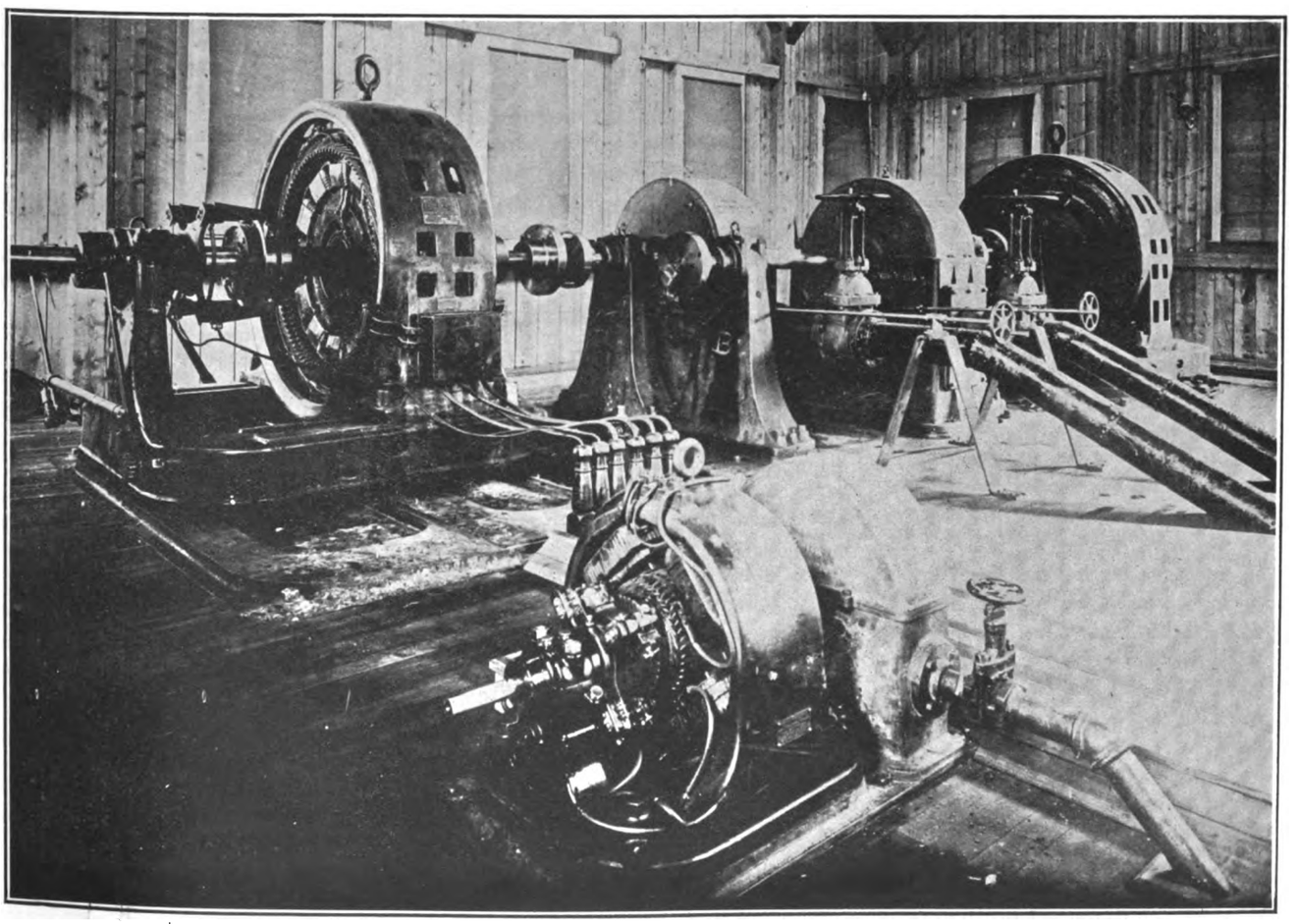
The principal use in mining to which the power is applied is the driving of pumps, lighting the pit, etc. Two electrically driven portable cranes are used in moving larger boulders, etc. These cranes are of the boom type, and are equipped with variable-speed alternating-current type F motors capable of exerting thirty horse-power. One 150-horse-power constant-speed motor is used to drive a centrifugal pump and assists in keeping the pit dry. There is also a well equipped machine shop driven by a fifty-horse-power constant-speed motor. In this shop were made the large wrought-steel water mains used in the placer system.

Distribution of current is made to these motors at 220 or 440 volts, according to location, from a substation at Breckenridge. The lighting of the town is from 2,200-volt mains, also from the same substation.

The plant has been in full operation for a short time only but has proven the wisdom of the outlay by materially reducing the cost of the mining operation.



GENERATOR STATION AND TRANSFORMER HOUSE OF THE GOLDPAN ENGINEERING AND MINE SUPPLY COMPANY, BRECKENRIDGE, COL.



INTERIOR VIEW OF THE GENERATOR STATION, SHOWING PLAN OF DRIVING FROM PELTON WHEELS, GOLDPAN ENGINEERING AND MINE SUPPLY COMPANY, BRECKENRIDGE, COL.

Transactions of the American Electrochemical Society.

The third volume of the transactions of the American Electrochemical Society is being distributed. This contains the proceedings of the spring meeting, held in New York city April 16 to 18. Although the society has been organized but a little over a year, it has a membership of 510.

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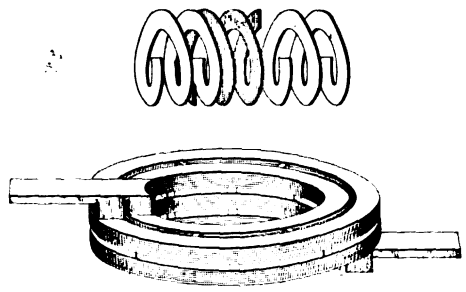
Electrical Patents.

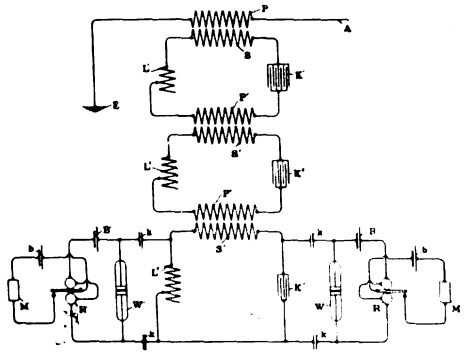
A coil for dynamo-electric machines has been invented by Mr. Hermann F. T. Erben, of Schenectady, N. Y., and the patent obtained thereon has been assigned to the General Electric Company, of New York. This invention relates to a method of making heavy field coils for dynamo-electric machines, such as the series coils for compound-wound motors and generators. The coil which is produced consists of a plurality of parallel layers of a flat copper conductor wound edgewise, the layers making one or more turns, as determined by the design of the machine, and connected in series or in parallel, as the case demands. If connected in parallel, the coil is, in effect, the same as a solid bar having the same cross-section as the combined layers; but it has been found that the mechanical difficulties involved in winding a solid bar of large cross-section practically prohibits such construction. In winding a coil composed of a plurality of parallel strips of small size the several strips might be wound simultaneously, each being run through its own tension device; but for large coils this is impracticable, owing to the difficulty of obtaining a winding machine sufficiently strong to bend all at once the full section of copper. This invention obviates this trouble, permitting the several layers to be wound successively. The invention consists in forming the requisite number of convolutions or layers of metal separately, assembling them side by side in parallel relation, and securing their adjacent ends to suitable terminals. The inventor prefers to use a flat-sided conductor, such as a flat strip, of considerably greater width than thickness and of even dimensions throughout. To form the separate convolutions, he winds such a strip edgewise into a helical coil of a large number of turns, then cuts the coil into lengths, and then interweaves the lengths by screwing them together until they all lie parallel with their ends flush. The ends of the layers are then soldered together and to a terminal of proper cross-section. If a greater cross-section of coil is desired, a second coil of smaller or greater diameter can be similarly constructed and slipped inside or outside of the other, the terminals of the two being connected in parallel.

The Consolidated Wireless Telegraph and Telephone Company, of Philadelphia, Pa., a corporation of Arizona Territory, controls a patent issued to Cornelius D. Ehret, of Ardmore, Pa., on improvements in wireless signaling systems. By this system the electroradiant energy is received upon a suitable receiving conductor or conductors and produces therein fluctuating electric currents of a frequency equal to that of the transmitted energy. The receiving conductor is itself so adjusted as to its electrical constants as to be selective of energy of a predetermined frequency, and associated with such receiving conductor or circuit are one or more circuits, each of which is also



Coil for Dynamo-Electric Machine.

adjusted as to its electrical constants as to be selective of currents of a frequency equal to that of the transmitted energy. These circuits are preferably arranged inductively in tandem with each other, and the capacity and inductance of the first circuit will produce a product equal to the product of the capacity and inductance of each succeeding circuit; but it is the inventor's intention to have a relatively great capacity in the circuit nearest the receiving conductor or circuit while the inductance is relatively small. In the next circuit the capacity is relatively smaller and the inductance relatively greater, and so on in each succeeding circuit the capacity becomes relatively smaller, while the inductance becomes relatively greater, the product of the capacity and inductance being the same for each circuit. Referring to the accompanying diagram, A



Wireless Telegraph System.

represents the usual aerial conductor of a wireless signaling system, between which and the earth-plate E is connected the primary P of the transformer. A may however, represent a metallic line conductor of an ordinary telegraphic or signaling system, upon which have been impressed alternating currents of a definite frequency and controlled to represent a signal or message. S represents the secondary of the transformer, and in circuit therewith are the capacity or condenser K′, inductance L′ and the primary P′ of a second transformer. S′ is the secondary associated with the primary P′, and in circuit therewith are the condenser K^2, inductance L^2 and the primary P″ of a third transformer. S″ is the secondary of this third transformer, in circuit with which are the condenser or capacity K^3 and the inductance L^3. The circuits just described are inductively connected with each other in tandem, and, as shown, the capacity of the several circuits becomes progressively smaller, while the inductance becomes progressively greater. The product of capacity and inductance of each circuit is, however, equal to the product of capacity and inductance of every other circuit. The resistance of each circuit is maintained as low as consistent with other requirements. The inductances are shown as adjustable, and, in fact, these inductances are not the entire inductance of a circuit, inasmuch as the primary and secondary windings also constitute a portion of the total inductance of a circuit. The capacities are also adjustable. In shunt to the inductive L^3 is connected the wave-responsive device W′, which controls the usual local circuit including the relay R′ and the source of energy B′. The relay R′ controls the local circuit, including source of energy *b′* and recording device M′. In shunt to the condenser K^3 is the wave-responsive device W, which controls the local circuit embracing the source of energy B and the relay R. The relay R controls a local circuit, including source of energy *b* and recording device M. Condensers *k* are connected between the wave-responsive devices and the inductance L^3 and the condenser K^3 for the purpose of preventing the relay batteries from normally energizing the relays. With the product of the capacity and inductance K′ and L′ being adjusted the circuit including them becomes selective of a certain message or signal represented by electroradiant energy of a definite frequency. This selectivity is, however, not very sharp, because of the relatively great amount of capacity. With the product of the capacity and inductance remaining the same throughout the tandem circuits and progressively increasing the inductance and correspondingly decreasing the capacity the selectivity becomes sharper and sharper. In consequence in the circuit including the inductance L^3 and condenser K^3 the selectivity is the sharpest, and any stray or undesired harmonics will not produce effects in this most sharply selective circuit to produce any false or undesired signal. It is of the essence of the invention, therefore, that the receiving circuits become progressively more sharply selective, to the end that none but the desired electroradiant energy shall be able to influence the receiving apparatus.

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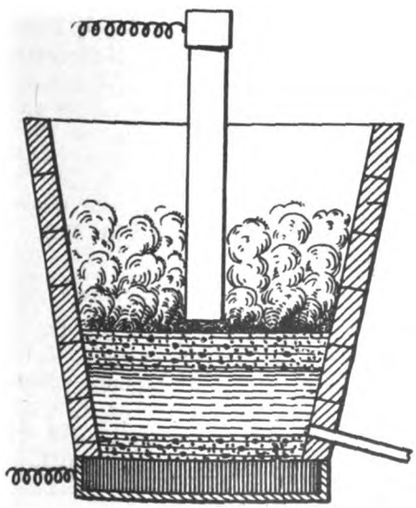
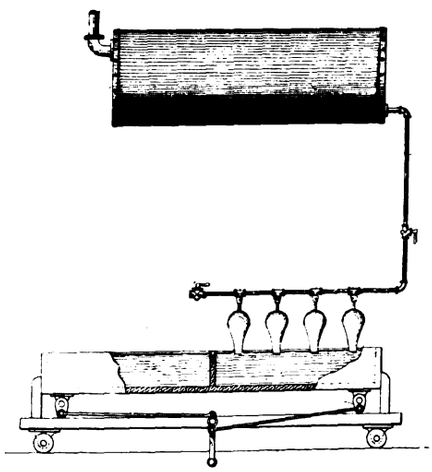
Dr. Georg Egley, a German chemist, residing in Charlottenburg, Germany, has devised a new process of smelting metals and metal compounds by means of electricity. In the reduction of metals in the electrical furnace, especially in the preparation of nickel by reduction of protoxide of nickel in the electrical furnace in presence of carbon, the molten metal easily takes up carbon from the electrodes, thereby appreciably diminishing the value of the product. According to the present invention this inconvenience is avoided by the formation of a scoria of almost two centimetres thickness. This slag or scoria is composed of a substance which is chemically inert or undecomposable to as high a degree as possible at high temperatures and in the presence of carbon and metals which will not melt or which melt only with great difficulty at the temperatures at which the reduction of the nickel oxide takes place and is volatile only to a very small extent and which at the same time is a good conductor of electricity. Under this invention a scoria or slag of this nature is formed over the lower electrode of an electrical smelting furnace previous to the smelting operation, and the fact that the same will remain solid or nearly solid at the melting temperatures will enable it to remain over the said electrode, and thus screen the metal formed at the reduction process against the absorption of carbon from the said electrode. Magnesia is a substance especially well fitted for the formation of



ELECTRICAL FURNACE.

such a scoria, being indifferent to high temperatures to a remarkable degree. The invention, therefore, adds to magnesia a substance conducting electricity in a cold state or at red heat and which is chemically inert and non-volatile and undecomposable at high temperatures—such, for example, as fluorspar, titanium dioxide, titanium monoxide, or the like. Admixtures of this nature materially add to the conductivity of the magnesia without lowering the melting point of the mixtures below the heat to which they are subjected in the smelting operation. The proportions in which these admixtures are added to the magnesia are about twenty to twenty-five per cent by weight. After the lower electrode, which in the case of continuous currents is the cathode, is covered by a scoria of the nature described, it is allowed to cool to red heat, and then the reduction of the protoxide of nickel is carried out, preferably, by continuous current of low density. The current density employed is preferably about two amperes to the square centimetre, although good results may also be obtained at lower current densities.

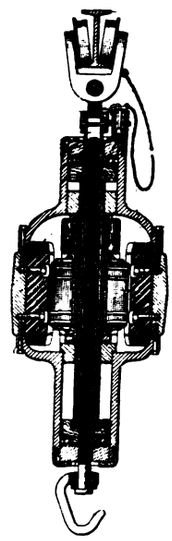
A new method of frosting glass bulbs or globes has been devised by Mr. Patrick Kennedy, of New York city, who has assigned his entire interest to the Con-



METHOD OF FROSTING GLASS GLOBES.

solidated Railway Electric Lighting and Equipment Company. The object and purpose of the present invention are to produce on the inner surface of the bulb a frosted appearance, which may cover the whole of the said inner surface or only a part thereof, as will be hereinafter explained. To effect this object according to the present invention the upright bulb is charged through its lower tubular stem with an etching or corroding acid—as hydrofluoric acid, for example—by pressure on the body of said acid, and after it shall have produced the desired effect by corroding or etching the inner surface of the hollow bulb the acid is allowed to flow out by gravity, the pressure being balanced or removed. In order to cleanse the bulb thoroughly of the acid, the above operation is repeated with water, which rinses out the bulb. This result may be effected by immersing the lower stems or necks of the bulbs in the acid or liquid in a closed receptacle and putting air pressure on the liquid, so as to cause it to rise in the bulbs to the desired extent, or it may be done by using an open liquid receptacle and exhausting the air from the bulbs at their upper stems.

The General Electric Company has purchased a patent recently granted to Mr. Augustus A. Ball, Jr., of Lynn, Mass., on a hoisting motor. This inven-



HOISTING MOTOR.

tion relates to hoisting apparatus, and its object is to provide a simple, compact and powerful machine of this class driven by an electric motor and comprising a self-contained piece of mechanism which can be moved about from place to place whenever wanted. Such a device is of special value in machine shops, where it can be mounted on an overhead track and used to hoist and convey heavy castings and the like from one point to another; in warehouses for lifting and transporting goods; in plants for handling ore, coal, grain; in quarries, dockyards and, in fact, almost every place where things have to be lifted and moved about. The machine comprises a screw which is attached to any suitable abutment, such as a rope, bar, beam or a trolley running on an overhead track, and in such a manner that while it may swing or rotate in any direction it will resist the end pull of the hoist. Concentric with this screw is an electric motor whose armature shaft is hollow to encircle the screw and carries a nut meshing therewith. As the motor revolves it travels up or down on the screw. To increase its range of lift, the screw may be made tubular and the armature shaft may carry a second nut meshing with a solid screw rod sliding in and out of the tubular screw and arranged to be moved upward at the same time that the motor rises and to run downward when the motor lowers itself. This compound screw action gives a range of hoist preferably about double the travel of the motor. An automatic switch cuts out the motor when the hoist reaches the limit of its upward or downward movement.

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BOOK REVIEWS.

"Radium." William J. Hammer. New York. D. Van Nostrand Company. Cloth. 72 pages. 6 by 9 inches. Illustrated. Supplied by the ELECTRICAL REVIEW at $1.00.

This is a reprint of a lecture delivered at the joint meeting of the American Institute of Electrical Engineers and the American Electrochemical Society. The author reviews the present state of our knowledge of radium and other radioactive substances, polonium, actinium and thorium. He takes up the subjects of phosphorescent substances and fluorescent substances, the properties and applications of selenium, and the treatment of disease by the ultra-violet light. Certain of the suggested applications of selenium are ingenious and interesting, and the description of the Finsen method of treating skin diseases shows what has already been accomplished and indicates what may be expected of light as a weapon against disease.

"Secondary Batteries." An Engineer. London. Alabaster, Gatchouse & Company. Cloth. 83 pages. 5½ by 8 inches. Illustrated. Supplied by the ELECTRICAL REVIEW at $1.25.

This little work is intended—so the front page informs us—as "a practical handbook for owners and attendants." While there is some good and helpful information in the book of the character that will be understood by the general run of battery attendants, there is a distressing lack of explanatory diagrams and figures, the methods of expressing the ideas set forth are crude, and the work is marred by its inconsequential character and absence of any regular order. Apparently the author simply put down ideas as they occurred and never rearranged them under any divisions or subjects. However, it is, in spite of its faults, a good book for station men in charge of batteries to read and to follow, the matter being fairly reliable and trustworthy. The author insists throughout on the constant attention that should be given cells and on the absurdity of setting down records which do not represent actual observations. While this may appear axiomatic, it is nevertheless true that many records are merely guesswork and this note of protest shows that "Engineer" has come frequently in contact with such alleged records and has been lead by them into devious and unprofitable deductions.

"Alternate-Current Transformer." F. G. Baum. New York. McGraw Publishing Company. Cloth. 195 pages. 6 by 7¼ inches. 122 figures and diagrams. Supplied by the ELECTRICAL REVIEW at $1.50.

The number of works on the transformer and theory of alternating currents already in existence is so great that there is no room for a work on this subject unless the author has new methods of treatment of the complicated and mind-harassing phenomena that comprise the subject, which treatment helps to make clear in this branch of the art. Mr. Baum's contribution to the present literature is, however, well warranted and his work is a step forward toward the ideal treatise on alternating currents in that he discusses, to a large extent, the physical facts. The ideal work on alternating-current phenomena will, it is hoped, some time appear and will take up the physical side of each question and from the actual phenomena as they appear to the mind's eye, deduce the mathematical formulæ, which after all are merely the quantitative expression of the phenomena. Hitherto all the writers on alternating currents have proceeded the other way and deduced a picture of the physical happenings from the solution of mathematical formulæ. While the work under review does not by any means handle the subject in the rational way indicated, it comes much nearer the mark than any book yet published. There are several good, practical formulæ from which the small and negligible factors have been eliminated, making them short, easily used, and sufficiently accurate for engineering computations. The complete formulæ also appear and nearly all are fully derived, making the mathematical work easy reading. The method of referring all actions in the transformer to the magnetic flux simplifies the general theory of this device and it is also applicable to the induction motor. The chapters on "Representation of Pressure Relations," "Regulation" and "Systematic Design" are particularly good. The other chapters are "Elementary Principles," "Simple Transformer Diagram," "Efficiency," "Testing," "Series and Constant-Current Transformers, Regulators and Compensation Voltmeters," "Transformer Connections," commercial types, and an appendix giving extracts from the underwriters' rules.

Proceedings of the Engineers' Society of Western Pennsylvania.

The May issue of the proceedings of the Engineers' Society of Western Pennsylvania contains the following papers: "Commercial Gases for Power Purposes," by Alexander M. Gow; "Power Economy of the Gas Engine as Influenced by the Fuel," by William P. Flint; "Coal-Handling Machinery and Its Application to Steam Power Plants," by T. F. Webster, and "The Evolution of the Determination of Iron and Ores," by H. M. Craver.

Production of Platinum in 1902.

The report for 1902 to the United States Geological Survey on the production of platinum in 1902 is now in press. The report is in two parts, the first being the report proper, by Dr. Joseph Struthers, and the second being a paper by Professor J. F. Kemp on platinum in the Rambler mine, Wyoming.

The production of platinum from domestic ores in the United States decreased from 1,408 ounces, valued at $27,526, in 1901—the largest output recorded by the Geological Survey since 1880—to ninety-four ounces valued at $1,814, the smallest production since 1893. In connection with the platinum there were also obtained from the ores twenty fine ounces of iridium, as against 253 ounces in 1901. The domestic supply of platinum in recent years has been obtained as a secondary product chiefly from gold placer deposits in Trinity and Shasta counties, California. It is reported that the metal occurs, though not in commercially rich deposits, in many other gold placers of California, as well as in Washington, Oregon, Idaho, Montana, Colorado and Alaska. The Rambler mine, Wyoming, continues to attract attention, and during the year, a considerable quantity of the metal was collected, but not marketed, by the Waratah Minerals Company, at Kerby, near Grants Pass, Josephine County, Ore.

The Russian sources of platinum supply, which furnish about ninety per cent of the total consumption of the world, are comparatively limited. The platinum-bearing ores extend along the eastern watershed of the Ural Mountains in Eastern Perm and along the watershed farther south.

The imports of platinum into the United States during 1902 were valued at $1,987,980 as compared with $1,695,895 in 1901.

Professor Kemp's paper contains a brief description of the situation, topography, and geology of the Rambler mine, which is in Albany County, Wyoming, about forty-five miles southwest of Laramie, near the headwater of Douglas Creek, in the Medicine Bow Mountains; a description of the Rambler dike, and an account of the ore body itself. Great interest was excited late in 1901 and early in 1902 by the finding of the platinum group of metals in the copper ore of the mine and by the separation from the ore of sperrylite, diarsenide of platinum. The metal has not yet been extracted on the commercial scale. The paper is illustrated by a map of the Rambler mine.

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Power Developments at Niagara Falls.

It is impossible to appreciate the extent of the power developments going on at Niagara Falls at the present time without a visit to that important industrial centre.

Every one is more or less familiar with the condition of the developments on the American side. The Niagara Falls Power Company will, ere long, have all the machinery in its station No. 2 installed, which will give this company an available output of 105,000 horse-power. The Niagara Falls Hydraulic and Manufacturing Company can deliver about 40,000 horse-power with the machinery already on the ground.

It is on the Canadian side, however, that the greatest developments are going on. Here three separate companies are at work. The Canadian Niagara Power Company, which is allied to the Niagara Falls Power Company, is constructing a plant on the same general plan as that of the latter. The wheel-pit is now about complete, the tunnel has been driven through and is being lined, and part of the hydraulic machinery is being put in place. This wheel-pit will accommodate five 10,000-horse-power units, but by extending the pit the capacity of the station will be doubled.

The second company to start construction on the Canadian side was the Ontario Power Company. This company will convey the water from an inlet further up the river through pipes eighteen feet in diameter, placed underground in a trench. The power-house will be placed below the cliff near the Horseshoe Falls. The units will have an output of 10,000 horse-power each, and the total output of the station, when completed, will be 150,000 horse-power. In addition to this, the Ontario Power Company has been granted the right to draw water from Chippewa Creek sufficient to generate another 150,000 horse-power.

The third company on the Canadian side is the Toronto & Niagara Power Company. The power-house of this company will be erected on what is now the bed of the river. Here a wheel-pit will be excavated, and a tunnel driven to discharge the water below the Horseshoe Falls. The design of this station contemplates an output of 125,000 horse-power.

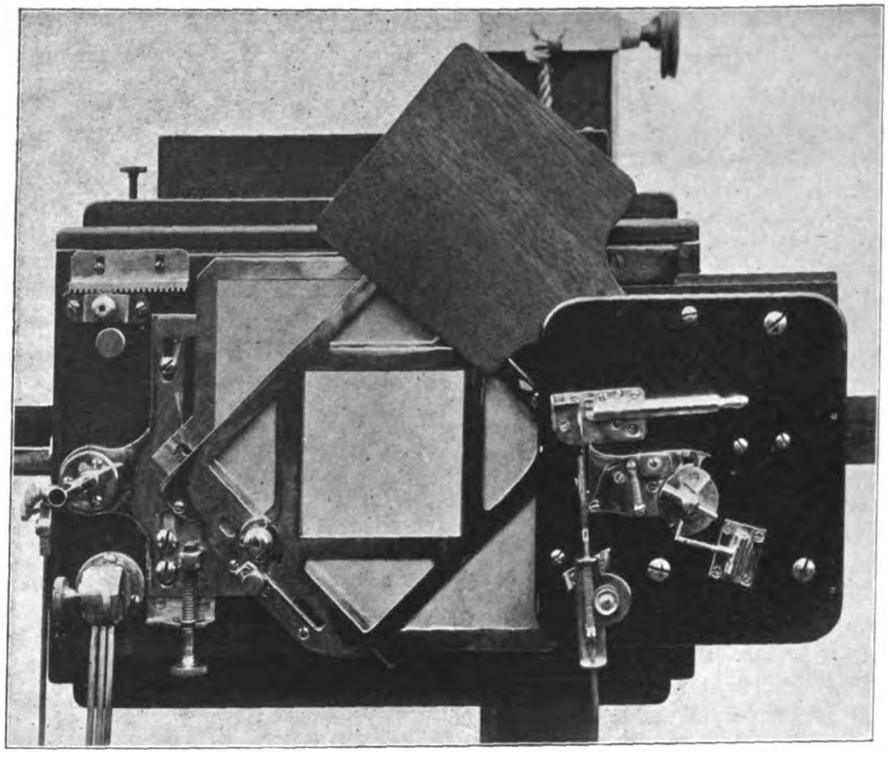

FIG. 1.—SHUTTER FOR X-LIGHT TUBE-BOX, OPEN.

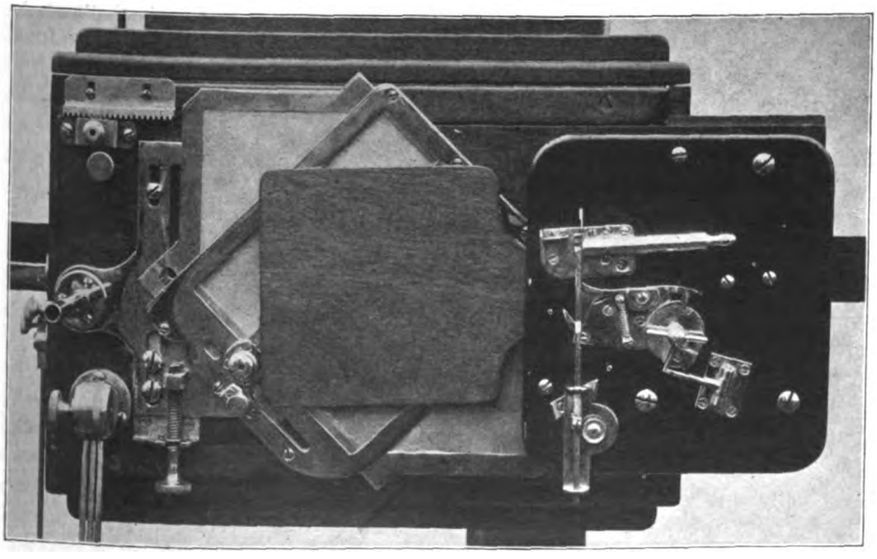

FIG. 2.—SHUTTER FOR X-LIGHT TUBE-BOX, CLOSED.

NOTES ON X-LIGHT.

BY WILLIAM ROLLINS.

NOTE CLXIX—A SHUTTER FOR AN X-LIGHT TUBE-BOX.

In earlier notes I have explained the advantage of using a shutter in taking photographs by X-light and given figures of shutters; the one to be described is a more convenient form. Figs. 1 and 2 are photographs of the shutter. Fig. 1 is a detailed front view of the tube-box slide (consult notes cxlix, clv and clvi), with the opening of the diaphragm plate exposed by the action of the shutter. Fig. 2 shows the same opening closed so that no X-light may escape from the tube-box. Figs. 3, 4, 5, 6 and 7 are drawings

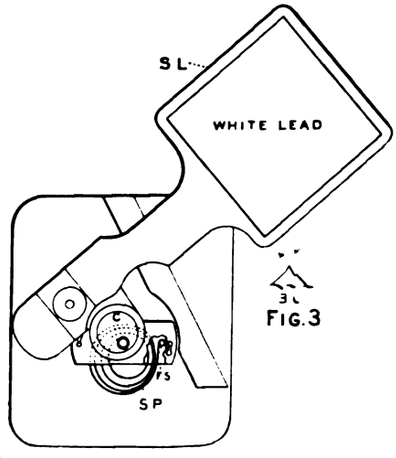

FIG. 3

BACK OF SHUTTER FOR X-LIGHT TUBE-BOX

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to explain the mechanism. Fig. 3 is a view of the back of the shutter, the slide of the tube-box having been removed. The leaf SL which closes the hole in the diaphragm plate is made of hardwood with a depression filled with white lead

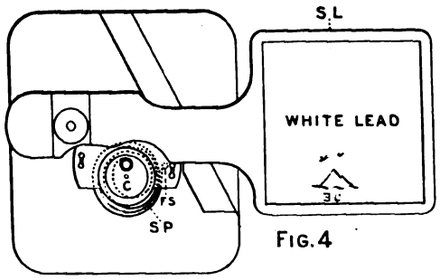

FIG. 4

SPIRAL SPRING FOR MOVING X-LIGHT TUBE-BOX SHUTTER.

and japan until opaque to X-light. The moving force is a strong spiral spring SP, Figs. 3 and 4. One end is attached to the axis of the cam C, which moves the leaf SL, the other to the fixed support FS, attached to the hard rubber plate supporting the mechanism of the shutter. Tension is made on the spring by turning the handle forming the head of the axis of the cam; shown in Figs. 5, 6 and 7. To prevent the action of the shutter from uncoiling more than one turn of the spring in closing the opening of the diaphragm plate, a stop ST is employed, Figs. 5, 6 and 7. To allow the spring to be wound to the proper tension the stop is turned back as shown by the dotted lines in Fig. 5. The shutter is ready for use (with the leaf SL closing the opening in the diaphragm plate), when the hook HK, Fig. 5, is in the very shallow notch NH. To open the hole in the diaphragm

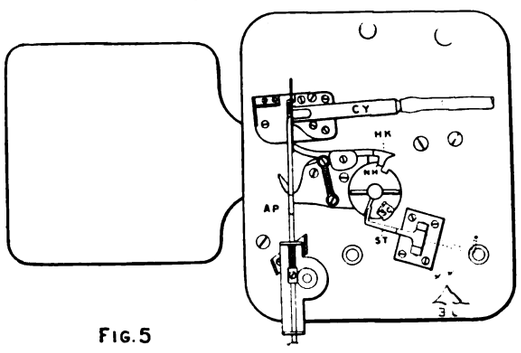

FIG. 5

DETAILS OF SPRING MECHANISM FOR X-LIGHT TUBE SHUTTER.

plate a rubber bulb attached to the rubber tube RT, Fig. 5, is pressed. The air which is driven from the bulb enters the metal cylinder CY, forcing forward a piston that by the force of its impact drives forward the arm AP to the position shown in Fig. 6, releasing the hook HK from the notch NH, thus allowing the spiral spring to turn the leaf SL until the opening of the diaphragm, Fig. 1, is exposed. The hook HK, Fig. 6, strikes against the catch SC, causing the opening of the diaphragm plate to remain exposed. To close the opening in the diaphragm plate, to shut off the beam of X-light, a second impulse is given to the bulb, which forces the arm AP forward to the position shown in Fig. 7, lifting the hook HK from the notch SC, Fig. 6, allowing the leaf SL to close the opening in the diaphragm plate. When a more rapid action of the shutter is wanted the catch SC is turned up by means of a hanger. One impulse of the rubber bulb will then open and close the hole in the diaphragm plate. I have illustrated this shutter with care to make the construction so evident that an ordinary mechanic could make one for any physician who was convinced of its utility. It is useful in photographing the chest and is well

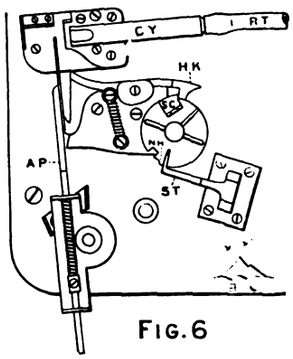

FIG. 6

POSITION OF MECHANISM WHEN OPENING X-LIGHT TUBE SHUTTER.

suited for some therapeutic purposes, especially in tube-boxes containing X-light tubes of the type described in note clxviii and used in treating two patients at one time. In the latter case the tube-box requires two shutters.

Chlorine Smelting with Electrolysis.

At the recent meeting of the Faraday Society, Mr. J. Swinburne described the new method of working sulphide ores, which he has developed in conjunction with Mr. Ashcroft. Essentially, the process consists in attacking simple or mixed metallic sulphide in a state of fusion with chlorine, whereby, under suitable conditions, sulphur is given off and may be condensed, leaving a simple or mixed chloride of the original metals. This chloride residue is then treated by chemical means, all its metallic constituents being eventually displaced by zinc, until the final zinc chloride is ready to be dissociated by igneous electrolysis, giving the chlorine required to treat a further quantity of ore. The method recovers all the ingredients of the mineral as elements, except the iron and manganese, which are obtained as their highest oxides. The former may be further treated to render it salable as an oxide paint, or may be reduced to yield pure iron. The only reagent needed is zinc chloride, zinc itself, or hydrochloric acid, as the case may be.

The application of this process to the Broken Hill ores was explained. The ore is crushed and introduced into a ten-ton transformer which is an iron vessel lined with fire clay. Chlorine is led in at the base through a carbon tuyere, the main gas pipes being of iron. Exothermic decomposition takes place, rendering artificial heating unnecessary. The temperature is controlled by feeding the ore at the proper speed. By means of a chimney the vaporized sulphur is drawn to a condensing chamber, where it is deposited as a solid. The chlorine is pumped in at a pressure of ten to fifteen pounds per square inch. At the end of the operation the ore melts and the gangue separates, usually floating. The ore is then run into water and filter-pressed, the solution being as concentrated as the cloths will bear. In the press remain the gangue and the lead and silver chlorides, the former is separated, the latter is fused with lead to extract silver and any gold. The filtrate is treated with spongy copper to precipitate any lead and silver in solution; with zinc, to throw out the copper; with chlorine, to convert the iron into a ferric state, whence it is precipitated as hydroxide and zinc oxide. Thus, an aqueous solution of pure zinc chloride is left, which is cautiously evaporated to dryness, and the residue fused. This is decomposed electrolytically in open vats where cheap anodes are used, before the bulk of the pure chloride is dissociated. The fused zinc chloride derived from the lead sub-

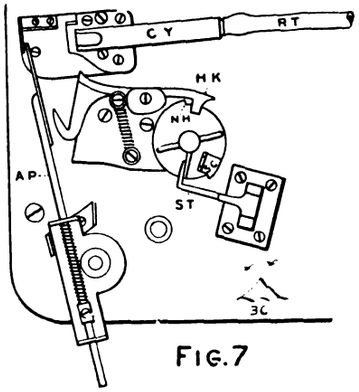

FIG. 7

POSITION OF MECHANISM WHEN CLOSING X-LIGHT TUBE SHUTTER.

stitution above is then incorporated with the rest of the salt, and the whole is electrolysed with a current of about four volts in closed vessels internally heated, which are kept under a slightly diminished atmospheric pressure to prevent loss of chlorine. The cost of working the process is given roughly as $7.50 per ton, over and above the cost of electrical energy.

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High-Speed Electric Traction on Railways.

At the recent conference of the British Institution of Civil Engineers a paper upon high-speed electric traction was read by Mr. J. W. Jacomb-Hood. High-speed electric service is defined as "frequent communication, without intermediate stops, between busy centres that are widely separated." The speed of the trains must not be less than sixty miles an hour. Means that are adopted for such high-speed services must be equally available for a modified stopping service, as well as for freight and shunting services. While the advantages of electrical service are admittedly considerable for many conditions of traffic, a wholesale conversion of steam services is so difficult a financial problem as to be practically impossible even if proved desirable. The subject divides itself into generation, consumption, transmission, distribution and collection of current. One of the vital questions connected with the power station is the economical limits of size of steam or gas generating units. After taking account of the increased cost and losses in extended transmission lines, reason would seem to dictate that the power stations should be as widely separated and as few in number as possible, to ensure a steadier load and a better load-factor. As regards driving motors, the practice of to-day seems to be in favor of a direct-current, series-wound motor with automatic field regulation. On the other hand, there is the alternative of a system that involves the use of smaller high-tension currents used in alternating, single or multiphase motors that are limited to one or two economical speeds. It is difficult to foresee the effect that invariable speed would have upon the conduct of general railway business. For all classes of work, variable speed is to be preferred. The multiple-unit system will almost certainly be employed for high-speed service, while electric locomotives will be used for freight shunting and other general business. In the transmission, distribution and collection of current the greatest practical difficulties are met. The urgent need for economy makes overhead bare conductors suitable for carrying current at high voltage desirable. Existing practice seems to show that a system of distribution to a third conductor rail best meets the needs of the case, but the existence of a third rail introduces troubles in the up-keep of the road and should be avoided if possible. An overhead conductor system will be less unwelcome to the maintenance engineer and, from some points of view, has advantages over any ground-collecting system. But if three-phase current is used the duplication of conductors presents another difficulty. Difficulties in the way of collecting comparatively heavy current from an overhead equipment appear to have been solved to some extent in the North Italian railways. Systems that have been advocated of collection from the primary conductor for use in a motor-generator on a locomotive seem attractive, as they would do away with substation difficulties. Further accumulator systems, though they may be useful and economical for light branch services, are thought to have any promise for heavy general railway work.

Automatic Control of Electric Cars.

Recently a demonstration was made at Devonport, England, of a new system of regenerative tram-car control which has been designed by Mr. J. S. Raworth. The car had four wheels and weighed about nine tons. It was equipped with two 1,000A Brush motors. The line upon which it was tried has a number of steep grades, varying up to ten per cent. The total length of level road does not exceed one-quarter of a mile in five miles. All the cars have been equipped with hand brakes, slipper brakes and rheostatic brakes, but in spite of these precautions a number of serious accidents have happened.

The alternations made in the equipment are as follows: The field winding has been changed from series to shunt, with the addition of an auxiliary series winding. The motion of the power handle has been limited to the series notches. A speed control lever has been added, interlocked with the power lever, and an automatic switch has been introduced into the emergency circuit to cut out resistances when the line current fails. No change has been made in the armatures or any other connections. Power is applied by the power handle as heretofore, but more quickly. This gives the car a speed of from two and one-half to three miles an hour. The speed lever is now pushed forward slowly for acceleration up to fourteen miles an hour. Regeneration takes place automatically on a descending grade by pulling back the speed lever quickly.

In descending a one to twelve grade the speed lever can hold the car steadily at two and one-half to three miles an hour. In the extreme backward position the speed lever releases the power handle, which instantly flies to the emergency stop and pulls the car up, without any shock, to one mile an hour. The effect is exactly the same whether the trolley be on or off the line. In climbing a hill the effect of shutting off the current is that the car drifts slowly backward at one mile an hour.

The net saving in energy obtained in a large number of trial runs is stated to be about thirty per cent, as measured on the car. Instead of 140 amperes, the maximum demand on the line is reduced to eighty amperes per car. In descending hills the regenerative effect is usually forty amperes, though it sometimes rises to fifty amperes. There is no heating or sparking of the motors beyond normal. Mechanical brakes are superfluous, except to hold the car on the grade. The regenerative control is said to be quicker and more certain in braking than any of the brakes with which cars are now fitted.

There are two handles on the controller —one for the field winding and the other for the armature. The latter can not be moved until the former is on the notch of the maximum excitation of the field, but it can then be advanced to any position. Resistance is gradually inserted into the field circuit to increase the speed by advancing the lever controlling the field resistances. Should it be desired to decrease the speed or to cause the motors to generate and return current to the line, it is only necessary to move this lever backward. When this lever reaches a position in which all resistance has been cut out, the armature lever flies back and breaks the circuit, unless it is purposely held forward. As shunt motors are used, current is returned to the line automatically when the car descends a grade. If the trolley comes off the line the motorman has merely to press a small handle attached to the field resistance lever, which switches in a series winding system of many turns of fine wire and short-circuits the motor. It is immaterial in what position either lever is, or whether the car is running backward or forward when this operation is performed. Immediately the auxiliary series winding is connected, the car is pulled up almost to a standstill. The inventor states that it is possible to combine his system with the series parallel, and in this way obtain an acceleration as great as that given by the latter system.

There are several varieties of mica, some of which have commercial value when in merchantable condition. The most common is muscovite, or potash, mica. This is the ordinary mica of commerce. By transmitted light it is various shades of yellow, green and brown, wine color, etc.

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Reviews of Current Engineering and Scientific Literature.

Metallurgy of Zinc.

In this article Mr. J. Izart discusses the various metallurgical processes for the production of zinc. A review is given of the different electrolytic processes, none of which, however, is thought to meet the requirements. The difficulties encountered in most of these are those of producing the zinc in a solid metallic form and purifying the electrolyte. Zinc, however, can be produced in a solid deposit with very heavy current densities at low temperatures, but the consumption of energy and the high counterelectromotive force of polarization are given as the reasons why the electrolytic method has not replaced the older methods.—*Translated and abstracted from the Revue Technologique* (*Paris*), *June* 30.

The Heat Absorbed in the Electrolysis of Silver Salts and the Principle of Maximum Work.

When a solution contains one part of silver nitrate and proportions varying from one to thirty-two of nitrate of copper for a hundred parts of water, the copper nitrate does not begin to decompose until the solution contains about thirty parts of copper to two of silver. By increasing the proportion of copper, a point is finally reached where the deposit contains one part of copper to two of silver. Where the solution contains eighty-seven parts of copper nitrate to two of silver nitrate, the deposit contains metals in equal proportions. According to Sprague's law, the silver nitrate should be decomposed first, followed by the copper salt, because the heat of the combination of copper nitrate is 52.3 calories and that of the silver is 17.4. If an acidulated solution of hydrogen peroxide is electrolyzed, hydrogen is given off and water is decomposed, but the peroxide is not reduced, although sixty-nine calories are required to bring about the former reaction, while the latter sets free 21.6 calories. These and other similar reactions have caused M. de Tommasi to state the following laws: "If a body is submitted to two chemical actions, that reaction which disengages the greater quantity of energy will take place, provided it can be started. Between two chemical reactions, that which requires the least heat or energy to start it will take place, even if it sets free less heat than the other reaction." The author then enunciates the following law, which he calls "the principle of minimum work": Of several possible chemical reactions that which requires the least energy to start it will take place, whatever the quantity of heat of reaction, if it be started."—*Translated and abstracted from l'Electricien* (*Paris*), *July* 18.

The Magnetic Rotation of the Plane of Polarization.

From his magnetic-optical theory, Voight predicted that exceptional rotation of the plane of polarization in the neighborhood of an absorption band would take place under the influence of a magnetic field. Mocaluso and Cordino have verified this deduction experimentally. Voight also stated that certain phenomena would be present, and this also was verified. In this article Herr J. J. Hallo explains the method used in this work, by which the quantitative law has been deduced. Light polarized by means of a Nicol prism was passed, first, through the axis of a Ruhmkorff coil, between the pole-shoes of which was a sodium flame. The light then passed through a Fresnel double quartz prism which was placed before the slit of a spectroscope. Immediately back of the slit was the analyzing Nicol prism. The slit was placed at the focus of a concave mirror, which threw the rays in this way made parallel upon a large Rowland grating. The spectrum thus obtained is stigmatic and, in consequence, the double quartz prism gives in the spectrum a system of horizontal alternating dark and bright bands. As soon as the magnet is excited, the bands in the neighborhood of the sodium absorption band are shifted in consequence of the rotation of the plane of polarization. The part of the spectrum in which the sodium lines are found is photographed, and this photograph is later enlarged five to seven times. On this photograph two rectangular axes are laid off, the axis of abscissa being parallel to the interference bands, and the axis of ordinates parallel to the absorption bands. The axis of abscissa is divided into half millimetre divisions, and the corresponding ordinate of the interference band for each of these points is read off. On each photograph the author found three interference bands, and the sum of their respective ordinates was taken as the mean. The deviation of a band from its original position at each point gives the rotation of the plane of polarization at this point. The results of one experiment are given and their application explained.—*Translated and abstracted from the Physikalische Zeitschrift* (*Leipsic*), *July* 15.

A New Detinning Process.

A new process of separating tin from tin scrap has been devised by Twnyan, which differs from those hitherto proposed, as voltaic action, aided by atmospheric oxygen, is made use of. Coke is crushed to a coarse powder and saturated with a strong solution of common salt. Any excess of solution above that required to saturate the coke is drained off, as it is important that air should be able to penetrate readily through the mass. The scrap to be stripped may be placed in any receptacle or even piled upon the ground. It is covered with this coke powder. Action commences rapidly and is completed in a few hours. The pile of scrap should be stirred from time to time to bring all parts in contact with the coke. The scrap iron is then screened from the crushed coke, which is allowed to fall upon a fresh pile of scrap tin. The iron is washed to secure the tin, which forms a white, milky precipitate in water, probably hydrated stannic oxide. No tin is found in solution as chloride. The moistened coke can be used over and over again, as long as it does not become too dry. The coke is not washed to secure the tin until sufficient is contained in the heap to make it worth while to clean up. The process is applicable to scrap of all sorts and all shapes, and it is said that a fairly complete separation of the tin is obtained at a very cheap rate.—*Abstracted from the Electrochemist and Metallurgist* (*London*), *July*.

Electric Power Appliances in the Mines of Europe.

There are few departments of engineering in which electricity renders more efficient aid than it does in the operation of a mine. In this article M. Emil Guarini gives a general survey of the field from the viewpoint of Continental practice. The disadvantages of the older systems were such that as soon as the possibilities of the application of electricity to mining were realized the field was actively entered by many large electric companies. The advantages of this power are, of course, the ease of transmission, the high efficiency, the conductors are readily

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placed, the machinery is easy to operate, requires little attention and is reliable. In addition, the power station may be placed at the most advantageous position for economical running, there is no loss of energy when the machine is not in operation, and the total number of employés may be considerably reduced. While many Continental mines are electrically equipped, the author states that so far as he knows there is none which is operated throughout solely by electricity. Nevertheless, every phase of work about the mine can advantageously make use of it—lighting, signaling, hoisting, drifting, ventilation, hauling and tramming, firing of shocks, the surface work, and ore treatment. In all of these operations electricity is a valuable and economical auxiliary, because no other agent lends itself so well to the requirements of the industry, the unavoidable losses are minimized, and the means are seldom wanting for the cheap generation of electric power in a mine. In the choice of the type of motor to be used—whether direct or alternating current—both sides have their advocates and there are many excellent installations of both types. The author explains the various uses to which electricity may be put and the means for controlling the machinery, the types of generating stations which have been installed, and the accessory apparatus. The telegraphic systems which have been developed for mine use are interesting. Each station is usually provided with a transmitter and a receiver. The receiver consists of a voltmeter, around the dial of which are arranged a number of signals or orders. The operator transmitting the order turns the crank of a magneto machine until the handle of the transmitter dial reaches the signal desired. The same signal is indicated on the receiver dial, and is usually accompanied by as many strokes of the bell as the needle has advanced degrees. The operator receiving the signal repeats it back to the sender. A small dial and a short needle permit the transmission of quite a number of signals. The telephone instruments are usually loud-speaking, the receivers and transmitters proper being closed by rubber stops when not in use. In noisy places the telephones are usually provided with movable receiver tubes which are drawn forward and adjusted to the ears. A series of push-buttons serves to keep the telephone in circuit with the various lines. A great deal of mine signaling is done by simple sounders. For this service two bare wires are run from the signal bell at the hauling engine through the gallery where the trams run. A piece of metal of any sort serves to complete the circuit at any point. The electrical transmission of signals promotes safety, makes the transmission of orders rapid, and establishes a bond between the various parts of the mine and the office of the mine's manager.—*Abstracted from the Engineering Magazine (New York), August.*

New Electricity Works of the Manchester Corporation, England.

In this number of this series of articles describing the generating stations of the Manchester Corporation, the Bloom street station is taken up. This station is practically an extension of the original Dickinson street station, from which it is separated by an arm of the canal. It was erected mainly for the purpose of supplying power to the tramways, and presents a case where a power station is designed and completely equipped from the very start, there being no possibility of extension on this site. This site is trapezoidal in shape, and the boiler room makes an angle with the engine room. The site is bounded on two sides by the canal and upon the other two by two streets. The power-house measures 172 feet by 36 feet, and contains eleven Babcock & Wilcox boilers set in six batteries. Each boiler is capable of evaporating 18,000 pounds of water per hour normally superheated 100 degrees Fahrenheit. The boilers are fitted with chain-grate stokers, and over each boiler is a Green economizer. Above the economizers are the feed-water tanks, and over all are the coal bunkers. These are capable of holding 800 tons of coal, which is brought into the works in wooden boxes, as is customary in that section, lifted by a crane which runs along the top of the bunkers, and dumped into the bunker where it is required. The engine room measures 150 by 44 feet and is 36 feet 6 inches high to the crane rails. The generating plant consists of four Musgrave-Westinghouse steam dynamos, each giving normally 1,800 kilowatts at seventy-five revolutions per minute. The engines are vertical, cross-compound, condensing engines with Corliss trip-valve gear driven by separate eccentrics. Provision is made for controlling the valve gear of both cylinders by means of the governor, but it is customary to control the high-pressure cylinder only, operating the low-pressure cylinder at a fixed cutoff. The generators are large twenty-pole machines with a drum-wound armature and a commutator consisting of 900 segments. The field frames are split vertically and are compound-wound. The machines supply current at 410 to 440 volts for lighting, or 500 to 550 volts for traction. When used on a lighting load they are operated as shunt machines only, but as compound machines for the traction load. Each engine is provided with a separate surface condenser, the circulating pumps of which are driven by electric motors. The plant is connected to the Dickinson plant across the canal by means of cables carried in troughing over a gangway.—*Abstracted from the Electrical Review (London), July 17.*

The Sterilization of Water by Oxygen Compounds of Chlorine.

In this article Dr. Edouard Imbeaux describes the ozone sterilizing plants of Weisbaden-Schierstein and of Paderborn, a description of which has already appeared in the ELECTRICAL REVIEW. The author then takes up the sterilization of water by the oxygen compounds of chlorine. This method is interesting, as the chemical (bleaching powder) is a by-product of certain electrochemical processes. A process was developed by Bergé, in which the peroxide of chlorine was produced by treating potassium chlorate with sulphuric acid, but this has never found application, as the method is extremely dangerous. A process free from this fault is due to M. Howatson. In this, bleaching powder and perchloride of iron are brought together in solution. This gives calcium chloride, ferric oxide and peroxide of chlorine, the latter acting as the oxidizing agent. The apparatus consists of two metallic towers containing each a double layer of sand, which acts as a filter. The lower layer is of coarse sand with the grains from three to four millimetres in diameter. This is thirty centimetres thick. The next layer is of equal thickness of sand with grains of about one millimetre in diameter. Over the two towers are the tanks containing the oxidizing reagent. From these tanks the reagent is allowed to drip into the pipe which delivers the water to the filters. The oxide of iron formed is deposited in a layer over the surface of the sand and arrests all solid matter and inorganic matter destroyed by the reaction. The operation of this apparatus is rapid and regular. It should be cleansed daily by forcing a current of water through the filter in the reverse direction. A filter four metres in diameter will sterilize about a thousand cubic metres of water per day.—*Translated and abstracted from la Revue Technique (Paris), July 10.*

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THE SITUATION REGARDING THE EDISON STORAGE BATTERY.

A VISIT AND INTERVIEW WITH THE INVENTOR AT HIS LABORATORY.

Any information regarding the Edison storage battery is read with interest, and with the idea of seeing whether there was anything new to be said on this subject, a representative of the ELECTRICAL REVIEW called upon Thomas A. Edison last week at his laboratory at West Orange, N. J. Mr. Edison was very busy at the time with one of the phonographs used in making the master records. This machine was misbehaving, and tests were being made to locate the trouble. After making a record from a grand piano, which was played for this purpose by an electric piano player, Mr. Edison passed the record through a phonograph and listened to it for some time. He then placed it under a microscope and examined it for mechanical defects.

"You know," he said, "there is nothing like a phonograph for giving trouble. The storage battery is nothing to it. That record is out less than the one ten-thousandth of an inch, but it is worthless. Now listen to this one," he said, placing a moulded record in the machine. The piece was a duet and was certainly very fine. "Pretty good, isn't it," said Mr. Edison, with a smile of satisfaction.

When asked whether he had made any recent tests with his electrical automobiles, he said: "I have made some automobile tests recently, but these were purely automobile tests, and not battery tests. We secured a large twenty-four-horse-power gasoline tonneau and took it out to see what it could do. We wanted to get some data for designing several machines for our own use. We ran this machine for all it was worth, and by the end of the run all of us were nearly in a state of nervous prostration, and many times it looked as though we would never get home again. We took it over rough roads and up hills and down, and in places we made about forty miles an hour; but I don't want to do it again. Talk about eighty miles an hour—Whew! I don't want to try it. Why, when we turned a sharp corner I thought every time the machine was going over; and when we finally did pull into the yard I didn't have strength enough to lift my cigar. But we got the data all right. Look here," he said, picking up a small red leather-covered notebook, "this is automobile data." He turned over a number of pages upon which there were tables and notes. A pocket at the back of the book contained a number of curves showing the results of the tests.

"That is all automobile data," he said, "and I am going to build a good machine. The machines built in this country are too amateurish and are not at all up to the best French machines. In fact, the French builders are three or four years ahead of the builders in America. For instance, the necessity of making the steering gear strong enough is just being recognized in this country. The French machines are much stronger than the American machines, although our roads are far worse than theirs."

"You are not going in for high-speed machines, are you?"

"No," said Mr. Edison, "I have had enough of that. These machines will be geared for twenty-five miles an hour, and they will make it right along. I believe that with one of these machines I will be able to beat, or, at any rate, keep up with any gasoline machine on a long run. If they run faster than my machine on a level, I will be able to go down hill just as fast as they will dare to, and for hill climbing, the electric motor is just the thing, so I will beat them there. On rough roads they will not dare to go any faster than I will; and when it comes to sandy places, I am going to put in a gear of four to one which I can throw in under such circumstances, and which will give me 120 horse-power of torque, and I will go right through that sand and leave them away behind! If the gasoline machine is stopped for any reason at all I will beat it easily. If they have no trouble whatever they may possibly beat me, though I doubt it. My machine will not break down at all."

When asked the condition of the storage battery, Mr. Edison said that they were turning them out and selling them at present.

"We are now making one set a day, and within a short time will be making two sets. We are not doing any advertising, because we have more orders than we can begin to fill. One large responsible automobile company offered to take all that we could make. The public doesn't seem to understand that it takes time to develop an invention. If there were nothing to be done except to invent the battery it would be easy, but it is when it comes to designing and making the machinery for turning out the battery in commercial form and quantities that it takes time and money. We had a good battery last fall and had the machinery for making it, but I found a method by which I could reduce the time for charging very greatly, and this necessitated the remodeling of all the machinery; but it had to be done. Why, it took six years to put the incandescent light on a commercial basis; it took eight years to develop a practical telephone, and it has taken sixteen years to make a satisfactory phonograph and nine years for the typewriter. But the public doesn't realize that, and think that as soon as a machine is invented it should be put on the market. Another thing that has held me back has been the difficulty in getting the kind of steel plate we need. We can get it all right, but we have to import it and pay a heavy duty. It is now being rolled in small quantities in this country by one firm, but machinery is being put in as fast as possible, so that we expect to have a satisfactory supply some time in the fall."

"The new battery, then, is much better than your old one, Mr. Edison?"

"It is better in that it has a higher charging rate. You can charge it within one hour enough to give seventy-five per cent of its total capacity. In fact, the battery for large delivery trucks can be charged sufficiently while the trucks are being loaded to enable them to deliver their goods. This, of course, means practically an unlimited travel. There is one truck now operating in New York, owned by B. Altman & Company. It is a two-ton truck, and had formerly something over 1,200 pounds of lead battery. We put in 1,200 pounds of my battery some time ago, and before long found that this battery was unnecessarily large. The man in charge decided to take out some of the cells. He took out one-half of them, I believe, leaving about thirty-six out of the sixty-six, calculating that this ought to give him a range of twenty-five miles, though he had some misgivings and thought it advisable to give it a thorough test for capacity before sending it out. He started out from the barn and began to circle around Central Park. He had figured out that he could make the twenty-five miles before six o'clock and keep an engagement which he had, but when six o'clock came the battery showed no signs of falling off, so he kept it going. He made twenty-five miles, thirty, thirty-five miles, and then he decided to take the truck back to the barn. At the end of the run he had made 36.8 miles, and the batteries were just beginning to show a falling off in voltage. He had only something over 600 pounds of battery in that two-ton truck, and that gave him a range of travel of thirty-five miles."

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"Does the battery require much attention?"

"No," said Mr. Edison, "it doesn't require any attention beyond seeing that the cells are kept full of water. You would think that any one would know enough to keep the cells full of water, particularly when a card is furnished with instructions to do so, but we had an experience with one man who was told to fill the cells from time to time, and who was not told to do anything else; but still he didn't do it. Of course, the water evaporated, the electrolyte fell, and the capacity of the cells ran down. He began to criticise the batteries, as they did not seem to be doing all that had been claimed for them. When we examined the battery there was only about one-third the volume of electrolyte that there should have been, and yet he thought the cells should give him the full capacity. When we filled them up with water they were all right again, and now we are going to put on each cell, 'keep full of water.'"

When asked whether he was thinking of bringing out a type of cell suitable for railway work, Mr. Edison said that he was satisfied, for the present, at least, to work on the automobile battery. They were very busy filling orders, and the question of adapting the battery to railway work would come later.

He said: "It will be very useful there, particularly in operating extensions to trolley lines already built. The batteries would be an economy in railway work, because a twenty-car system could be operated continuously with twenty-six cars, six cars being charged while the other twenty were on the road. The battery equipment should be a part of each car, and should not be removed. At the end of the trip the car could be run into the shed and charged in one hour sufficiently to keep it on the road three hours. As against the cost of the six additional cars and the batteries, there would be the saving in the transmission line. As yet, we have not detected any deterioration in the cells. Of course, the efficiency of the automobile cell is not as high as would be the case for a battery intended for station work, because other things are sacrificed in order to gain a high charging rate."

When asked whether he thought there would be any difficulty in reaching charging stations when on a tour, Mr. Edison said that he did not think there would be within a short time. Charging stations are now being put in in various parts of the country, and this work will go on more rapidly as soon as there is a demand for current.

He said, however, that he could not understand why every one was going mad on alternating currents. In many cases, the large amounts of copper required in the direct-current system would, in the end, be found to have cost less than the transformers, batteries and the other secondary devices necessary for the alternating system.

In speaking of rectifiers for obtaining direct current for charging from an alternating-current circuit, Mr. Edison recalled his old device in which a third terminal had been introduced into an incandescent lamp. A direct current was obtained from the third wire. But he did not think the device could be made practical.

Mr. Edison is looking very well, but seems to have forgotten that he said last winter he was going to take a long rest. Evidently he can not resist the temptation to grapple with the many problems which arise in his laboratory.

The Power Plant at Hamilton, Canada.

The Hamilton Electric Light and Cataract Power Company's steam power station in Hamilton, Canada, which will be used as an auxiliary to its water power plant at De Cew Falls, thirty-four miles distant, is to be equipped with the following machinery recently ordered from the Westinghouse Electric and Manufacturing Company: Two 1,000-kilowatt, two-phase, 2,400-volt, 8,000-alternation, engine-type generators, each driven by a vertical Corliss engine furnished by the Goldie & McCulloch Company, of Galt, Ontario; one fifty-kilowatt motor-generator exciter set for these alternating current generators, consisting of one seventy-five horse-power, two-phase, 400-volt, type C induction motor and a fifty-kilowatt, 125-volt, compound-wound, engine-type generator, constituting a two-bearing set; also a switchboard consisting of two generator panels. In the receiving station of the Hamilton Light and Power Company, which adjoins the auxiliary steam power station in Hamilton, will be installed six 500-kilowatt, oil-insulated, self-cooling transformers with transformer panels, stepping down the current from 20,000 volts or 40,000 volts, three-phase, to 2,400 volts, two-phase. The engine-type alternators mentioned above will be operated in parallel with the secondaries from these transformers. For the water power station at De Cew Falls, the Westinghouse company will furnish two 5,000-kilowatt, three-phase, 2,400-volt alternators, which will be direct-coupled to water-wheels that are being built in Italy; two 100-kilowatt motor-generator exciter sets, each consisting of a 150-horse-power, 2,400-volt, type C induction motor, and two 100-kilowatt, seventy-volt, direct-current, compound-wound, engine-type generators, constituting three-bearing sets; five 2,500-kilowatt, oil-insulated, water-cooled transformers, transforming from 2,400 volts, three-phase, to 22,500 or 45,000 volts, three-phase; together with the necessary switchboards to control the apparatus recently ordered as well as that already installed in the station, aggregating eight separate switchboards with a total of eighteen panels, these to be equipped with type F instruments and types C and B oil switches throughout.

The North-Eastern Railway System.

Particulars have been given in previous notes of the conversion to electrical working of a section of the North-Eastern Railway Company's system near Newcastle-on-Tyne. The work of equipping the permanent way is to be proceeded with forthwith, and the further details of the scheme herewith will prove interesting. Beyond the addition of the working conductor no alterations will be made to the running road. Experimental trips are anticipated by September next, and when the service is in full running order an average speed of twenty-two miles an hour will be maintained. Two electric locomotives will be employed to work the goods traffic. With regard to the construction of the new passenger cars, the sides of these will be built absolutely perpendicularly, and not sloping as is the case with ordinary steam trains, and the width of nine feet thus obtained will constitute the widest cars in England, of this description. The bodies of the cars will be built at the company's works, and the bogies will also be made in England to the design of the North-Eastern Railway Company's engineer. The approximate length of route—single track—will be eighty miles. The arrangements for the supply of electric power were dealt with in my last notes. While on the question of the conversion of steam roads to electrical working, it may be mentioned that the British Westinghouse Company has just secured the contract for the electrical equipment of the Werral Railway Company's system, which has running power over the Mersey company's lines. The equipment will be identical with that of the Mersey system, power probably being supplied from the same power-house. Mention may also be made of the power-house which has been temporarily erected by the District Railway Company for working the experimental trains, recently described in a separate article in the ELECTRICAL REVIEW. Really the plant is that which was used to operate the notorious experimental line at Earl's Court before the arrival of Mr. Yerkes, at a time when no disagreement existed between the two owners of the Inner Circle. There are two Belliss engines direct coupled to Siemens two-pole compound dynamos which generate at 550 volts. The Babcock & Wilcox boilers work at a steam pressure of 175 pounds. The power-house also contains a 270-cell storage battery.

London, July 25. A. W.

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INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Hot-Wire Voltmeters and Ammeters.

Recognizing the many advantages of hot-wire electrical measuring instruments, the Stanley Electric Manufacturing Company, Pittsfield, Mass., several years ago purchased the patent rights to what this company claims to be the most successful instrument of this character ever produced. Since this time their value has been generally recognized, and over 10,000 of these instruments are now in use in all parts of the world.

The action of a hot-wire instrument

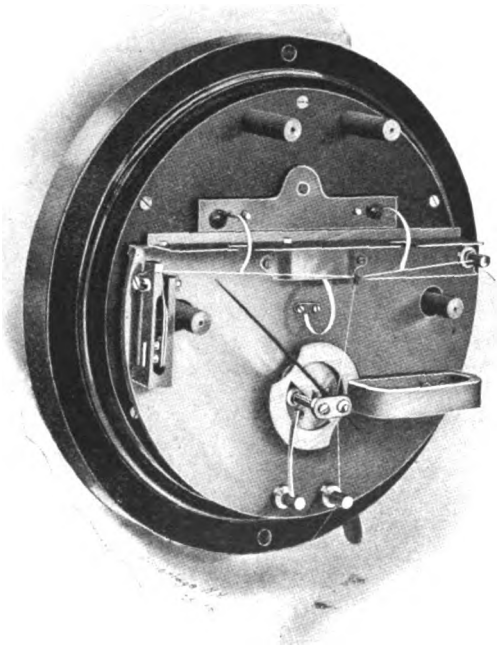

FIG. 1. - HOT-WIRE AMMETER, WITHOUT COVER.

depends, as its name implies, on the elongation of a wire suitably suspended and connected in the circuit, due to the heat produced by the current flowing through it. Owing to the fact that they operate independently of magnetic influences, hot-wire instruments are unaffected by the frequency of the current which they measure or by the wave-form, and they are correct on either direct or alternating-current circuits. Moreover, external magnetic fields due to the proximity of bus-bars, generators, etc., do not influence their action, and this instrument may be mounted wherever convenient.

Fig. 1 shows an "S. K. C." hot-wire ammeter without the case, and the working parts may be clearly seen. The hot wire proper which carries the current is made of platinum-silver, about six inches long, stretched between two terminals. Silver strips furnish auxiliary connections to the hot wire, so that the current has several paths in parallel through the same. Near the centre of the platinum-silver wire there is attached another wire made of phosphor-bronze, running to a terminal at the bottom of the instrument. Branching from the phosphor-bronze wire is a strong fibre, which is looped around a jewel-mounted steel drum carrying the pointer, and terminating in the spring (as shown in the lower left hand of the illustration) which maintains it taut.

It is well known that when a wire is stretched nearly straight between two points, the slightest change in its length causes a considerable change in the amount of slack. On the passage of the current through the platinum-silver wire, its elongation produces a considerable slack in the phosphor-bronze wire, and this slack is immediately taken up by the tension of the steel spring on the fibre, the drum around which the fibre is looped being thereby rotated in proportion to the slack taken up. Owing to this arrangement of the platinum-silver and the phosphor-bronze wires, a very slight change in the length of the hot wire causes the rotation of the drum through a considerable angle, and a scale of the usual dimensions is obtained with a pointer of the usual length. The whole of the hot-wire movement is mounted on a plate made from an alloy whose temperature coefficient is the same as that of the measuring wire. Therefore, the accuracy of the instrument is unaffected by external temperature changes.

These instruments are inherently dead-beat in their action, and the addition of a damping magnet, shown in the illustration, makes them perfect in this respect.

Ammeters for switchboard work are made in two different styles, one in which the working parts are mounted in a hard-rubber case with a plate-glass front, and one in which the working parts are mounted in an iron case.

All ammeters are provided with a short-circuiting switch, such as is shown in Fig. 2, by which the hot wire may be relieved of the current when it is not desired to take readings. Although this switch is in no way necessary to the successful operation of the instrument, it eliminates any possibility of a burn-out through an overload at times when the readings are not needed. Ammeters with a capacity of 100 amperes or less can be provided with an automatic short-circuiting device which comes into play when the instrument is subjected to a heavy overload.

Except in the special instrument de-

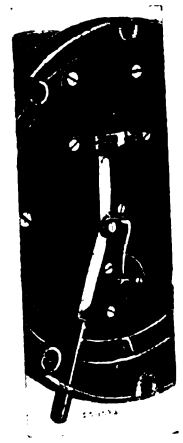

FIG. 2.—SHORT-CIRCUITING SWITCH.

signed for very low currents, only a small portion of the current measured passes through the hot wire, the main portion passing through a shunt of low resistance. For the switchboard type of instrument this shunt is external, and can be placed where most convenient. Figs. 3 and 4 illustrate two styles of shunt, the latter

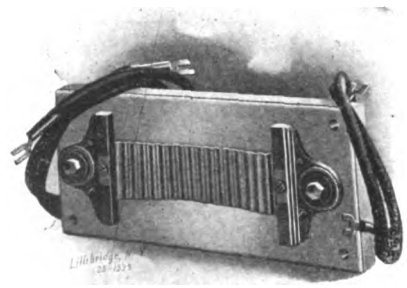

FIG. 3.—AMMETER SHUNT.

being for unusually large currents. Placing the shunt near the mains avoids the necessity of running heavy conductors to the place where the instrument is located. By providing several shunts, the same instrument can be used for widely different currents. In some cases the instrument can be marked with several different scales, or, where the shunts are of a convenient ratio, the proper scale can be

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provided for one shunt and the readings multiplied or divided, as the case may be, when other shunts are used. For example, without a shunt the full scale readings may be three amperes; using a shunt, the full scale of the same instrument may be 3,000 amperes. Shunts are ordinarily used with switchboard instruments on circuits not exceeding 3,000 volts. On circuits of over 3,000 volts, a series transformer is used in place of a shunt. By this means the instrument is thoroughly insulated from the line, and the danger of shock to the attendant is eliminated.

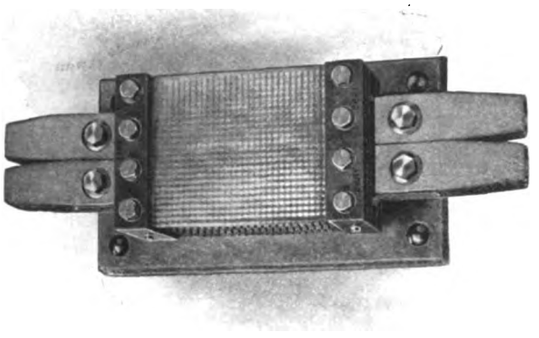

FIG. 4.—AMMETER SHUNT.

There are three types of series transformers. The dry type, shown in Fig. 5, is used on voltages up to 10,000 volts with currents of 15 to 300 amperes, and is very light and compact. This is mounted on a suitable marble base. The oil type, shown in Fig. 6, is mounted in an iron case large enough to give ample room for free circulation of oil about the coils of the transformer, and the mechanical design is such that it can be placed upon the floor or upon suitable brackets. This type is used on voltage from 10,000 to 30,000, with currents up to 200 amperes. The third type, shown in Fig. 7, is used for voltages up to 10,000, with currents from 400 to 1,000 amperes. It is so constructed that it can be mounted directly on the bus-bar, which thus constitutes the primary winding.

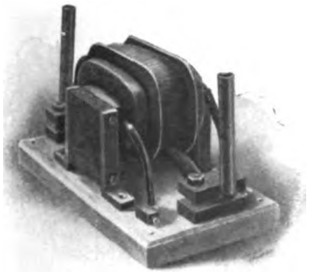

FIG. 5.—SERIES TRANSFORMER, DRY TYPE.

The series transformers furnished with these instruments all have a secondary current up to three amperes, that being the current which the hot wire proper is designed to carry. When instruments are used with series transformers the leads running to the same from the instrument can be made any convenient length.

"S. K. C." hot-wire voltmeters present quite the same appearance as the ammeters. They operate on exactly the same principle and exhibit the same independence of magnetic conditions and of external temperature changes. Instruments reading up to and including 150 volts have their resistance mounted in the case. External resistances are used with instruments of a higher voltage.

Ordinarily potential transformers are used for voltages above 750. For such service a special transformer of extremely close regulation, with a rated capacity of forty watts and designed for sixty periods per second, is used. At this load and periodicity the regulation of this transformer is 0.6 of one per cent. Portable instruments are mounted in a finished oak case, provided with lock and key. Like the switchboard type, portable instruments are provided with a suitable means for bringing the pointer to zero. Laboratory instruments, from which very accurate readings must be taken, are provided with a mirror placed beneath the scale, in order that the error of parallax may be eliminated.

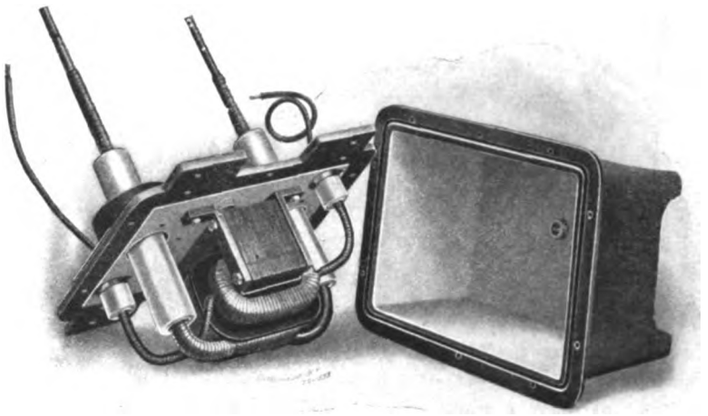

FIG. 6.—SERIES TRANSFORMER, OIL TYPE, KNOCKED DOWN.

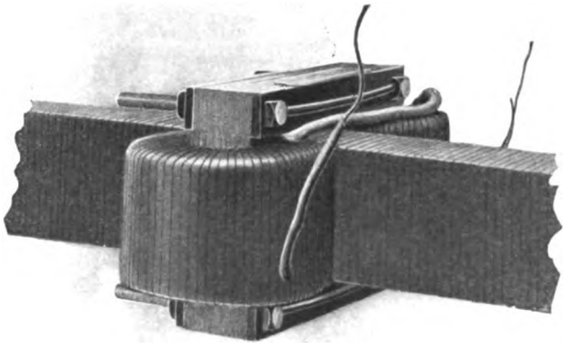

FIG. 7.—SERIES TRANSFORMER, BUS-BAR TYPE.

New Electric Turntable in Germany.

A new type of electric turntable has been developed in Germany for use in railway yards. The apparatus consists of a small motor mounted on the side of a table. Motion is communicated to the latter through gears. A simple type of controller is placed at a convenient point on the turntable, and current for operation is taken, by means of a trolley, from an overhead wire.

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Some New Telephone Specialties.

The accompanying illustrations show some telephone specialties which have been developed by the Eureka Electric Company, Chicago, Ill. Fig. 1 is a view of a complete portable desk set. This can be used either for central energy or series and bridging magneto service. The stand is furnished either in full nickel-plate or polished and lacquered copper, the standard being of solid engine lathe turned metal, highly finished. It is furnished complete with a terminal block, series or bridging hand generator in box, and extension bell of any resistance. A view is given in Fig. 2 of the Eureka triplet set.

FIG. 1.—PORTABLE DESK SET.

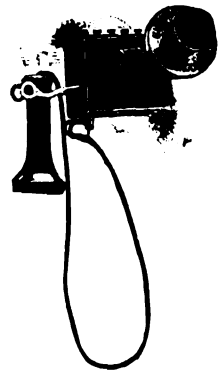

FIG. 2.—TRIPLET TELEPHONE SET.

FIG. 3.—RECEIVER ASSEMBLED.

This instrument combines in a most compact form all parts in the complete talking circuit of a long-distance telephone. It can be readily attached to any type of telephone, which will be appreciated by those having old-style telephones in which the generators and ringer movements are in good working order, but where the talking apparatus is not standard and up to date. This set is furnished with the Eureka long-distance non-packing transmitter, No. 20 Eureka receiver, long-distance induction coil, automatic hook with heavy rim pattern, which decreases the possibility of breakage. The permanent magnet is made from the very highest platinum contacts, adjustable transmitter arm with japanned iron retaining-box.

The No. 20 receiver is shown assembled in Fig. 3, the parts of the receiver appearing in Fig. 4. The shell of this receiver is of the finest hard-blown rubber, highly polished. The cap is of the latest grade of magnet steel and is carefully hardened and finished in nickel-plate. The cord terminals are soldered to a special clip, ensuring positive connections between the electromagnets and the cords. The adjustable lug is made of brass, ensuring good wearing and permanent adjustable features. It is stated that the receiver is extremely simple to adjust, and that when once adjusted it will remain in that condition. This is stated to be a valuable feature, since the rubber is susceptible to atmospheric changes, which cause a variation in the efficiency of the instrument. To adjust the receiver it is necessary only to release one set screw. The acoustic chamber is large and of the correct design, giving the full benefits of a bipolar receiver.

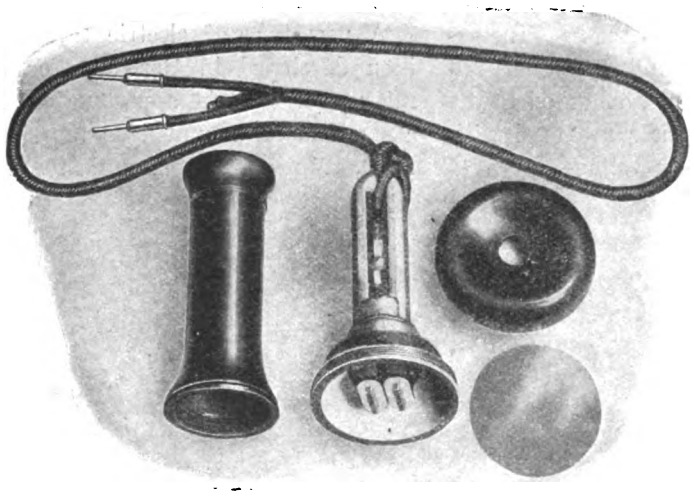

FIG. 4.—PARTS OF RECEIVER.

Fig. 5 illustrates a well-arranged chief operator's toll line switchboard.

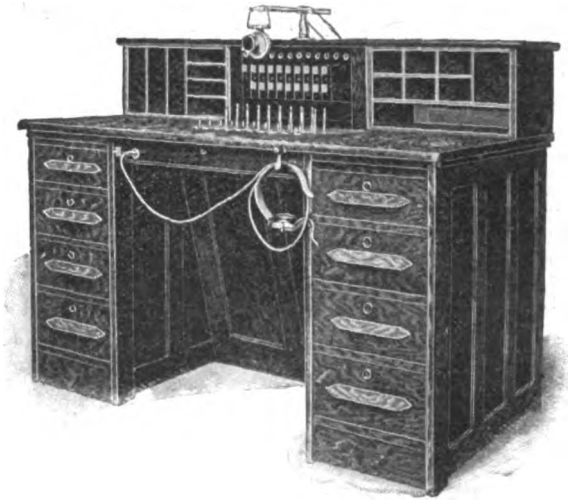

FIG. 5.—CHIEF OPERATOR'S TOLL LINE SWITCHBOARD.

Development in Direct-Current Meters.

During the past year there appeared in these columns a description and data regarding the development of the Halsey direct-current meter. Several improvements have been made recently and the meter has been tested in a number of laboratories of technical institutions. It is stated that these tests show that although the revolving element of this meter is submerged and floats in mercury, and the field is that of a permanent magnet, without a single turn of wire, the accuracy curve is almost a straight line indicating that the friction of commutation and supporting bearings is reduced to a minimum. It is said that the tests made at Cornell University and other institutions show the amount of current required to overcome the standing friction of station and maintain rotation varies from 0.03 to 0.04 of an ampere.

FIG. 1.—DIRECT-CURRENT METER.

Another striking characteristic of this meter is that its drop at full load between the terminals is only about 0.007 part of an ampere, and on this account it is possible to connect this meter up with

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a shunt of a very large carrying capacity for large switchboard meters. Mr. Halsey has just completed a 12,000-ampere meter of this nature for the works of the Carnegie Steel Company, at Youngstown, Ohio.

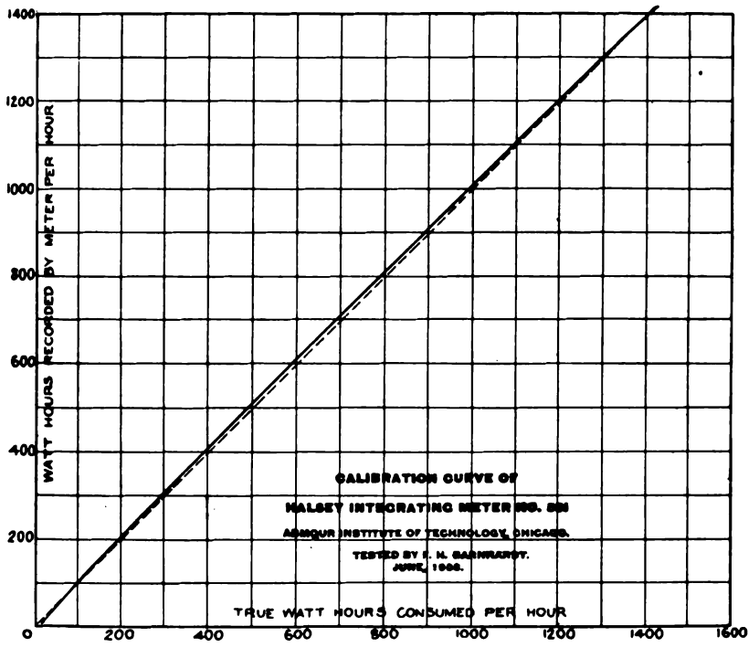


FIG. 2.—DIAGRAM OF ACCURACY CURVE.

An extremely high torque is claimed for this meter, amounting to 11,000 centimetre dynes, with infinitesimal mechanical friction.

This meter is virtually an ampere-hour meter, geared and calibrated so as to show directly upon its face the number of watt-hours that have been passed through it at the constant potential for which it is calibrated. The accompanying illustration gives a view of the meter with its cover. This meter is one of the simplest of direct-current meters, consisting essentially of a plain copper-disc armature submerged in the mercury bath so as to rotate freely in the concentrated field, maintained by the powerful permanent magnet, in a one-eighth-inch gap of about one circular-inch area. This armature disc is made to rotate by the current being led to it and through it by the mercury at the centre of this concentrated field.

Fig. 2 is a diagram of an accuracy curve described by a twelve and one-half ampere, 110-volt meter, that was made at Armour Institute, by which it is shown that there is no point where there is an appreciable error between a point below any minimum commercial load to overload. This meter is manufactured by Edward S. Halsey, Chicago, Ill.

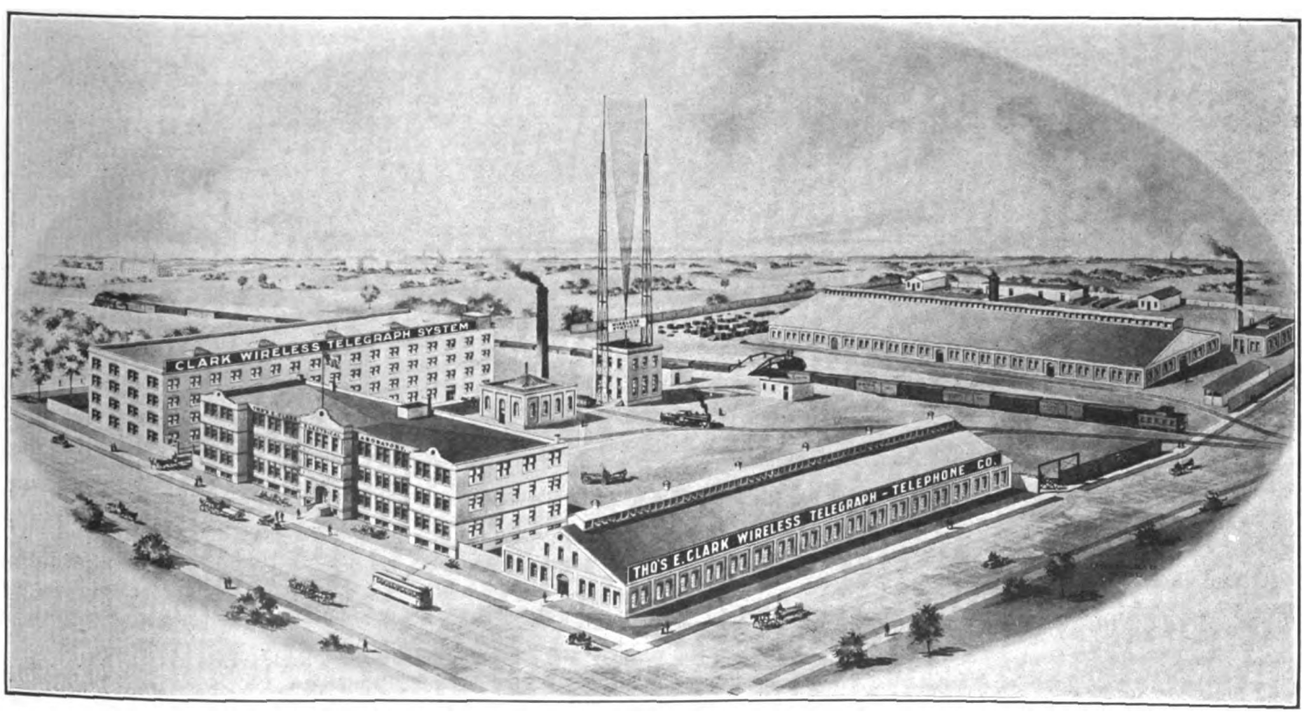
Large Wireless Telegraph and Telephone Factories.

The accompanied illustration shows the factories of the Thomas E. Clark Wireless Telegraph and Telephone Company. The factory is located in Pontiac, Mich., and when completed will cover an area of nearly six acres. Pontiac is an active manufacturing town about thirty-five miles from Detroit, to which it is connected by steam and electric railways.

The main office is 120 feet long by 50 feet wide with a high basement and has a floor space of 2,400 square feet.

The electrical laboratory is situated on a high point overlooking the surrounding country and will be fitted with an aerial tower 250 feet high. This building will be used for the experimental work, which is being carried on actively and continuously. The factory will be thoroughly equipped with the best machinery, which is now going on.

The active management of the company consists of Thomas E. Clark, president and general manager, and Gustave F. Reefstahl, secretary and general superintendent, and from the announced plans of the company and well-known energy of its officers substantial results may be expected in the development and application of wireless telegraphy.



LARGE WIRELESS TELEGRAPH AND TELEPHONE FACTORIES.

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National Electrical Contractors.

A photograph of a few of the gentlemen attending the convention of the electrical contractors is presented on this page. This group was taken at Detroit during the convention week, July 14 to 17, and includes several of the officers of the association. There were about six hundred in attendance at the convention, and the occasion was a highly successful one and important in its influence on electrical work of all kinds in the future.

A Group of Members of the National Electrical Contractors' Association—Photographed at Detroit.

Electrical Installation at Durham, N. C.

The Blackwell's Durham Tobacco Company has recently placed an order with the Westinghouse Electric and Manufacturing Company for an alternating-current generator, seventy-five kilowatts capacity, 250 volts, 3,000 alternations, 500 revolutions per minute, this being the third generator ordered by this well-known tobacco company for its factory at Durham, N. C.

About two years ago the initial installation was made of a 150-kilowatt, 3,000-alternation, 200-volt, belted type Westinghouse alternator, together with exciter and switchboard, and also about 150 horse-power in Westinghouse induction motors, ranging in capacity from three to twenty horse-power. These motors are used to drive the various machinery used in the manufacture of this brand of smoking tobacco.

The original electrical installation proved so successful that last year the tobacco company decided to install an additional generator and ordered a Westinghouse seventy-five-kilowatt, two-phase, 220-volt, 3,000-alternation, belted generator, complete with switchboard. This was arranged to run in parallel with the previous generator.

The factory has now been further enlarged and it was found necessary to increase the output of the combined plant which led to the placing of this recent order for a seventy-five-kilowatt generator and a new switchboard arranged for the control of all three generators, and also the necessary feeders.

By having three generators of the above sizes it is enabled to shut down certain generators when only a few departments in the factory are in actual operation, thus making a highly economical plant. Previous to the installation of electrical apparatus, when it was found necessary to operate one division of the factory overtime or if it was found advisable to shut down some other department and operate the rest of the machinery, there was a constant loss in the shafting due to the fact that all of the line shafting had to be run to operate one part of the factory. Under the present arrangement the departments can be operated or not as desired without operating any useless shafting.

From tests taken at this plant about a year ago, it was found that with the power required for the old factory and also for two new buildings the friction load was fifteen per cent less than when the old building alone was driven by shafting method.

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CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

NEW AUSTRALIAN ELECTRIC TRACTION SYSTEM PROJECTED—It is reported that an electric railway will be constructed from Melbourne to Whittlesea *via* Fitzroy. The distance is twenty-six miles. The scheme contemplates a continuous tramway between Whittlesea and a suitable terminus in Melbourne and the total cost of construction and equipment is put at $850,000.

BIG ELECTRIC LINE PROPOSED FOR MONTANA—The Butte & Salmon River Electric Railroad Company, with a capital of $2,000,000, has been incorporated at Helena by P. B. Moss and other eastern Montana men. The company proposes to build a railroad of 187 miles from Butte to a point in the Salmon River country in Idaho at or near the mouth of the North Fork, by the way of Horse Prairie and Lemhi Pass.

TO BUILD ELEVATED TO BRIGHTON BEACH—The Brooklyn Rapid Transit Company announces that it will spend $1,000,000 in the reconstruction of the old Brighton Beach line. Under the law the company must do away with all grade crossings. It has been found impossible to depress the tracks, so the problem was met with a plan to make the road an elevated one from Prospect Park to the beach, where it now runs on the surface.

OMAHA ELECTRIC LIGHT DEAL—The Omaha Electric Light and Power Company, a recently organized $3,000,000 corporation, has taken over the property of the Omaha Thomson-Houston Electric Light Company, together with the two lighting companies of Council Bluffs. Floating indebtedness of $400,000 and bonded indebtedness of $298,000 will be taken up and new bonds to the extent of $1,500,000 issued. The new company is organized under the laws of the state of Maine and a number of its heavy stockholders are residents of Boston. It is announced there will be no change in the management of affairs of the concern.

RECEIVERS' CERTIFICATES TO BE ISSUED—It is announced that four million dollars worth of receivers' certificates will be issued by the receivers of the Union Traction Company, of Chicago. Judge Grosscup has authorized the issue, which will be used to take up the floating indebtedness of the company and the underlying concerns, the West and North Chicago corporations. The indebtedness thus will become an obligation of the court, and must be paid before the reorganization is undertaken. Notices of the stockholders' meeting of August 19 have been sent out. There are 7,000 stockholders, and each will receive about four pounds of mail, consisting of documents pertaining to the plans and history of the street car companies.

WIRELESS COMPANIES' DISPUTE—A cable despatch states that the German Wireless Telegraph Company, which was recently organized through the amalgamation of the Slaby and Braun systems, has issued a statement regarding Signor Marconi's utterances on the possibility of the German company intercepting Marconi messages to England. It is stated that Marconi's opinion that such interception is only possible if the German company's stations are erected in England is erroneous. The German company says that all that is necessary is to erect a strong station on the shores of the Baltic or the North Sea, attune its receiving wires to Marconi's station at Poldhu, Cornwall, and it would be impossible for Marconi to receive transatlantic messages.

TO ATTEMPT TO CROSS ARCTIC CIRCLE—Mr. and Mrs. Charles J. Glidden, of Lowell, Mass., left Copenhagen on July 29 in their automobile in an attempt to make a trip in the Arctic zone. The United States consul accompanied them to Elsinore and arranged for their safe passage across the country. The route lies through Christiana and thence northeastward to Bergen. From there the direction will be changed to the northwest through Trondjham, from where the dash across the Arctic line will be made, Beleren being the objective point. This town is about thirty miles north of the Arctic circle. The return trip will be made through Denmark, and after a trip through Holland and Germany they will go to England. Mr. Glidden was well known in telephone circles for a number of years, being at the head of the Erie Telephone and Telegraph Company.

NEW CUBAN ELECTRIC COMPANY—The Havana Electricity Company, Limited, has been organized in London with a capital of $1,500,000, for the purpose of adopting an agreement with Don Tiburcio Castaneda and La Compania de Electricidad de Cuba to construct, equip, develop and control railways, tramways, electric light, telephone and telegraph works and other public and private works in Cuba and elsewhere; to acquire all or any part of the shares and bonds of La Compania de Electricidad de Cuba, which is organized under the laws of Cuba and has a concession for the establishment in Havana of an electric plant; to acquire shares and obligations of any other company, and to carry on the business of supplier of electric light, heat and power, and a general electrical business. The registered offices of the company are in London.

NEW YORK-BOSTON TROLLEY—A decision of Judge Elmer in the Superior Court, granting a trolley charter to build an electric road from Montowese, a small town a few miles north of New Haven, to Wallingford, five miles further north, closes the last gap in the trolley line from New York to Boston. With the completion of this line a through service will be established between the two cities, with the exception of perhaps one change. The distance by trolley is 251 miles, and the quickest time in which the trip can be made is twenty hours. The road passes through the most picturesque part of Connecticut and Massachusetts. From Boston to Worcester the line runs along the Charles River, through expanses of farm land. At Springfield the course of the Connecticut River is followed to Hartford, and from Hartford to New Haven the route is by way of New Britain. From New Haven to New York the trolley line follows the New York & New Haven road in an almost parallel line.

PROPOSED REGULATIONS FOR THE OPERATION OF TROLLEY CARS—The New York *Times* comments as follows on the question of the operation of urban and suburban trolley roads, which is now attracting attention in the state of Massachusetts. "Urban and suburban trolley lines, despite their many similarities, are yet made quite different things by the difference of the conditions in which the service is conducted, and especially by the higher speed invariably maintained in the country. The general failure to recognize this fact is at the bottom of many of the accidents daily occurring on the suburban lines, which, being in reality under-sized railroads instead of over-sized street car companies, follow the methods of the latter at the great peril of their passengers. There is, therefore, pertinency, if not any large amount of practical wisdom, in some suggestions just made in an open letter sent to Governor Bates, of Massachusetts, by Mr. W. H. Wheeler, of Worcester. Mr. Wheeler wants the legislature to see to it, first of all, that no motorman shall be employed on a country trolley line until he has had two years' experience, and has, besides, proved to a state licensing board that he is able to do the right thing in an emergency as well as to manage his car when no dangers are in sight. Just how the test is to be made is not revealed, and not much would be revealed by prearranged difficulties. Still, something could be done in this direction, and the idea has certain merits. In the next place, Mr. Wheeler would have the state pass a law forbidding one rapid transit car to follow another at a less distance than 100 yards—which seems extremely close—and ordering the equipment of all such cars with a double set of air brakes, so that one could be used in case the other failed. That, we fear, is a counsel of perfection and not to be expected while the world and corporations remain what they are. It must be remembered, however, that the transportation companies, for the very best of reasons, are struggling with many another problem, and legislative interference should be slow and cautious in matters upon which the practical expert alone has a right to speak the final word."

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ELECTRIC LIGHTING.

PLAINFIELD, WIS.—T. Starks and F. V. Skeel will light the village by electricity.

HUDSON, MICH.—The North Adams council has let the contract for the village lighting plant.

BOSTON, MASS.—The Pittsfield Electric Company will increase its capital stock from $100,000 to $150,000.

BETHEL, OHIO—This town will install an electric lighting plant, $8,000 in bonds to be issued for the purpose.

CARROLL, IOWA—A twenty-five-year franchise has been granted to the Carroll Electric Light and Power Company.

RICHMOND, IND.—The Richmond Light, Heat and Power Company announces that it will double the capacity of its plant.

RALEIGH, N. C.—Burlington has decided to issue bonds to the amount of $18,000 for the purpose of installing an electric light plant.

MARION, OHIO—The Marion Railway, Power and Lighting Company announces that it will build a $350,000 power and lighting plant in this city.

RIVER ROUGE, MICH.—At a special election it was decided to issue bonds to the amount of $28,000 for the purpose of building a municipal electric plant.

NEEDHAM, MASS.—The town selectmen have signed a contract with the Greendale Chemical and Electric Lighting Company for street lighting for five years.

PORTSMOUTH, OHIO—The contract for erecting a $100,000 power-house has been let by the Portsmouth Street Railway and Light Company, and work will commence at once.

FAIRMOUNT, IND.—Nearly all the money necessary for the building of the city electric plant has been subscribed, and it is hoped to have the plant installed before the winter.

MERIDIAN, MISS.—Work has been commenced on the new power-house which is being erected by the Meridian Light and Railway Company, and will be pushed with all possible speed.

WOONSOCKET, R. I.—The city has entered into a five-year contract with the Woonsocket Electric Machine and Power Company to light the streets. The city is to pay at the rate of forty cents per light per night, and also has a contract for incandescent lights at $30 a year per light.

FORT WAYNE, IND.—The city of Fort Wayne has entered into a contract with the Fort Wayne Electric Light and Power Company to light the streets. The city is to use 324 arc lamps and to pay at the rate of $75 per lamp per year. The contract is to continue in effect until January 1, 1935.

NASHVILLE, TENN.—For the first six months of the present year the operation of the city electric plant, including the expenditures made for additions and equipment, has been $36,525.38. This does not include $6,137.90 expended for gas light and $3,000 interest on the $150,000 bonds issued for the purchase of the plant, which would make the total expenditure of the light department under municipal ownership for six months $45,663.28.

HAVERHILL, MASS.—An order has been issued by the Board of Gas and Electric Light Commissioners, sustaining an appeal by the Haverhill Electric Company from a decision of the board of aldermen of Haverhill in favor of the Haverhill Illuminating Company, and annulling the action of the Mayor and aldermen in granting the Illuminating Company the right to carry on the business of supplying electric light and power in the city.

MARINETTE, WIS.—The Penn Mining Company, of Norway, Mich., will, it is stated, shortly start the work of harnessing the water power at the mouth of the Sturgeon River at Norway, just across the line from Marinette County. A bill was passed in the last Wisconsin Legislature to allow it to build a dam in Marinette and Menominee counties. Plans have already been drawn for the improvement, which will cost over $500,000. Electric power will be developed for running the mines, and it is also planned to light Norway by electricity and later build an interurban line to connect all the Menominee range towns.

ELECTRIC RAILWAYS.

PITTSBURG, PA.—The new line of the Pittsburg Railways Company to Trafford City has been opened. The distance is about eighteen miles, and the time taken is one hour and twenty minutes.

PHILADELPHIA, PA.—A charter has been issued by the state department to the Central Pennsylvania Traction Company, of Harrisburg, with a capital of $2,100,000, to operate the lines of the Harrisburg Passenger Railway Company and the East Harrisburg Street Railway Company.

EVERETT, WASH.—It has been officially announced that the Everett Improvement Company, which has for some time contemplated building a trolley line from Everett to Snohomish, has leased the branch line of the Northern Pacific between the two cities, and will immediately install the service.

JAMESTOWN, N. Y.—Active work has been commenced on the proposed trolley road from Jamestown to Mayville. A new power-house is being erected in this city, and substations will be erected at Ashville, Stowe and Mayville. It is stated that the road will be in operation before the end of the present season.

MARION, IND.—Joshua Strange has been granted a franchise by the county commissioners to build and operate a passenger and freight electric line from Marion to Van Buren, and thence south to Upland. The franchise is for fifty years and the road is to be in operation by September, 1905. The power-house will probably be located in Marion.

BANGOR, ME.—The railroad commissioners have granted a charter for an electric railroad between Presque Isle and Perham, both towns in Aroostook County. The road will be sixteen miles long, and will be intended primarily for the transportation of farm products, although passengers and mails will be carried. It is stated that the capital stock has been subscribed almost entirely by farmers along the route.

ANDERSON, IND.—A mortgage for $5,000,000 by the Indiana Union Traction Company to the Girard Trust Company, of Philadelphia, has been filed for record here. It secures a bond issue by the Indiana company and is payable thirty years from July 1, 1903. The mortgage covers existing systems leased by this company and such additional lines as may be built in eight counties named out of ninety-two in Indiana.

PAWTUCKET, R. I.—The Rhode Island Company has issued an official statement to the effect that it will expend $1,004,070 in the reconstruction of the local street railway system. This will include the cost of laying about thirty-two miles of standard gauge track, new rolling stock, and $100,000 which the company is to pay the city toward the widening of Main street. In return, the company receives exclusive franchises in the city until 1913.

ALBION, ILL.—Articles of incorporation of the Southern Electric Railway Company have been filed for the record. The company has a capital of $50,000, and proposes to construct an electric railroad from East St. Louis through the counties of St. Clair, Clinton, Washington, Marion, Jefferson, Hamilton and White to a point on the Illinois side of the big Wabash River, at or near the town of Maunie. The principal office of the company will be located at Mount Vernon.

HARRISBURG, PA.—It is stated that New York capitalists have become interested in the building of a new trolley line from Steelton to New Cumberland, and thence to Bowmansdale and Mechanicsburg, with a branch line from Bowmansdale to Dillsburg. The road will be twenty-three miles long and will touch the following towns: Mechanicsburg, Kollerton, Shepherdstown, Bowmansdale, Lisburn, Silver Lake Park, Lewisberry, New Market, New Cumberland and Steelton, Bishop's Park, Siddonstown, Mount Pleasant and Findley's Church.

MUNCIE, IND.—The Consolidated Traction Company, which is now building a line to Crawfordsville, by the direct route through Jamestown, will, it is stated, build a line from Crawfordsville to La Fayette, and extend the Indianapolis-Crawfordsville line on to Danville, Ill., through Veedersburg and Covington, and will build a coal road from Crawfordsville down into Parke County. The road will be a coal-carrier into Indianapolis. It is probable that the road into Parke County will be pushed on to Rockville, where it will connect with the Danville company's line into Clinton and Terre Haute.

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ELECTRICAL SECURITIES.

It is with a feeling of general relief that Wall street has settled into a sort of satisfied rest. The spasm of activity and violence that shook several business houses into ruin has evidently passed, and left behind it little of the fear that generally attends a like movement. It is assumed that the suspended local firms will soon resume business. Following the drop in prices there was considerable buying both by large interests and by the speculating outsiders. The bargain conditions were soon eliminated, however, by the quick recovery of prices.

ELECTRICAL SECURITIES FOR THE WEEK ENDING AUGUST 1.

New York:	*Closing.*
Brooklyn Rapid Transit	45¼
Consolidated Gas	187
General Electric	162
Kings County Electric	155
Manhattan Elevated	132¾
Metropolitan Street Railway	119
New York & New Jersey Telephone	161
Westinghouse Manufacturing Company	170

The statement of the Brooklyn Rapid Transit Company for the nine months ending March 31, 1903, is as follows: Gross earnings, $9,905,176; disbursements, $5,870,373, leaving net profits of $4,034,803, an increase of $801,214 over those for the corresponding period of the previous year.

It is stated that Manhattan Elevated earnings are showing an increase of $4,000 a day, as compared with last year, and that from the present outlook the company will earn 10 per cent for the fiscal year.

The Consolidated Gas Company has declared the regular quarterly dividend of 2 per cent, payable September 15. Books close August 27 and reopen September 16.

Boston:	*Closing.*
American Telephone and Telegraph	131½
Edison Electric Illuminating	225
Massachusetts Electric	80
New England Telephone	120
Western Telephone & Telegraph preferred	83

Although June this year was a poor riding month, Boston Elevated gross earnings amounted to $1,040,000, and during that month there was a total of 3,987,000 car-miles run, as compared with 3,958,000 miles in June, 1902. For the first three weeks of July, the gross earnings were $100,000 in excess of those of last year.

Philadelphia:	*Closing.*
Electric Company of America	8
Electric Storage Battery common	59
Electric Storage Battery preferred	59
Philadelphia Electric	5½
Union Traction	44
United Gas Improvement	85

It is stated officially that the net earnings of the Electric Storage Battery Company for the six months ending June 30 were $1,200,000, by far the largest for any similar period in the history of the company. The net earnings for the entire year of 1902 were $1,113,199. Of last year's total earnings $812,427 were paid out in dividends, so that the net for six months ended June 30 last enabled the company to pay a full year's dividend and still possess a surplus of $387,573.

Chicago:	*Closing.*
Chicago Telephone	125
Chicago Edison Light	148
Metropolitan Elevated preferred	54
National Carbon common	22
National Carbon preferred	90
Union Traction common	5
Union Traction preferred	30

It is reported that the Union Traction statement for the year ending June 30 last shows a deficit of $240,000.

OBITUARY NOTICE.

MR. CHARLES ANTHONY MORSS died at Boston, July 27, of heart disease, aged seventy-one years. Mr. Morss was a pioneer in the wire business, and for several years had been at the head of the Simplex Electrical Company, which manufactures the Simplex wire. He was born in Boston in 1822, and his ancestors on both sides were among the original Puritan settlers of Newburyport. Mr. Morss entered the wire business soon after leaving school with a firm which occupied the Cornhill Building, which had been for nearly sixty-five years his headquarters. His widow and four sons survive him.

PERSONAL MENTION.

MR. H. F. T. ERBEN, of the General Electric Company, Schenectady, N. Y., is a son of Admiral Erben, United States Navy, and is taking high rank in electrical work. A recent patent issued to Mr. Erben for a dynamo coil has been assigned to his company.

MR. C. E. FARRINGTON, treasurer of the Massachusetts Chemical Company, Boston, Mass., sailed for Europe last week. Mr. Farrington expects to be away eight or nine weeks, and will combine business with a well-earned rest from a very active life in the electrical field.

MR. F. L. DAME, for the past two years general manager of the Union Electric Company, Dubuque, Iowa, has accepted the position of engineer of the local companies' committee of the General Electric Company. It is expected that Mr. Dame will assume his new duties with headquarters at Schenectady, N. Y., about the middle of August.

MR. H. M. KOCHERSPERGER, New Haven, Ct., controller of the New York, New Haven & Hartford Railroad, has been elected president of the Stamford Street Railroad Company, succeeding Colonel N. F. Heft, resigned. Mr. Kochersperger is one of the best known men in his profession in the United States and while retaining his important position with the New Haven road, will bring to the electric railway energy and executive ability of a high order.

COLONEL N. F. HEFT has resigned from the presidency of the Stamford Street Railroad Company, which is owned by the New York, New Haven & Hartford Railroad Company, and also from the presidency of the Meriden Street Railroad Company, of Meriden, Ct. Colonel Heft's retirement is due to a desire for a long vacation in Europe. He will retain his interest in the Stamford Railroad Company, of which he is a director. It is believed that plans are under way to extend the Stamford railroad so that through service between that point and New York city can be given.

SIR WILLIAM H. PREECE, consulting engineer to the British Post Office, is critically ill with pneumonia. His son, Mr. Llewellyn Preece, who arrived at New York on the steamer Lucania last Saturday, making the trip with Mr. Franck Z. Maguire of the Bridgeport Brass Company, found a cable message awaiting him announcing the sudden illness of his father. This was Mr. Llewellyn Preece's first visit to this country, where he intended to inspect the electric railways, and to visit the electrical developments at Niagara Falls. A second message was received asking him to return at once and he left on a returning steamer two hours after his arrival. Sir William Preece is consulting engineer for the British Post Office. He is associated with his sons and Major Philip Cardew as consulting engineers, and has a very large practice throughout the United Kingdom and the British colonies. He is an accomplished lecturer, a distinguished scientist and inventor, and is the author of many valuable books and papers.

TELEPHONE AND TELEGRAPH.

OWENSBORO, KY.—An automatic telephone exchange is to be constructed by the Home Telephone Company.

COLUMBUS, GA.—The Columbus Automatic Telephone Company has been granted a franchise in Phenix City.

KOKOMO, IND.—The council has granted a forty-year extension of franchise to the Citizens' Telephone Company.

SPRINGDALE, WASH.—The Springdale & Cedar Cañon Telephone Company's line has been sold to O. U. Hawkins, of Springdale, by E. M. Denny and W. I. Reeves.

CEDAR RAPIDS, IOWA—A new telephone company has been formed by J. P. Shurman, O. A. Ontje and J. Laverka, to establish a farmers' telephone line for this vicinity.

WORSHAM, VA.—The Southside Telephone Company has been incorporated by the following: J. D. Eggleston, Jr., P. Winston, K. T. Crawley, E. W. Venable and W. M. Holliday.

CLEVELAND, OHIO—The Cuyahoga Telephone Company has issued a letter to its employés announcing that beginning July 1, after paying all expenses, taxes and interest on bonds, it will set aside one-fifth of the surplus remaining, and distribute this during January to all in the employ of the company at that time, in proportion to the salary of each and the time of his connection with the company.

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INDUSTRIAL ITEMS.

THE PEERLESS ELECTRIC COMPANY, Warren, Ohio, will send its "Transformer Blue Book" on request. This contains interesting information of the kind that transformer users should have.

THE OKONITE COMPANY, LIMITED, New York city, reports one of the busiest summer seasons in its history. Its extensive factories at Passaic, N. J., are very busy, often working overtime to fill orders promptly.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, Pa., in its recent report, makes a particularly fine showing. The profits for the year are announced to be the largest in the history of the company.

THE NERNST LAMP COMPANY, Pittsburg, Pa., through its Portsmouth, N. H., agents, Messrs. W. T. Trafton & Son, recently closed a contract with H. C. Hewitt & Company, of Portsmouth, N. H., for a number of six-glower Nernst lamps. These lamps have been installed and, it is stated, are giving entire satisfaction.

CHARLES E. MILLER, who has a large automobile supply house with headquarters at 97-101 Reade street, New York, has opened a branch store in "Automobile Row" on West Thirty-eighth street, New York city. Mr. Miller keeps a very complete line of automobile supplies, and represents the Dayton Electrical Manufacturing Company, of Dayton, Ohio.

THE WRENN COMBUSTION GOVERNOR COMPANY, 290 Broadway, New York city, manufacturer of combustion governors, steam damper regulators, diaphragms, valves, etc., has issued an illustrated catalogue giving a very complete description of the Wrenn combustion governor, as well as additional valuable data relative to this subject. Any one interested can obtain the catalogue by a request to the company.

THE WARREN ELECTRIC MANUFACTURING COMPANY, Sandusky, Ohio, under the able management of President C. C. Warren, has recently been extending its manufacturing facilities to meet the requirements of a rapidly expanding business. The Warren alternator is widely and favorably known, and the company has branch offices in all the leading cities. The large extension was completed this year, and the company is now able to promptly handle all orders for its product.

THE ELECTRICAL REVIEW has been in receipt recently of a number of very attractive catalogues published by the various manufacturers in the electrical and allied fields. All this literature is of a high grade and is evidently carefully prepared. The catalogues not only present the excellent qualities of the various products, but in nearly every instance contain valuable information that will interest consumers and the lay public generally. Probably no industry was ever so well supplied with such excellent literature.

THE FOUR-TRACK NEWS for August, published by George H. Daniels, of New York, is a very comprehensive and beautifully illustrated issue. The frontispiece is a particularly fine half-tone reproduction of Sir Thomas Lipton's challenge yacht, Shamrock III. This is one of the best pictures of the yacht that has yet been presented. The number contains some seventy pages of interesting and well illustrated text, covering a great variety of subjects, keeping particularly in view the outing advantages and recreation spots of this country.

THE LAWRENCE-HALL ELECTRIC COMPANY, Cincinnati, Ohio, organized a few months ago with Mr. F. D. Lawrence as president and treasurer, and Mr. William Albert Hall as vice-president and secretary, is meeting with pronounced success in extending its business in a very important and progressive territory. This company, in its recent announcements, calls attention to the admirable location of Cincinnati for supplying its various products economically as regards express and freight rates. The company carries large stocks of standard electrical equipments, and is agent for all the Okonite products.

THE HYDRA BATTERY COMPANY, 72 Reade street, New York city, announces that the orders for its "Hydra" type and "Vesuvius" dry-cell batteries continue to keep it busy to its full capacity. The company states that it is experiencing considerable success in the sale of its new "Hydra" jump spark plug. This plug is constructed in one solid body, thus avoiding loose joints, and is insulated with the best grade of imported mica washers. It is furnished with a brass head, thus preventing rust in the cylinder head, and has extra heavy platinum points. The company will be pleased to furnish full information upon request.

THE STANLEY ELECTRIC MANUFACTURING COMPANY, Pittsfield, Mass., has issued bulletin No. 136, descriptive of "S. K. C." induction motors. This describes the construction of the type of induction motor which has recently been brought out by this company to complete its line of alternating-current apparatus. The motors are built for twenty-five, forty and sixty cycles, in sizes up to 200 horse-power. In addition to the constant-speed motor a type of variable-speed motor has also been developed. The motors may be mounted in any position, either on the floor, wall or from the ceiling, and are designed for the several standard potentials.

THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, Rochester, N. Y., and Chicago, Ill., in its bulletin No. 4 describes its generator-call telephones. The catalogue is a very handsome one, and among the apparatus illustrated is the following: Transmitter arms, lightning arresters, bridging telephones, extension bells, central checking telephones, induction coils, combination telephones, divided-circuit telephones, dry battery type telephones, hand generators, generator-call telephone parts, hook switches, magnetos, portable combination telephones, portable desk telephones and test sets. The company will be pleased to send this on request, and also announces that it now publishes a perpetual price list on the loose-leaf method, covering various lines of its product. This can be secured by interested parties.

MESSRS. KELLER, PIKE & COMPANY, 112 and 114 North Twelfth street, Philadelphia, Pa., mechanical and electrical engineers and contractors, have been awarded the contract for the entire electrical equipment in the new Pennsylvania State Capitol at Harrisburg, Pa. This contract covers six engines, aggregating 1,200 horse-power; six direct-connected generators, having a capacity of 800 kilowatts; a white Italian marble switchboard, consisting of twelve panels, with Weston instruments and Cutter circuit-breakers; electric wiring for motors, aggregating 200 horse-power, and over 10,000 incandescent lamps. The contract also includes an annunciator system connecting each member of the senate and the house with a central station, and another system connecting the head of each department with his subordinates, as well as a telephone exchange connecting the governor with the heads of the twenty departments, the president of the senate with twenty committee rooms, and the speaker of the house with forty committee rooms. All the rooms in the building are also connected by a telegraph system with a central office. This contract makes a notable addition to the already extensive line of important installations by Messrs. Keller, Pike & Company, which includes, among others, the National Export Exposition, the United States Mint at Philadelphia, and the large department store of Gimbel Brothers.

NEW INCORPORATIONS.

MAYFIELD, PA.—Independent Electric Light, Heat and Power Company. $6,000.

JERMYN, PA.—Household Electric Light, Heat and Power Company. $6,000.

JACKSON, WIS.—The Jackson Telephone Company. $2,000. Incorporators: C. W. Frank, F. P. Leish, George H. Frank and M. R. Rutledge.

JERSEY CITY, N. J.—The Southern Electric Securities Company. $1,000,000. Incorporators: Kenneth K. McLaren, Joseph M. Mitchell, Louis B. Dailey.

COLUMBUS, OHIO—The Mount Vernon Telephone Construction Company. $5,000. Incorporators: L. W. Breece, C. E. Bointer, E. O. Arnold, P. S. Keiser and H. C. Devin.

CANNON FALLS, MINN.—Cannon River Electric Power Company. $500,000. Incorporators: Foster B. Seager, Edward J. Peters, A. L. Ober and Thomas T. Comstock.

WASHINGTON, D. C.—The International Motor and Power Company. $15,000,000. Incorporators: H. H. Darneille, W. L. Walter, B. H. Brockway, E. G. Siggers, C. H. Freq, John M. Carpenter, J. S. Zeigler, S. H. Bell and Alexander H. Bell.

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CHARLES W. PRICE . . . . PRESIDENT and EDITOR
STEPHEN H. GODDARD . SECRETARY and MANAGER
WM. HAND BROWNE, JR. . . . TECHNICAL EDITOR
AINSLIE A. GRAY . . . . . ASSISTANT EDITOR

WESTERN OFFICE — 40 Dearborn Street, Chicago, Ill.
CHARLES FFRENCH, Manager.

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TO ADVERTISERS

CHANGES for advertisements should be in this office by Friday noon for the following week's issue.

NEW ADVERTISEMENTS should be in the office not later than Monday noon to assure publication in that week's issue.

WIRELESS TELEGRAPHY IN THE WAR GAME.

During the manœuvres recently carried on by the fleets of the United States Navy, the wireless telegraph apparatus on several of the ships of the "defending" squadron gave a good practical illustration of its utility. One of the best features of this method of communicating at sea is its independence of fog or darkness. As to the matter of secrecy the same conditions are entailed, and with any form of signaling secrecy is only relative and depends entirely upon the knowledge which the enemy has of the code used. The "wig-wag" with flags by day and lights by night can be interpreted only when the code is understood. Why should the wireless message be less safe from intentional interception?

SPEED AND PUBLIC SAFETY.

On another page of this issue will be found a contribution from the pen of Dr. Louis Bell, which discusses the various phases of the problems presented by the speed of mechanically driven vehicles on public streets and highways.

Cause of Many Accidents.

Dr. Bell first takes up the prevalence of accidents which he believes are due to several causes, but particularly to the ignorance or recklessness of the man in charge of the vehicle. The motorman of an electric car seldom realizes the length of the danger space in front of his car and is prone to lay the blame for an accident on his brake, although it may have been in good condition and have done all that could be expected of it. Another point is that the motorman does not always realize how fast his car is going. The tendency is to build larger and heavier cars, and to equip them with motors having a high rate of acceleration. The heavy car gets under way quickly and before the motorman realizes it there is a danger space ahead of him of a couple of hundred feet. It is also true that pedestrians and drivers of other vehicles do not realize the length of the danger space and are apt, for this reason, to take risks which are greater than they imagine, and to throw the responsibility for avoiding an accident upon the motorman, who may be utterly unable to prevent it.

Precaution on Interurban Roads.

Danger of accidents from high speed on public roads can be and is being decreased by running these over private rights of ways and equipping them with reliable power brakes. The tendency on these roads is toward steam railroad practice and it would be well if every one would realize that such roads should be really classed as railroads and not as tramways, and the corresponding precautions necessary to avoid accidents should be taken both by the company and those who find it necessary to cross such roads.

Restraining Reckless Automobile Running.

The problem presented by the automobile is more difficult, because, although the automobile has a greater brake capacity than the electric car and it is also able to turn out of the way and thus may avoid a collision, the speed capacity is generally higher and the man in charge feels greater freedom to run at a high speed and to take chances than does the motorman. However, accidents due to automobiles are brought about by a limited number of reckless men who show little or no feeling for the rights of others. Dr. Bell does not think that accidents caused by this class of men can be decreased by stringent speed regulations. It is difficult to obtain satisfactory evidence and bring the offenders to book in this way, and such regulations can not but be oppressive to those who operate their machines with due respect of the rights of others. The remedy suggested will doubtless meet with much opposition, though it would certainly be effective. It is to forbid the use on public highways of motor vehicles capable of operating on level ground above a certain speed.

Evil of Insuring Automobilists.

Another phase of this question touched upon is the practice of casualty companies of insuring automobilists against accidents. Dr. Bell states this "comes as near to putting a premium on criminal carelessness as anything well can." The remedy suggested for this evil is to make a special criminal law to cover injuries inflicted by vehicles of all sorts due to carelessness of the driver, or of his employer if, at the time of accident, he be part occupant of the vehicle.

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ELECTRICAL POWER FOR FARMING WORK.

A field in which the application of electricity seems to be making slow progress is in farm work. There is on all but the smallest farms a good deal of work which might be done more economically by some form of power other than that due to turning a crank by hand or the slow movements of horse or ox. These sources of power are not only expensive, but they are too slow, and the question may be fairly raised why has not some other method found more general use on the farm?

Reasons for Tardy Application of Mechanical Power.

At this time a number of reasons may be given in explanation of this tardiness, though some of these are not likely to prevail for many years longer. In the first place on the average farm there is ample time for the work which must be done, except during two or three short seasons of the year, and any machinery installed with a view to handling especially the work of the busy season would stand idle for a large part of the time during the dull seasons. Again, and this is a serious obstacle, machinery suitable for stationary work—that is, work about the house and barns—is generally not suitable for work in the field; while the mechanical apparatus so far developed for plowing and cultivating is cumbersome and expensive, and although the driving motor of this apparatus could be used for power purpose at other times, this part of the apparatus usually forms a minor part of the whole apparatus, and the greater part would be idle.

Other Difficulties.

Another reason which should be considered is the investment required, as this would be more than the average farmer can afford to tie up in machinery. Another difficulty lies in the distance from the farm to the power station, as the latter is usually located in a village or town and not in a position or of a design suitable for distributing power in small quantities over a large district. These difficulties, while serious for the small farmer, do not hold with the same force for the manager of a large tract of land, to cultivate which recourse must be had to all mechanical aids, and the investment thus made represents but a small part of the total. Steam power is now used frequently on the large farms in the West, where the press of work is so great at times that every means must be taken to get it done as quickly as possible. On these farms, so far as we are aware, electricity is being used only in a secondary way for lighting and for light work, such as pumping and driving small machines around the barn. It has, however, been tried both in this country and abroad for work in the field and with reported success, so far at least as the cost of operation is considered as a criterion.

Weight of Machinery a Drawback.

One difficulty in adapting the electromotor to cultivating ground lies in the fact that motor-drawn vehicles are invariably heavy, and in this character of work they are called upon to travel over very difficult grounds. This difficulty becomes less serious for large fields, because the machine can be made more powerful without increasing its weight proportionally, and in this way more ground can be worked during each journey than would be practicable for smaller fields; as in the latter case the increased cost of the larger would be a serious objection and because there is comparatively little work for it to do.

Minimizing the Difficulty of Weight.

The troubles brought about by the weight of the machine may be overcome more or less, by not running it over the fields but by using it to draw a rope, which in turn draws the plow. This scheme, however, seems clumsy and adds to the equipment required on the machine. It is reported, however, to have given satisfactory results on a number of estates abroad.

Relative Value of Electricity and Steam.

An electrical apparatus for this purpose has some advantages over gas or gasoline, but it has serious disadvantages. Its travel in the field is limited by the length of cable connecting it to the power circuit, and for the same reason the machine can not be used to haul freight, so that the farms supplied with an apparatus of this kind must, nevertheless, retain horses for hauling. The storage battery is, of course, out of the question as yet for apparatus of this kind.

The Trackless Trolley and Farming.

It might seem, therefore, that there is but little prospects of a more general use of electricity for cultivating farms, and it is probable that this condition will prevail for some years to come. But there is one line of development which may take place, and which would seem likely to stimulate the use of electricity for the farm. This development is what has been called the "trackless trolley," that is, an electrically equipped vehicle which runs along an ordinary road where power is supplied by means of trolleys and two overhead circuits. When all turnpikes are supplied with these trolley wires so that vehicles of this kind can travel everywhere, will not those who will then cultivate the soil be only too glad to avail themselves of this cheap and reliable power? One well equipped vehicle will be able to do all the farm work and do the work about buildings, and do all the hauling, and if the machine is well built it could be kept at work all day, and if necessary all night.

Influence of Machinery on Farm.

Conditions at present then seem to be this, it is asserted by those who have had experience that electrical power is cheaper than horse power for farm work, but unless the electric motor can do all the work which is now done by the horse there is little hope of its coming into general use. If, however, the trackless trolley system is developed to any extent, then there is a strong probability that the electric motor will begin to displace the horse on the farm, just as at present it has displaced him for railway work and promises to displace him for all city hauling. And should this come about would it not be another factor to attract men from the city to the country? When all farm work is done by machinery will it not attract men who now look upon it as drudgery of the worst kind?

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SPEED AND PUBLIC SAFETY.

THE PREVALENCE OF SERIOUS MISHAP—THE GREATER OPPORTUNITIES FOR ACCIDENT WITH HEAVIER AND FASTER VEHICLES—THE OPERATOR'S INTELLIGENT UNDERSTANDING OF THE DANGER SPACE AHEAD AND THE ULTIMATE POSSIBILITY OF CONTROL—THE ADDED RESPONSIBILITY OF THE PUBLIC—HIGH SPEED WITH SKILFUL HANDLING COMPARATIVELY SAFE—THE REGULATION OF RECKLESS DRIVING SHOULD NOT BE SUCH AS TO ELIMINATE ALL CONVENIENCE TO THOSE WHO OBEY THE LAW.

BY DR. LOUIS BELL.

The last few years have seen a very large increase in the number of fast and heavy motor-driven vehicles used in one way or another on the public roads, and the result has been so ghastly a muster-roll of accidents that public safety demands a grave consideration of the problems that have arisen. In the list of offenders must be joined in evil notoriety both recklessly driven automobiles and recklessly driven electric cars. One can hardly pick up a morning paper without finding fatalities due to both causes and the frequency of these accidents appears to be on the increase even in proportion to the number of vehicles in service. Accidents from vehicles and from street cars have never been rare of late years, but the present epidemic of negligence demands and will receive drastic treatment if it continues much longer.

Neither the electric car nor the automobile is necessarily a menace to safety on the public street, but both may become so when carelessly managed, and in point of fact both must be so classed in numerous instances. The cause of the recent gruesome list of accidents is not to be sought in the increased speeds alone, nor in a marked increase of personal carelessness, but in the combination of high speed, involving new conditions of control, with lack of proper skill or care on the part of the operators. As has often been pointed out the fast driving tough in a buggy has been responsible for many accidents and has often exceeded the legal rate of speed, but the same chap in a forty-mile-an-hour "Red Devil" has vastly greater opportunities in both directions and has improved them with an assiduity worthy of a better object. Moreover, his new resource has very largely increased the proportion of killed among his victims. The electric car likewise has, in careless hands or through various chances for which the motorman may or may not be responsible, a long list of accidents to its discredit as the horse car had before it, but the ordinary tram car is one thing and the fast interurban car is quite another when it comes to the question of adequate control. The result is painfully manifest in increased frequency and severity of collisions, and the present summer has started out as a record breaker in this particular.

These accidents, if accidents they can be called when reckless operation is the cause, occur in spite of undeniably better safety precautions than in the past, and an enquiry into their cause and into possible remedies is certainly pertinent.

The ostensible causes are very various, but when gone carefully over and classified they simmer down to one exceedingly simple proposition, *viz.*, the car was not under the control that its speed and the proximity of possible obstacles demanded. The actual cause of this lack of control may be various; in rare—very rare—instances the brakes fail through a definite fault; more commonly they fail because they have not been properly tested and inspected; the motorman may have been coasting recklessly or may have been racing up to a blind curve in the opinion that nothing could be beyond it. In the writer's opinion, however, these collisions occur generally not through sheer carelessness in inspecting or operating the equipment, but through perhaps equally culpable ignorance as to the real meaning of proper control. Most fast interurban cars are kept in first-class operating order, supplied with good brakes and manned by sober and intelligent crews, who would not wittingly take what they believed to be long chances.

But not one motorman in twenty fully realizes the length of the dangerous space in front of his car or knows from experience what actual space is required for stopping the car at the various speeds at which he is wonted to run. Until this knowledge is generally disseminated and acted upon the present epidemic of collisions will continue. The dangerous space of a car is the distance required at any speed for stopping after the brakes are set. This distance obviously increases with the speed and weight of the car and with any unfavorable condition of the track, and it is mainly the increased speed and weight that are responsible for the added dangers that have come with modern fast interurban cars. The actual length of the dangerous space under service conditions is so much greater than is popularly supposed that collisions can and do occur when the motormen believe themselves entirely safe. After the wreck there is a complaint that the brakes did not hold, whereas the fact is that they did hold all that could reasonably be expected, but were simply incapable of the task set before them.

In an Institute paper read last year by Mr. J. D. Keiley may be found a valuable summary of results in braking modern electric cars that ought to be read by every street railway man in the country from the presidents down to the motormen. The experiments related to a modern car weighing about eighteen tons and fitted successively with various brakes, the operating speeds being about twelve to eighteen miles per hour. At the latter speed the space required for stopping varied from 101 feet with the best attainable power brake to 205 feet with a first-class hand brake worked for all it was worth. The track was in good condition, the brakes were in perfect order and the stops were emergency stops, using all the pressure possible without skidding. Adding to these distances fifty per cent to make safe allowance for unfavorable conditions of track or apparatus, and it at once becomes evident that to take an average car at this speed the dangerous space ranges from about fifty yards to over 100 yards; the former with power brakes, the latter with hand brakes. And it should be added that under these conditions the average power brake would show a dangerous space nearer seventy-five yards than fifty. These are actual experimental results not likely to be bettered appreciably. At higher speeds, which are often reached on interurban lines, the dangerous space is likely to be 100 yards or more.

Now the application of these figures is obvious. If on an interurban line running such cars on a single track, an approaching car looms up through the fog or around a curve a couple of hundred feet ahead, a collision is practically inevitable, and unless the motormen act with great promptness and judgment it is likely to be a serious one. It is useless to charge up such an occurrence to the brakes being out of order, for they are simply incapable of doing the work set for them. The only way to safety, aside from an absolute block system, which is very hard to apply to a long interurban line, is reducing the speed at all points and times when there is not clear and visible track ahead to the extent of double the danger space. On double-track roads and as respects other vehicles the full danger space of clear track will ensure safety. Unless such an allowance of space is made the

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car is not under control for the purposes of public safety, and should be considered as running negligently. Once the idea of dangerous space is fully grasped the avoidance of collisions and other accidents becomes relatively simple. No one blames a motorman who runs with due caution and keeps his car under proper control, but in order to do this he must understand what it means. On the other hand, the public is not without its increased responsibilities. It should understand that what was ample leeway in crossing a car track ten years ago is to-day taking desperate chances, and should govern itself accordingly. A car running at even fifteen miles per hour covers twenty-two feet per second, and is likely to require nearly forty yards for a stop. Increased speed has come as the result of a general demand, and is an important factor in the comfort of urban life. The real question is the safe limit of speed when the cars share the roadway with other vehicles. Questions of right of way are comparatively simple, because the electric car is confined to a track that all may see and avoid. And as to the actual speed permissible, it is likely with present conditions that the common limit of fifteen miles per hour on public roads is not far from right. That is, any considerable increase above that maximum is likely to involve considerable added danger. But whatever the nominal limit of speed the important thing is that the motorman should know his dangerous space and keep his car under control accordingly. Demands for high speed will resolve themselves into practically requiring a separate right of way, already common on fast interurban lines.

Speed questions concerning the automobile are very much more troublesome. The automobile has far less dangerous space, based on braking capacity, than the electric car, and it also can readily turn out for other vehicles. On the other hand, it has generally far greater capacity for speed and is run at higher speed in far more dangerous circumstances. The writer firmly believes that the automobile has come to stay and that it should be fairly treated and given reasonable encouragement. Nevertheless, it is only too obvious that it is often operated so recklessly that it is a grave menace to other occupants of the highways. A legal speed limit is fixed for automobiles, but everybody knows that most such vehicles are deliberately intended for far higher speeds and run above the legal limit customarily and intentionally. Furthermore, in careful hands they can do this safely and without inconvenience to anybody. A skilfully handled machine at twenty or twenty-five miles an hour is far less dangerous than one in reckless hands at half such speed, but unhappily the careful handling is frequently at the lower speed and the criminal recklessness at the higher.

The whole question of safe automobile speeds resolves itself into eliminating the person who drives his auto or causes it to be driven with impudent and brutal disregard of the rights of other travelers. The occupant of the Red Devil has just as much and no more privilege on the highway than Weary Raggles plodding along toward the next township. As a class, Mr. Raggles has far more rights, for he can outvote his more speedy fellow traveler ten to one. It is altogether impudent for the latter to bluster and demand the right to butt the former into the ditch. In solemn fact, the entire contingent who owns or habitually rides in automobiles is and will be for a long time to come so minute a fraction of the population that its collective rights are utterly inconsequential in the public welfare. And of this small fraction only a small number have to be considered in relation to speed. Nine automobilists out of ten intend to be law-abiding, to pay due regard to the rights of their fellows, and to behave in all respects like the decent citizens that they are. It is the tenth man who blatantly denounces all regulations as outrageous, runs at full speed through crowded streets, laughs and puts on more speed when a horse bolts, and skips the town when he runs down a pedestrian. In point of fact, he has no more "right" to careen through the highways than he would have to insist on rifle shooting in the public parks.

And the task before the community is to restrain this tenth man without needlessly inconveniencing the other nine. Speed limits, as at present administered, are utterly farcical. If low enough to remove the real and serious danger it is so low as to rob the automobile of the properties that will ultimately render it most valuable. As generally constituted, the limits are so low that they are frequently passed in complete innocence, and the usual plan of police traps to catch the offenders generally gets the wrong men. No speed limit can be properly enforced as generally managed, since no man without using a stop watch can definitely state whether the speed was a quarter mile above or below the limit.

There is just one way in which a speed limit can be enforced—by absolutely forbidding the use on public highways of motor vehicles capable of operating above the limit on level ground, under penalty of permanent forfeiture of license and fine if necessary. The maximum speed of a vehicle can be tested before licensing, and reexamined if there is reason to suspect fraud. This would be drastic but effective, and it is "up to" the law-abiding majority of automobilists to see that it is made unnecessary.

It is utterly silly to prate about the spirit of the times demanding more liberal speeds, and to cite electric cars as justification. The fast automobile is not a common carrier nor a public convenience. It is and is likely to remain a private vehicle used for pleasure by a few tenths of a per cent of the population. The automobile as a practical working vehicle for ordinary purposes will involve no serious speed questions. A speed limit of fifteen miles an hour, enforced, as just noted, would probably be actually a good thing for the progress of the art, tending to the development of useful vehicles capable of running long distances under load, and eliminating most of the objectionable characters who would abandon the sport if kept to moderate speed.

From the standpoint of public safety, one of the most serious matters is the insuring of automobilists by casualty companies against damages resulting from killing or injuring their fellow travelers. If this practice continues the risks even at moderate speeds will be greatly increased. It comes as near to putting a premium on criminal carelessness as anything well can. The only proper rejoinder is to make a special criminal statute to cover injuries inflicted by vehicles of all sorts due to carelessness of the driver or his master if a cooccupant of the vehicle. A moderate term in the penitentiary for a few offenders would settle the present difficulties more speedily than anything else, and the average jury can be trusted to convict the criminally reckless and release the innocent. Fines are worse than useless against the offenders, particularly if insured, but imprisonment would not be a nice thing to contemplate. A proper statute of this sort would render a speed limit almost needless, or at least would allow a much higher limit than at present without increasing the danger of accidents. Finally, there ought to be a statute settling a proper rule of the road for vehicles of various sorts, based on the same sort of common-sense requirements as the marine rules in universal use. Our present rules fail in not including the contingencies arising from enormous differences of speed, weight and general managing ability. The automobile is a menace to safety only when recklessly used and regulations concerning it should be aimed at recklessness, and not made to inflict petty annoyances on the law-abiding.

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Preliminary Report of the Electric Light and Power Plants of the United States for the Year Ending June 30, 1902.

The following report has been received from the United States Census Office, Division of Manufacturers:

DEPARTMENT OF COMMERCE AND LABOR,
BUREAU OF THE CENSUS.

WASHINGTON, D. C., August 3, 1903.

HON. S. N. D. NORTH,
Director of the Census.

SIR—I have the honor to make the following preliminary report on the electric light and power plants of the United States for the year ending June 30, 1902. This report includes central stations only. It does not include isolated plants, plants operated by electric railway companies or plants that were idle or in course of construction.

The final report will contain an analysis of the above totals and present detailed statistics by states and for other phases of the industry. The statistics for this industry at the census of 1890 were confined to the state of New York, the city of St. Louis, and the District of Columbia, therefore no comparison can be made with the totals for the United States.

Very respectfully,
W. M. STEWART,
Chief Statistician for Manufacturers.

Approved:
S. N. D. NORTH,
Director.

CENTRAL ELECTRIC LIGHT AND POWER PLANTS.

	Total.	Private.	Municipal.
Number of establishments	3,619	2,804	815
Cost of plants	$502,181,511	$480,161,038	$22,020,473
EARNINGS FROM OPERATION.			
Total	93,585,410	76,748,554	6,836,856
From light service	69,731,931	62,983,068	6,748,863
Arc lighting	25,459,437	22,070,192	3,389,245
Commercial or private	8,443,280	8,203,114	240,166
Public	17,016,157	13,867,078	3,149,079
Incandescent lighting	44,272,494	40,912,876	3,359,618
Commercial or private	41,536,392	38,668,096	2,868,296
Public	2,736,102	2,244,780	491,322
All other electrical service	18,853,479	13,765,486	87,993
Income from all other service	1,560,013	1,481,764	128,249
Gross income	85,145 423	78,180,318	6,965,105
EXPENSES.			
Total	67,688,075	62,442,088	5,245,987
Salaries and wages	20,551,989	18,672,267	1,879 722
Supplies and materials	22,814,758	20,392,467	2,422,291
Rent of stations and offices	1,285,540	1,270,798	14,748
Taxes	2,654 065	2 643,945	10,120
Insurance	896,445	820,804	65,641
Miscellaneous	6,994,227	6,645,567	348,660
Interest on bonds	12,501,045	11,996,240	504,805
POWER-PLANT EQUIPMENT.			
Steam engines.			
Number	5 921	4,861	1,060
Horse-power	1,377,041	1,230,023	147 018
Water-wheels.			
Number	1,378	1,296	82
Horse-power	381,134	369,916	11,218
(1) Estimated value if paid for at prevailing rates.			
GENERATING PLANT.			
Dynamos.			
Direct-current, constant voltage. Number	3,820	3,402	418
Horse-power	441,621	418,088	23,534
Direct-current, constant amperage. Number	3,537	2,955	582
Horse-power	195,481	157,668	37,763
Alternating and polyphase current. Number	5,106	4,284	822
Horse-power	978,428	887,740	90,688
OUTPUT OF STATION.			
Kilowatt-hours, total for year	2,437,218,732	2,241,314,293	195,904,439
LINE CONSTRUCTION.			
Miles of mains and feeders	12,470,494	10,936,603	1,533,891
LIGHTING SERVICE.			
Arc lamps.			
Total number	385,208	334,413	50,795
Commercial or private	173,502	167,709	5,793
Public	211,706	166,704	45,002
Incandescent lamps.			
Total number	18,006,521	16,429,060	1,577,461
Commercial or private	17,552,756	16,058,111	1,494,645
Public	453,765	370,949	82,816
AVERAGE NUMBER OF EMPLOYES AND TOTAL SALARIES AND WAGES.			
Salaried officials and clerks	6,976	6,026	950
Salaries	$5,632,880	$5,175,499	$457,381
Wage earners	25,258	20,791	2,467
Wages	$14,919,109	$13,496,768	$1,422,341
Foreman and inspectors	1,560	1,478	82
Wages	$1,358,272	$1,297,585	$60,687
Engineers and firemen	8,020	6,671	1,349
Wages	$5,201,988	$4,416,929	$785,059
Linemen	4,209	3,860	349
Wages	$2,704,529	$2,503,957	$200,572
All other employés	9,469	8,782	687
Wages	$5,654,330	$5,278,297	$376,023

Position and Protection of the Third Rail on Electric Railways.

At the recent engineering conference held in London, a paper was read by Mr. William E. Langdon on the "Position and Protection of the Third Rail on Electric Railways." By the third rail is here meant the rail carrying the current to the motors, and it is pointed out that there is a tendency now to add a fourth or return rail in order to avoid the use of the track rails as conductors. The author thought that the time had now arrived when surface lines of railway and lines of ordinary construction for steam haulage have to be considered in relation to their operation by electricity. It was very important that some decision should be reached as to the position of the conductor rail. In England there appears to be no uniformity in practice, but this may be accounted for by the fact that there electrically driven railways have been mainly confined to underground routes.

While there is no absolute necessity for protecting the return rail, for the third or conducting rail protection is desirable and has in some cases been provided. This protection consists generally of a vertically arranged plank on one or both sides of the rail, but this affords no protection from weather and but an imperfect protection against accidental contact. As climatic conditions will be found to give more trouble than accidents, it would appear desirable that the most complete protection should be provided for. A cover should be installed, extending so far beyond a vertical line drawn from the edge of the rail as would prevent a person standing against it or an implement placed against it from touching the conductor. The two important questions presented were, first, the distance which should supervene between the near wheel rail and the conductor, and, second, whether the sleepers which carry the wheel rails should be used for the conductor rails. It is probable that the first of these questions will be determined only after experience of the climatic effects.

In respect to the second question, it should be borne in mind that the permanent way must be constantly patrolled and that packing and drainage of the sleepers are essentially an every-day occurrence, that renewals of sleepers and rails, etc., must be provided for, that when laying out stores for any of these works the outside of the line is almost invariably used, and that this side is also used by persons walking the line. These conditions, it is thought, suggest the propriety of confining the conductor rails to the space between the tracks and dissociating them entirely from the sleepers which carry the wheel rails.

Where a fourth rail is used, this would necessitate the provision within the same space for the return rail, but these might be placed upon the same structure as the conductor rails. This would be more complicated than placing the return rail between the track rails, but it would be more convenient for repairs to have both rails placed between the two tracks. With the rails between the tracks, some special construction would be necessary to maintain the conductor at crossings when locomotives are used, but with multiple unit trains there would be no necessity for this.

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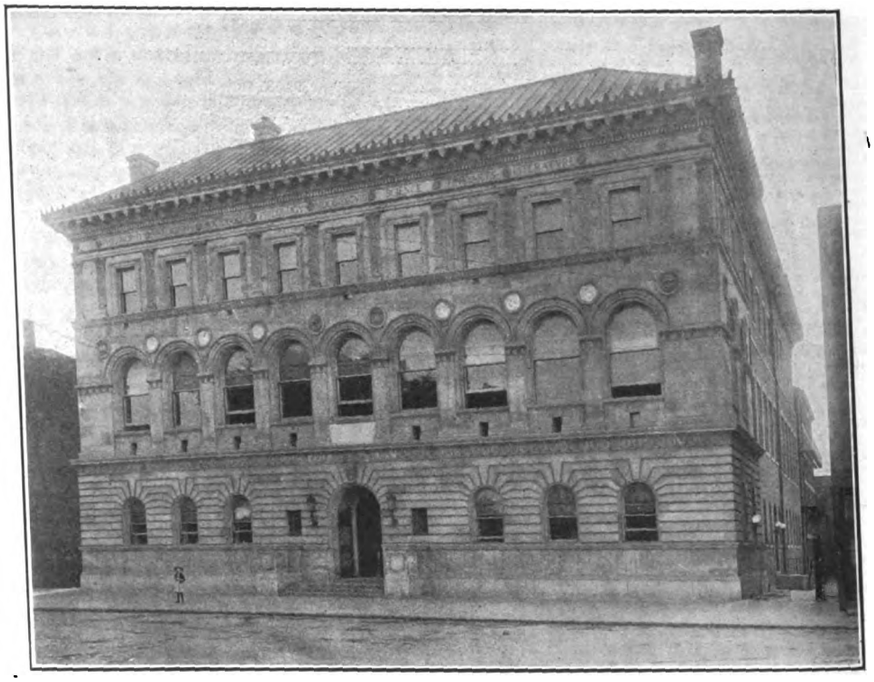
Mechanical Plant in the Newark, N. J., Free Public Library.

The buildings of the Free Public Library of Newark, N. J., are located on Washington street, near the intersection of Broad street, and occupy a site about 102 by 220 feet in extreme dimensions. The main building is four stories in height and 102 by 137 feet in area, and is constructed mainly of brick, but faced on the front and part of the sides with Indiana limestone appropriately carved with figures and names prominent in art, literature and bookmaking. The interior is more strikingly beautiful and resembles an arrangement and style now common in public and municipal buildings. The entrance vestibule at the centre of the front is executed in white Italian marble and mosaic and the central rectangular corridor into which it leads has a wainscoting of marble and a plaster frieze and ceiling decorated in color. Through the centre the corridor is open to the skylight roof, leaving hallways at each floor in the form of arcades surrounding the courtlike centre space. From floor to floor these are reached by two bronze-railed marble stairways at each side, except from the first to the second floor, where they are replaced by a single broad staircase entirely of marble rising through the middle of the corridor with its base directly in front of the main entrance and its head at the entrance of the library delivery room on the second floor. The first floor accommodates the children's library, newspaper room, toilets and janitor's room. The main features of the second floor are the delivery room, just mentioned, and a large reading room, both handsomely furnished and finished in dark oak. The third floor contains a trustees' room and a librarian's room, and the fourth floor, a lecture room and art gallery. The book stacks are in a practically detached fireproof building, which stands near one corner of the rear of the main building and is connected with it only by passageways, so that it was possible to have windows on all sides of both structures.

The buildings are lighted by direct-current arc and incandescent lamps and heated with exhaust steam by indirect radiation in connection with a plenum system of ventilation, and supplementary direct and direct-indirect radiation in the most isolated locations. A passenger elevator, five book-lifts, a plenum fan and three exhaust fans, all motor-driven, constitute the power load. The mechanical plant, including boiler and engine rooms, occupies a third separate building, located at the other rear corner of the main building, on a level with and adjoining the basement through which the pipe, duct and wire runs are carried. The boiler room is thirty-four feet long by twenty-four feet wide and is situated under the rear courtyard, so that coal may be brought in from the street and dumped through chutes to the storage bins, which are at one side of the room facing the boilers with a six-foot firing floor between. The steam-generating equipment comprises two 100-horse-power return tubular boilers set side by side with space left for a third. They were furnished by the Erie City Iron Works, are five and one-half feet in diameter by sixteen feet long, and contain five and one-half by six-foot grates. The boiler settings are arranged with firebrick flues above so as to cause the gases of combustion to pass back over the shell after passing through the tubes before being finally discharged through the brick smoke header. The latter contains a damper automatically controlled by a Kieley regulator to maintain the desired steam pressure, and connects to a rectangular brick chimney seventy-four and one-half feet high and three and one-half feet square on the inside. From a dry pipe in each boiler connection is made by a six-inch copper bend to a ten-inch steam header, which, pitching slightly downward, passes through the dividing wall into the adjoining engine room, where it terminates in a down-curving elbow, the bottom being closed with a blank flange and dripped to a steam trap. A seven-inch pipe is taken from the upper side of the main near the end to a point overhead between the engines, where through an inverted Y it divides into two five-inch pipes to supply each of the two engines.

The engines are Watts-Campbell Corliss-type, sixteen by thirty-inch horizontal side-crank, extra heavy engines, and drive two Crocker-Wheeler 100-kilowatt, direct-current, eight-pole generators by direct-connection at 120 revolutions per minute. When admitting steam at an initial pressure of eighty-five pounds, cutting off at one-quarter stroke and exhausting with a back pressure of five pounds per square inch, the engines are capable of developing 136 indicated horse-power. Speed regulation is obtained in the usual manner by altering the point of cutoff through the agency of a flyball governor and mechanism, but to avoid accident, should this one fail to work, a second governor is provided and so set that an increase in speed of ten revolutions per minute will cause the closing of a butterfly valve, cutting off the steam supply. The flywheels are ten feet in diameter, weigh 20,000 pounds and are placed between the cranks and generators.

The generators were designed for a normal load of 800 amperes at 125 volts and a safe momentary overload of forty per cent, but have proved capable of carrying even more, and for a considerable length of time. On one occasion, while only one set was running, the load was gradually increased until at 1,130 amperes, or 41 per cent overload, the engine reached its



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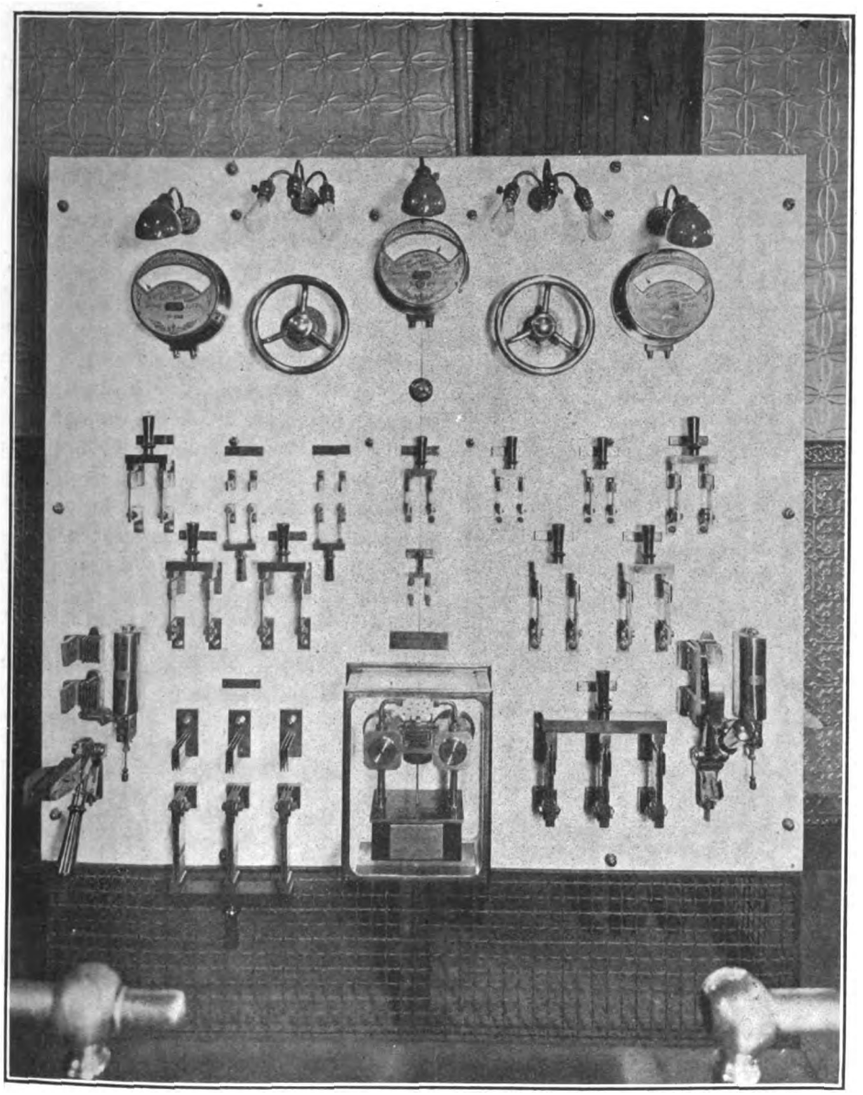
limit of power and refused to cut off. It is reported that throughout the test there was no noticeable sparking at the commutator and that at the close of it the field coils were only about thirty degrees and the brushes seven degrees warmer than the surrounding air. A total of some 2,500 sixteen-candle-power lamps constitutes the lighting load and, as previously stated, the power load includes four motors in connection with the ventilation system, five motors for book-lifts and one motor for the passenger elevator.



SWITCHBOARD, NEWARK, N. J., FREE PUBLIC LIBRARY.

Live steam from the large main is also used to supply two boiler feed pumps, a sump pump and the heating system through a pressure-reducing valve when the exhaust steam is insufficient. The pumps are located in the engine room near the boiler-room door. Those used for feeding the boilers are six by four by six-inch Barr duplex pumps, cross-connected so that they may be used interchangeably. The other is a four by four by five-inch single-acting pump, used to drain the blow-off tank to the sewer. The tank is five feet in diameter and twelve feet long and located under the coal vault.

The eight-inch exhaust connections from the engines are laid in trenches under the floor and combine with the pump exhaust into a twelve-inch overhead main, containing a grease extractor. In its cleaned state part of the steam is taken through a six-inch branch to a Webster 100-horse-power, open feed-water heater, another part through a ten-inch branch to the heating system, while the remainder, if any, escapes to the atmosphere through a ten-inch riser, after passing a back-pressure valve set at about two or three pounds. The connection to the heating system is made at a cross, one arm receiving the eight-inch live steam connection and the other two, six and eight inches, respectively, delivering into the heating mains, the former for the tempering coils in the intake of the air for ventilating and the book-stack building, and the latter for the main building.

The condensation from the heating system is collected in a six-inch main and returns by gravity over a loop-seal four feet high into the feed-water heater which thus serves the additional function of a receiving-tank. Since the heater is of the open type, it condenses within the feed all exhaust steam used for heating the latter. It is, therefore, evident that the only waste is the amount lost through the exhaust riser. This is compensated for by cold water taken from the city service and automatically admitted by a float governor, so as to maintain a minimum height of water in the heater. A similar governor causes the opening of an overflow valve, allowing the surplus to drain to the sewer if a maximum height is exceeded.

The air circulation for ventilating is established by an eight-foot Seymour disc fan driven by belt at 220 revolutions per minute by a fifteen-horse-power motor and discharging in that time between 63,000 and 65,000 cubic feet of air. The removal of the vitiated air is made positive by the use of three exhaust fans of the Seymour disc type located in the attic. One having a four-foot wheel is driven by a five-horse-power motor, and two having three-foot wheels, by three-horse-power motors. Of the motor-driven book-lifts, three will raise twenty-five pounds at the rate of 150 feet per minute, and the other two will carry 100 pounds 100 feet a minute. All are provided with electric control, whereby the cars may be brought to any floor by pushing the button corresponding thereto, if all of the doors into the shaft are closed. The opening of any one of them breaks the circuit and stops the car. The passenger elevator has a travel of about fifty-two feet and will carry a maximum load of 2,000 pounds at 200 feet per minute, or an average load of 1,200 pounds at 250 feet per minute. In addition to the customary slack-cable safety device and automatic top and bottom stops, the shaft was made tight at the bottom to afford an air cushion to catch the car in case of a failure of the other protections. After its installation the elevator was tested by loading the car with a weight of 2,000 pounds and allowing it to drop from the top of the shaft, which it did without receiving any injury.

The switchboard is about six and one-half feet wide, seven and one-half feet high and consists of two panels of white Italian marble. A single set of bus-bars on the back of the board serves for both light and power service, being connected to each generator through a single-throw, three-pole switch protected by a single-

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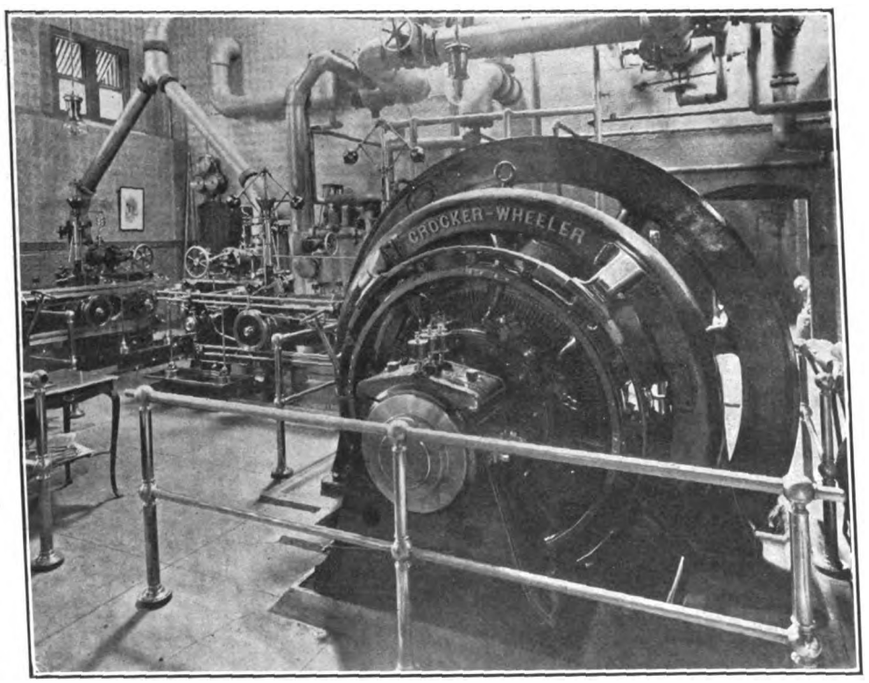
pole circuit-breaker. The instruments include two ammeters, one for each machine; a voltmeter, which by a multiple-point switch may be connected to either generator, and a recording station wattmeter. The feeder-circuit switches are symmetrically grouped on both panels between the dynamo switches and the indicating meters. Three are for power and the remainder for light. The lighting feeders are supported on porcelain knobs four feet apart and lead from the switchboard to and up the elevator shaft. These include two sets of conductors for the first floor and one set for each of the floors above. From a cutoff box near the shaft at each floor the distributing circuits are taken to the various marble panel-boards, seventeen in all. In determining the sizes of the conductors, the maximum loss of potential allowed between the switchboard and the lamps was five volts; three in the mains, one in the sub-mains and one in the distributing circuits.



ONE OF THE 100-KILOWATT, EIGHT-POLE, DIRECT-CURRENT GENERATORS, NEWARK, N. J., FREE PUBLIC LIBRARY.

The architects for the building were Messrs. Rankine & Kellogg, of Philadelphia, and Messrs. Francis Brothers & Jellett, of the same city, prepared the plans and specifications for the heating and steam work. Mr. James M. Seymour, Jr., of Newark, N. J., was the consulting engineer in behalf of the library trustees. The contractors for the various parts of the equipment were as follows: The Philadelphia Steam Heating Company for the heating system and steam pipe work; Messrs. Gillis & Geohegan, of New York, for the fans and tempering coils; the Crocker-Wheeler Company, of Ampere, N. J., for the electric generators; and Messrs. Blake & Williams, New York, for the electric wiring. Mr. George A. Warren is the operating engineer of the plant.

Commercial Vehicle Contest.

The Automobile Club of America has issued the report and awards of the commercial vehicle contest held in New York city, May 20 and 21, 1903. But eleven vehicles started in this contest and seven finished. These vehicles were all commercial machines and were run loaded. The contest lasted two days and was of such a nature as to bring out the features of the long haul as well as the short haul and by enforcing conditions simulating as nearly as possible those of actual delivery and traffic to determine the vehicles best adapted to each variety of haulage. Each machine made forty miles each day. On the first day, no stops were made, except such as the conditions of the traffic made necessary. On the second day, the vehicles made a number of specified stops, varying from five for trucks carrying 20,000 pounds dead load to 100 stops for machines carrying from 750 to 1,500 pounds dead load.

But one electrically driven machine was entered. This was a Waverley delivery wagon constructed by the Pope Motor Car Company, of Toledo, Ohio. The motor equipment consists of two three-horse-power motors, each capable of an overload of an additional three horse-power. The speed could be varied from five to twelve miles per hour. The weight of the truck and equipment was 2,420 and the dead load carried was 1,210 pounds. This machine completed the two days' run. The first day it ran forty miles carrying two passengers and the load. The actual running time was five hours and twenty-nine minutes, making an actual running speed of 7.26 miles per hour. As the machine was sent out not fully charged, it was necessary to make a stop to recharge the batteries. Twenty-four minutes were required to make connections and twenty minutes were spent in charging. There were in addition two minutes used in stops for traffic, making a total of forty-six minutes' stop and an elapsed time of six hours and fifteen minutes.

Before starting, the batteries had been charged with ten kilowatt-hours. During the noon hour, one kilowatt-hour was added and during the stop mentioned above a second kilowatt-hour, making in all twelve kilowatt-hours. At six cents per kilowatt-hour, the total cost for power was seventy-two cents, making the cost of power per ton-mile 0.0296 cent. On the second day, the machine traveled the same distance with the same load in four hours and fifty-three minutes, the actual running speed being 8.19 miles per hour. One hundred specified stops of fifteen seconds each were made and sixteen traffic stops. The total time required for this was twenty-five minutes, making the elapsed time five hours and eighteen minutes. Before starting, the batteries received a charge of ten kilowatt-hours. At the noon hour, two kilowatt-hours were added in forty-five minutes, making twelve kilowatt-hours in all, which gives the same cost per ton-mile as on the first day.

It should be noted that no allowance is made in these estimates for the condition of the battery before and after charging except voltmeter readings. On the first day, the voltage of the batteries fell from eighty volts at thirty-ampere discharge at the start to seventy-five volts at twenty-five-ampere discharge at the end of the run. On the second day, the voltage was eighty volts at a twenty-five-ampere discharge at the start and seventy-nine volts at the same rate of discharge at the end of the run. This vehicle was given the third prize in its class.

The international conference on wireless telegraph assembled in Berlin, Germany, on August 4. Italy was represented by Rear-Admiral Grillo, captain of the gunboat Bonomo, delegated by the Minister of the Marine, and MM. Cardalii, chief of the Department of Posts and Telegraphs, and Solari, lieutenant of the navy, delegated by the Minister of Posts and Telegraphs.

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POWER MEASUREMENT ON ALTERNATING-CURRENT CIRCUITS.

BY R. B. WILLIAMSON.

Power measurement on alternating-current circuits, particularly on polyphase circuits, involves the consideration of a number of features not met with in direct-current power measurements. In a direct-current circuit the power in watts is obtained by taking the product of the volts and amperes, but with alternating-current circuits this can not usually be done because of the phase difference which, in most cases, exists between the current and the electromotive force.

In Fig. 1 let the light line wave represent the electromotive force applied to a single-phase circuit or receiving device, and the heavy line wave the current that is set up by the electromotive force. The electromotive force at any instant is equal to the projection of the uniformly revolving line $o\ b$ on the vertical; $o\ b$ is supposed to revolve at the rate of n revolutions per minute in the counter-clockwise direction as indicated by the arrow. In the same way the projection of the line $o\ a$ on the vertical represents the value of the current at any instant. The lengths of $o\ b$ and $o\ a$ are laid off to scale to represent the maximum values of the electromotive force and current respectively. In one second the lines would revolve through an angular distance of $2\ \pi\ n$ radians and t seconds the angular distance moved over would be $2\ \pi\ n\ t$ radians. At the instant represented in Fig. 1 the lines $o\ a$ and $o\ b$ have revolved through the angle $2\ \pi\ n\ t$ where t is the time that has elapsed since the beginning of the cycle or revolution, when $o\ a$ and $o\ b$ coincided with the horizontal. The projection of $o\ a$ on the vertical is equal to $m\ n$, and $m\ n$ therefore represents the value of the current at the instant under consideration; $m\ p$ represents the value of the electromotive force at the same instant. For every complete revolution of $o\ a$ and $o\ b$ the electromotive force and current pass through a complete cycle of instantaneous values as represented by the sine waves and hence the number of revolutions per second n is numerically equal to the frequency of the electromotive force or current. It will be noticed that Fig. 1 is drawn for the case when $o\ a$ and $o\ b$ revolve exactly together and the two curves consequently pass through their maximum values at the same instant and pass through zero at the same instant. The electromotive force and current are in phase—a condition which would exist if the current were flowing in a circuit devoid of inductance or capacity, or in which the inductance and capacity, if present, neutralized each other.

In the case shown in Fig. 1 the current i at any instant is equal to the projection on the vertical or is equal to $\mathsf{I} \sin 2\ \pi\ n\ t$ where I is the maximum value of the current represented by $o\ b$. The electromotive force e at any instant will be $\mathsf{E} \sin 2\ \pi\ n\ t$ where E is the maximum electromotive force. Now the power supplied at any instant is found by multiplying the electromotive force at the instant by the current at the same instant. This is true no matter what phase relation the maximum values of current and electromotive force may have. We have then

instantaneous power $= e\ i = \mathsf{E} \sin 2\ \pi\ n\ t\ .\ \mathsf{I} \sin 2\ \pi\ n\ t = \mathsf{E}\ \mathsf{I} \sin^2 2\ \pi\ n\ t.$

In the great majority of cases the power at any instant is of little concern. What is required is the average power supplied and from the above we have

average power $= e\ i = \mathsf{E}\ \mathsf{I}$ av. $\sin^2 2\ \pi\ n\ t.$

From trigonometry we have $\sin^2 a + \cos^2 a = 1$, where a is any angle, and hence average $\sin^2 a +$ average $\cos^2 a = 1$. But in passing through a set of values say from 0 to 90 degrees, the sine varies from 0 to 1 and the cosine from 1 to 0. Each passes through the same set of values so that the average of the squares of all the values of the sine must be equal to the average of the squares of all the values of the cosine. Consequently we may write av. $\sin^2 a +$ av. $\cos^2 a = 2$ av. $\sin^2 a = 1$, or av. $\sin^2 a = \frac{1}{2}$ and average power $= 2\ \underline{\mathsf{E}}\ \underline{\mathsf{I}}$. Now alternating measuring instruments do not indicate the maximum values E and I of the electromotive force and current. They indicate virtual or effective values which are equal to the square root of the average of the squares of the instantaneous values. We have just seen that the instantaneous value of the electromotive force is

$e = \mathsf{E} \sin^2 \pi\ n\ t$, hence

$e^2 = \mathsf{E}^2 \sin^2 2\ \pi\ n\ t$ and

av. $e^2 = \mathsf{E}^2$ av. $\sin^2 2\ \pi\ n\ t = \frac{\mathsf{E}^2}{2}$

$\sqrt{\text{av. } e^2}$ = effective value, $\mathsf{E} = \frac{\mathsf{E}}{\sqrt{2}}$. Also effective current $\mathsf{I} = \frac{\mathsf{I}}{\sqrt{2}}$.

If we substitute these values of E and I as the expression found above for the power, we have

average power $= 2\ \mathsf{EI} = 2\ .\ \frac{\mathsf{E}}{\sqrt{2}}\ .\ \frac{\mathsf{I}}{\sqrt{2}} = \mathsf{EI}$

In other words, when the current and electromotive force are in phase the average power, in watts, can be obtained by taking the product of the voltmeter and ammeter readings as with direct current.

In Fig. 1 the ordinates of the dotted curve are proportional to the power at each instant and it will be noted that at all instants the power is positive because the power curve lies wholly above the horizontal axis. This means that, at all instants, power is being supplied to the circuit or receiving device.

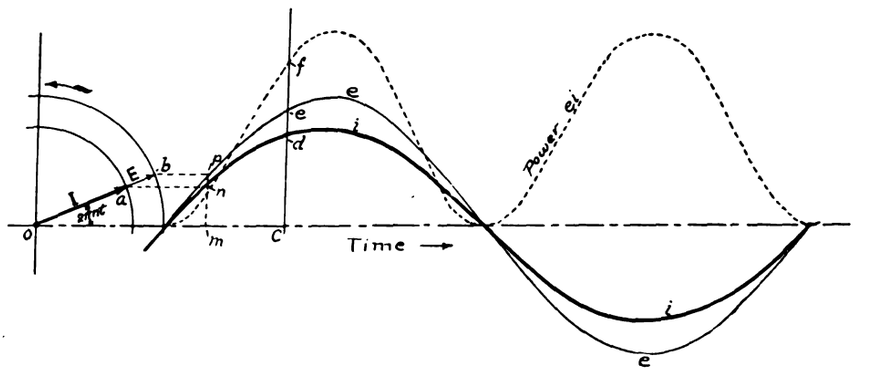

FIG. 1.—POWER MEASUREMENT ON ALTERNATING-CURRENT CIRCUITS.

In most cases the current and electromotive force will not be in phase and the phase difference between them has an important bearing on the amount of power supplied. Suppose the current $o\ a$ lags behind the electromotive force $o\ b$ by the angle ϕ indicated in Fig. 2. The corresponding current and electromotive-force waves are now represented by $i\ i$, $e\ e$ and the ordinates of the dotted wave are, as before, proportional to the product of e and i at each instant. Lines $o\ a$ and $o\ b$ revolve at the uniform rate of n revolutions per second, but $o\ a$ always lags behind $o\ b$ by the fixed angle of lag ϕ. Now, on account of the phase displacement between the current and electromotive-force waves, it is easily seen that at certain instants the current and electromotive force are opposed to each other. For example, at the instant represented by point g, the current $g\ h$ is positive while the electromotive force $g\ l$ is negative. The product of the two, *i. e.*, the

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power, is therefore negative. The portions of the power curve represented by the shaded areas are negative, as during these intervals power is being returned by the circuit or receiving device and the actual energy supplied is the difference between the positive and negative areas between the power curve and the horizontal. It is easily seen, then, that when the current and electromotive force differ in phase, the power can not be obtained by taking the product of the current and electromotive force. A factor must be introduced which will take account of this phase difference; this can be obtained as follows:

Let $e = \mathbf{E} \sin 2\pi n t$ represent the electromotive force at any instant in Fig. 2, then the current at the same instant will be $i = \mathbf{I} \sin (2\pi n t - \phi)$. The instantaneous power $= e\,i = \mathbf{E}\,\mathbf{I} \sin 2\pi n t \cdot \sin (2\pi n t - \phi)$, $\mathbf{E}$ and $\mathbf{I}$ being the maximum values of the electromotive force and current as before. Now $\sin (2\pi n t - \phi) = \sin 2\pi n t \cdot \cos\phi - \cos 2\pi n t \cdot \sin\phi$, and hence $e\,i = \mathbf{E}\,\mathbf{I} \sin^2 2\pi n t \cdot \cos\phi - \mathbf{E}\,\mathbf{I} \sin 2\pi n t \cdot \cos 2\pi n t \cdot \sin\phi$, and average of values of instantaneous power = average $e\,i =$

$$\mathbf{E}\,\mathbf{I} \cos\phi \text{ av. } \sin^2 2\pi n t - \mathbf{E}\,\mathbf{I} \sin\phi \text{ av. } \sin 2\pi n t \cdot \cos 2\pi n t.$$

Now the average value of $\sin 2\pi n t \cdot \cos 2\pi n t$ is zero because it passes through positive and negative values alike, consequently

$$\text{average power} = \mathbf{E}\,\mathbf{I} \cos\phi \text{ av. } \sin^2 2\pi n t,$$

but $\mathbf{E} = \sqrt{2}\,\mathrm{E}$ and $\mathbf{I} = \sqrt{2}\,\mathrm{I}$, when E and I are the volts and amperes (square root of mean square values), as indicated by the measuring instruments. The average value of $\sin^2 2\pi n t$ is $\frac{1}{2}$, hence

$$\text{average power} = \sqrt{2}\,\mathbf{E}\ \sqrt{2}\,\mathbf{I} \cos\phi \cdot \frac{1}{2} = \mathrm{EI} \cos\phi.$$

Or in a single-phase alternating-current circuit, the average power supplied is obtained by multiplying the product of the volts and amperes by the cosine of the angle of phase difference between the current and electromotive force. In passing, it may be noted that in a single-phase circuit the power pulsates with a frequency double that of the current or electromotive force, as is easily seen by referring to Figs. 1 and 2. The product EI is the number of volt-amperes or apparent watts found by multiplying the instrument readings together. Hence, in order to get the actual watts expended it is necessary to multiply the apparent watts by $\cos\phi$. This factor is called the power-factor of the receiving device or circuit, and is best defined by the relation

$$\text{power-factor} = \frac{\text{actual watts}}{\text{apparent watts}}$$

From the above it is seen that the power-factor is, in single-phase circuits, numerically equal to the cosine of the angle of phase difference between current and electromotive force. Evidently the power-factor becomes equal to unity when the electromotive force and current are in phase and it can never have a value greater than unity. Later on it will be seen that the quantity $\cos\phi$ as applied to a multiphase circuit is somewhat indefinite because the angle ϕ may have a different value in each of the phases of a system and it is therefore best to define the power-factor as the ratio of the true or actual watts to the apparent watts or volt-amperes, or as the factor by which the apparent watts must be multiplied to give the true watts. Since average power $= \mathrm{EI} \cos\phi$ it is easily seen that when the angle of lag becomes ninety degrees, $\cos\phi = 0$ and the power delivered becomes zero, even though there may be a considerable current flowing under a high impressed electromotive force. In this case the current is wattless, and in a figure similar to Fig. 2 the shaded areas of the power which come below the horizontal would become equal to those above. If ϕ should be more than ninety degrees, $\cos\phi$ becomes negative, thus making the power negative and indicating that power is being returned from the receiving device.

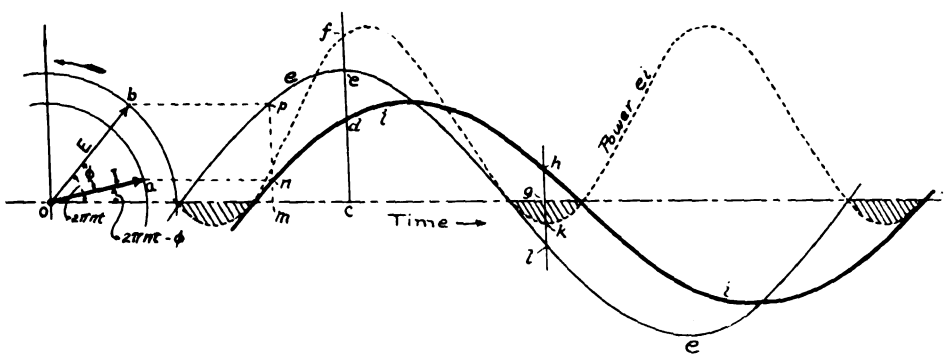

FIG. 2.—POWER MEASUREMENT ON ALTERNATING-CURRENT CIRCUITS.

Having glanced briefly at some of the points affecting the determination of power in alternating-current circuits, let us consider a few of the more important methods of making power measurements. In doing so wattmeter methods alone will be taken up. It has just been shown that the phase difference between current and electromotive force has an important bearing on the amount of power, hence it is desirable to use an instrument which will take account of this phase difference. A wattmeter does this and hence wattmeters are used almost exclusively for alternating-current power measurements. Methods have been devised for making such measurements by means of ammeters and voltmeters, but these methods are awkward, are liable to introduce large errors, involve more or less calculation, and are now seldom used.

The wattmeter is a modification of the Siemens dynamometer. It consists of a fixed current coil of a few turns of heavy conductor through which the current supplied to the receiving circuit flows. Inside of the current coil is suspended a fine wire coil which, in series with a non-inductive protective resistance, is connected across the circuit. When currents flow in the coils the swinging coil tends to arrange itself with its plane in the plane of the fixed coil. This movement is counteracted by suitable springs. The current in the swinging coil is proportional to the voltage, while the current in the main coil is equal or proportional to the current in the circuit. Now a given deflection of the movable coil depends upon a certain average or constant force action between the coils. For example, in Fig. 3 let a represent the potential coil in series with which is the protective resistance r, b is the fixed current coil and $c\ c$ the circuit in which the power is expended. If e is the instantaneous value of the electromotive force applied to $c\ c$, then the current through the fine wire coil is $\frac{e}{r}$ assuming that the inductance and resistance of a are negligible. The corresponding instantaneous current in b will be i. The instantaneous force action or torque exerted between a and b will be proportional to the product of the two currents or will be $k \cdot \frac{e}{r} \cdot i$ and the average force which produces the deflection will be $\frac{k}{r}$. average $e\,i$ where k is a constant. But average $e\,i$ is the average power expended in the circuit, and the wattmeter will indicate the power expended no matter what the power-factor may be, because

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its deflection is the average result of all the instantaneous force actions of the current and electromotive force, and the relative values of the current and electromotive force at each instant depend upon the phase relation. A wattmeter will not give accurate indications unless the current in the potential circuit *a r* is in phase with the applied electromotive force, but in good wattmeters the resistance of the potential circuit is so great as compared with its reactance that the angle of lag is very small and the indications of the wattmeter are practically correct.

If in Fig. 3 the power-factor of the receiving circuit were zero, *i. e.*, angle of lag ninety degrees, the circuit would return just as much energy as was given to it. The current would be wattless and in Fig. 2 the negative areas of the power curve below the horizontal would become equal to those above. The average torque action on the swinging coil of the wattmeter would therefore be zero and no deflection would result. This is as it should

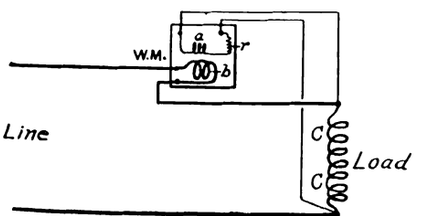

FIG. 3.—POWER MEASUREMENT ON ALTERNATING-CURRENT CIRCUITS.

be, because EI cos $\phi = 0$ and no power is expended. If the lag between the currents in *a* and *b*, Fig. 3, should become greater than ninety degrees, the coil of the wattmeter would reverse its deflection, and in order to get a deflection over the scale of the instrument it would be necessary to reverse the connections of one of the coils. The reading so obtained should therefore be considered as negative because the flow of energy is back toward the supply circuit. This action of the wattmeter should be kept in mind as it will be referred to later in connection with three-phase measurements.

POWER MEASUREMENT ON SINGLE-PHASE CIRCUITS.

The measurement of power on single-phase circuits calls for little comment. The wattmeter is connected as shown in Fig. 3, and for a given current will give its maximum reading when the power-factor of the load is one. If the power-factor becomes zero the wattmeter reading also becomes zero. If the angle of lag becomes greater than ninety degrees the resultant flow of energy reverses and the wattmeter reading also reverses. However, on single-phase circuits this reversal would not occur under ordinary conditions.

(To be continued.)

Ferrosilicon in France.

Consul-General Robert P. Skinner, at Marseilles, France, has made the following report on the status of ferrosilicon in France. This report has been made at the request of the *Iron Trade Review*, of Cleveland, Ohio. A paper read by M. Albert Keller before the Iron and Steel Institute in London, has also been appended:

Ferrosilicon manufactured by electrical process is now being shipped regularly in commercial and rapidly increasing quantities from France to the United States. It is being forwarded both from Grenoble, the shipping point nearest the place of manufacture, and Marseilles. During the year ended June 30, 1903, the exports from Marseilles amounted in value to $33,242, as compared with $196 in 1892, and there are evidences of an increasing demand and capacity to supply that demand. The concerns principally interested as manufacturers in this enterprise are the Compagnie Electrothermique Keller, Leleux & Company, 3 Rue Vignon, Paris (works at Livret-et-Gavet, Isère); the Compagnie Générale de l'Electro-Chine, Bozel, Savoie, and the Société Electro-Chimique de la Romonche, Livret-et-Gavet, Isère. The rapid development of this industry has been enveloped in all the mystery compatible with the marketing of the product. The shipments of the material are made by middlemen, who, not unreasonably, desire to retain as their own property such facts as may be called trade secrets.

In the French Alps the work of damming streams for the generation of electricity has been going on for about four years with feverish activity, and a region hitherto without important manufacturing enterprises bids fair to become a great producing centre. The engineers in charge feel that they have within their grasp a knowledge of electrometallurgy which must sooner or later free the country from its dependence on coal.

The first satisfactory discussion of the subject of ferrosilicon in France was made in May before the Iron and Steel Institute in London by M. Albert Keller. M. Keller is a graduate of the National School of Arts and Crafts at Angers, and under his direction electrical power has been installed in twelve electrometallurgical works. He has devised improvements in the manufacture of carbide of calcium, and has invented a process for the electrical treatment of iron ore and iron and steel waste. It will be surprising, indeed, if, with full knowledge of the work being done in France, the United States remains long behind in the competition for supremacy in the adaptation of electricity to metallurgical furnaces. M. Keller's paper follows:

THE ELECTROMETALLURGY OF SILICON.

Silicon, on account of its character as a thermal, chemical and mechanical agent in the metallurgy of iron and steel, forms as much a part of the groundwork of metallurgy as manganese, and with the commencement of the manufacture of ferrosilicon in the electric furnace the latter may be said to have achieved its entry into the domain of metallurgy, in which the success of its application has deservedly secured a lasting place for it. It had as a rival the blast furnace, in which ferrosilicon containing ten to fifteen per cent could be blown without difficulty when working very hot, notwithstanding which fact the electric furnace could readily enter into competition with it owing to the higher temperature attainable. The electric furnace, even when working at moderate temperatures, can produce without difficulty alloys richer in silicon than those yielded by any blast furnace, and it was by these means that ferrosilicon containing from twenty-five to eighty per cent silicon was first brought out.

The process of finding a market for the ferrosilicon manufactured in the electric furnace was at first rather slow. The products as supplied at the beginning were very impure, so that even the most favorably disposed users were at first discouraged. Taking into consideration, moreover, that the introduction of any new system or product is, generally speaking, always a matter of extreme difficulty, it will not be surprising to learn that in the past three years it was only during the last one that the advantages of high-grade ferrosilicon began to be appreciated. The use of it has now, however, so far extended that at the present time thirty and fifty per cent ferrosilicons are commonly employed in foundries and steel works; and it may be said that in competing with low-grade ferrosilicon the only question is now one of comparative economy, since metallurgists naturally prefer the product which provides them with silicon at the cheapest rate per unit delivered at their works, not omitting, however, to take into account the value of the iron contained in the alloy. That the electro-ferrosilicon can compete successfully with blast-furnace ferrosilicon is proved by the simple fact that the sale of the former of these products has now assumed very considerable proportions.

Formerly high-grade ferrosilicons la-

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bored under various disadvantages, partly on account of their lower density and of the ease with which they were oxidized in the bath of metal compared to ten or fifteen per cent ferrosilicon, and partly on account of the fact that their melting point differs slightly from that of the low-grade alloy.

ADVANTAGES OF HIGH-GRADE FERROSILICON.

In enumerating the following advantages attending the use of high-grade ferrosilicon, the author entertains no doubt that a discussion will prove highly useful in bringing to light new points of interest bearing upon its application in the manufacture of iron and steel.

1. Purity—The degree of purity attainable in the electric furnace in making high-grade ferrosilicon is particularly noteworthy. In fact, generally speaking, the higher the content of silicon in the alloy the greater is its purity. This will be readily understood when it is considered that the increased percentage is obtained by using a larger quantity of silica and of reducing carbon without increasing the iron, the latter being just that constituent which introduces all the impurities subsequently found in the alloy. Besides this, for two given qualities of ferrosilicon, one containing twelve per cent and the other fifty per cent silicon, and each containing an equal amount of impurities, the percentage of impurities introduced into the bath of metal per unit of silicon is four times less in the case of the rich alloy than in that of the poor one. Finally, the manufacture of high-grade ferrosilicon necessitates a more powerful and prolonged calorific action, which aids the expulsion of impurities, either by volatilization or by secondary reactions.

The following is the current analysis obtained by the author for fifty per cent ferrosilicon:

Phosphorus	0.02
Sulphur	Trace.
Carbon	Trace.

2. Economic Advantages—In the manufacture of high-grade ferrosilicon on a large scale, the higher the proportion of silicon in the product the lower is the cost of production per unit of silicon. This is explained by the fact that the iron, which is the most important item influencing the cost price of low-grade alloys, becomes of much less account in the case of a high grade, the chief constituent being then the silicon, which is very cheap. Again, in adding ferrosilicon to a bath of metal, the cooling effect is proportionally less the smaller the mass to be added, which is a further argument in favor of the high-grade alloy. It is probable that in view of the increasing favor with which metallurgists regard the use of high-grade ferrosilcon, the time is at hand when silicon will be employed in no other form than that of the rich alloy, in the same manner as manganese is now used.

The question then arises: Is it possible, in substituting high-grade ferrosilicon for the poorer alloy, to meet the entire demand for silicon; or, in other words, (*a*) can the electric furnace attain an output sufficient to meet the whole demand? or, (*b*) can the electric process of manufacture sustain a successful rivalry against the blast furnace with regard to the price of production per unit of silicon?

To these questions the obvious answer is that if the present consumption exceeds the amount now manufactured by thermo-electric methods, this new industry is nevertheless susceptible of such rapid extension that it would soon be able to secure the whole market for silicon by lowering considerably the present current market value. In demonstration of this, it may be stated that the results of working have shown that the energy required for the production of one ton of thirty per cent ferrosilicon amounts to 3,500 kilowatt-hours. A hydroelectric works developing 10,000 effective horse-power upon the shaft of the turbines would therefore be capable of producing 16,000 tons of thirty per cent ferrosilicon annually, or nearly thirty tons per day. These figures are well within the range of possibilities, seeing that even now in Europe, and notably in France, several hydroelectric stations are in existence of a higher aggregate power than the above.

The works at Livet, in the Department of Isère, where the thermo-electric firm of Keller, Leleux & Company, is engaged in the manufacture of high-grade ferrosilicon by its own processes, have an available source of 15,000 horse-power. The author has recently inaugurated the process of manufacture at Livet which the same company formerly carried on at a smaller works, and he has found that with 4,000 horse-power applied to this particular process it is possible to turn out twenty tons of thirty per cent ferrosilicon per day. The works are also equally well adapted for manufacturing higher grades than this, and with the existing apparatus any required percentage in the product is obtainable. Up to the present time the highest grades which have been made contain seventy-five to eighty per cent silicon.

THE MANUFACTURE OF FERROSILICON BY ELECTRICITY.

The manufacture of ferrosilicon can only be carried on with real economy in a large installation consisting of powerful electric furnaces. Those at the Livet works are of 650 horse-power each. The raw material employed are preferably quartz, scrap iron and coke. Quartz is more suitable than sand, since the latter is often productive of obstructions in the furnace. Scrap iron and steel are to be preferred to iron ore, for the reason that, together with a pure quartz, the working proceeds without the formation of any appreciable quantity of slag. The purity of the product depends, therefore, entirely upon the care bestowed on the equipment of the works. The furnaces employed are of the resistance type.

The author does not propose to discuss here the details governing the cost of production of ferrosilicon in the electric furnace, but he can confidently predict that the lower selling price will shortly secure for the ferrosilicon produced by the electric method a preponderance in the market.

As the use of high-grade ferrosilicon becomes more general, the demand for electro-ferrosilicon will increase; for, as already mentioned, the cost of production per unit of silicon is lower the higher the content of silicon in the finished product. For the manufacture of one ton of ten to fifteen per cent ferrosilicon in the blast furnace, as much as three tons of coke are requisite, owing to the hot working and to the refractory nature of the slags. The process is thereby at once rendered too costly to compete on a large scale with the electrically produced ferrosilicon. If the additional cost of transport per unit of silicon in the case of alloys poor in silicon is considered, it may be concluded that the use of rich ferrosilicon is likely to be adopted, if solely for reasons of economy. The future of the electric furnace as applied to the metallurgical preparation of this alloy is therefore assured beyond question, and, for the reasons above mentioned, the development of the industry is likely to assume considerable proportions at no distant date.

Cheap Electric Light for Berlin.

An article in the *Frankfurter Zeitung* recently states that, commencing on January 1, 1904, the price of electric light in Berlin will be reduced twenty-seven per cent—from fifty-five pfennigs to forty pfennigs (13.1 cents to 9.5 cents) per kilowatt-hour—and that the price for electric light in Berlin will then be cheaper than in any other large city. This reduction was made to compete with gas-light.

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Electrical Installation of the City of Brussels, Belgium.

The Character of the Work Necessary to Keep Up with the Growth of the City and Consequent Demand for Increased Service.

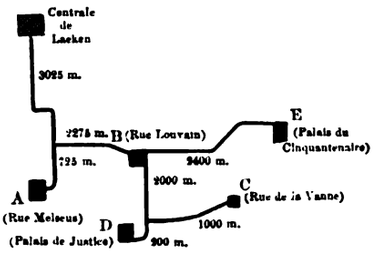
By Enrico Bignami.

IF there ever was an electrical installation which on account of adaptations and conditions which have been found necessary without ever having a radical transformation present great complexity, it is, without doubt, that of the city of Brussels. Even recently, when the necessity arose for a large new central station, instead of beginning that when the time was ripe, recourse was made to a number of complicated expedients in order to supply the demands for a few years in spite of the constant increase in the demands for electrical energy for power and lighting.

These expedients, although they only retard the final solution and can only suffice in a precarious manner, yet will repay the trouble of description on account of their ingenuity and because they can be adopted with good results in the whole solution.

It should be noted that last year before these were adopted there were three stations and there are still three feeding the distributing system of the city of Brussels, a system relatively very extended, as it has a total length of 340 kilometres of cable.

When the necessary extensions to the distributing system which these stations feed have been made, their capacities will have to be 2,400, 1,350 and 170 kilowatts, respectively. At the commencement of the last year the first station A had an output of 2,775 kilowatts, to which should be added an accumulator with a capacity of 675 kilowatts during a three-hour discharge. The second station B had an output of 620 kilowatts and in addition a

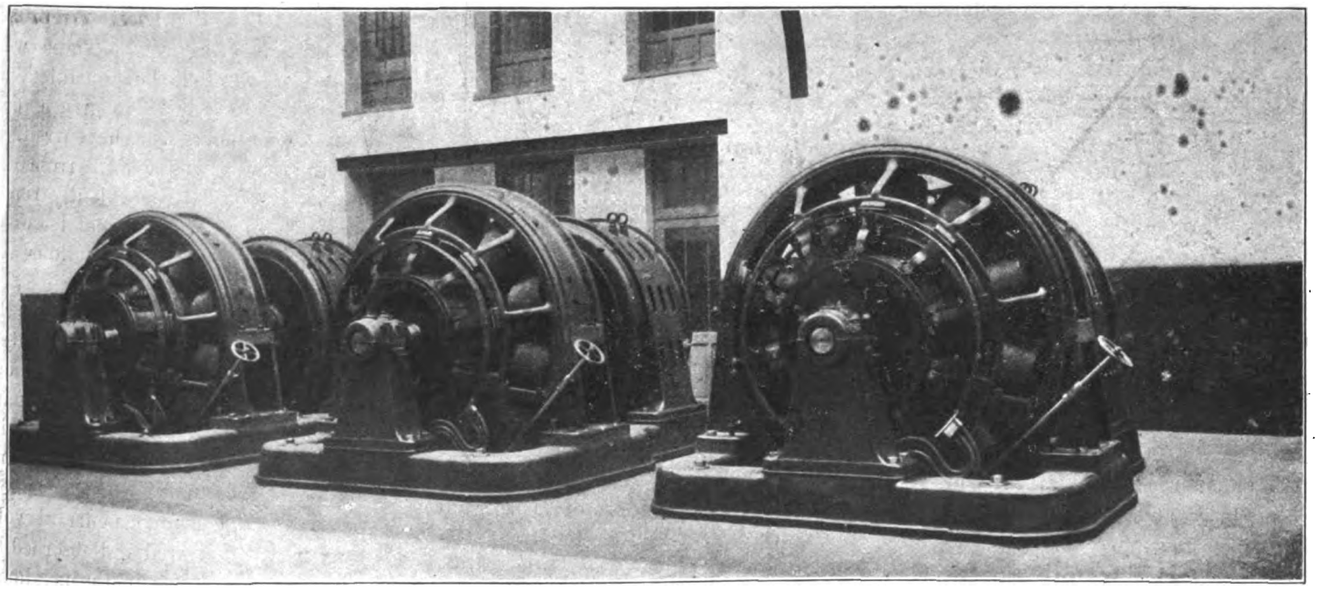


battery with an output of ninety kilowatts. The third station C had an output of 135 kilowatts with a battery of about thirty-five kilowatts during a three-hour discharge. The output of the stations was at that time about 3,450 kilowatts, 710 kilowatts, 170 kilowatts, so that the aggregate power was sufficient for the needs of the complete system, but the relative conditions of available space in the different stations had gradually brought about a division of power which could not in the end be satisfactory. For this reason it has already been necessary to transmit power from station A to station B by means of continuous currents at 260 volts.

With this condition of affairs, it became necessary to consider the effects of inevitable extensions to the distributing system. In order to provide for immediate needs a steam engine with an output of 1,000 horse-power and a dynamo of 675 kilowatts were ordered to reenforce station A, which station still had sufficient space to accommodate it, and it was proposed to resort to an arrangement capable of increasing considerably the available output of station B by a method more satisfactory than the transmission by direct currents. This station is greatly confined and already completely occupied by gas engines.

Experts were called in and they declared that the only satisfactory solution would be the construction of a single new station equipped in such a way as to provide for all future needs of the distributing system. This should be erected without the city before the winter of 1904. To provide provisionally for the lack of the present stations, they recommended the adoption of an arrangement which could be used entirely in the future and which involved no other new expense than the setting up of the third 1,000-horse-power engine, which had already been decided upon in station A. This machine is efficient and can be used with superheated steam and it will be installed later on in the new station; the continuous-current dynamo being replaced by a 675-kilowatt generator.

To reenforce station B it was proposed that motor-generators be installed. These are composed each of a three-phase synchronous motor receiving current at a



675-KILOWATT MOTOR-GENERATORS, SHOWING DIRECT-CURRENT SIDE, ELECTRICAL INSTALLATION, CITY OF BRUSSELS, BELGIUM.

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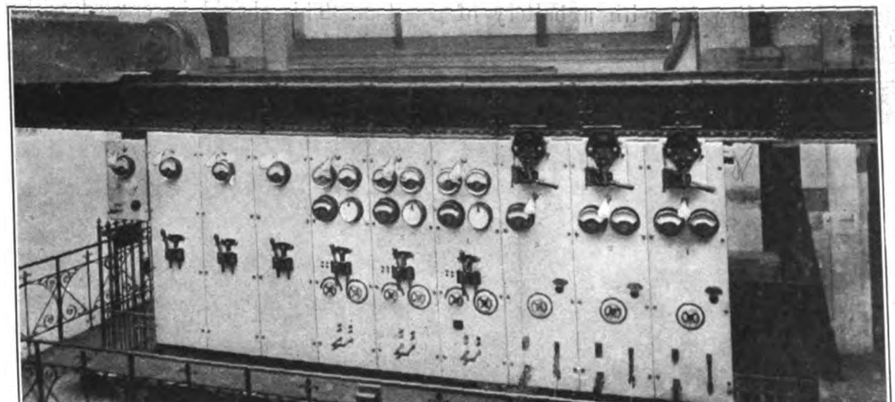
high tension from station A and a continuous-current dynamo developing low-tension current for the distributing system. Later these motor-generators will be supplied from the new station, the current being fed from station A and this will be done without necessitating any modification. In order to transmit energy from A to B three three-conductor cables with copper conductors 180 millimetres in cross-section and which are already installed will be used. These sets will take the place in station B of two gas engine groups, which themselves will be used to reenforce station C.

To provide temporarily at station A for the high-tension currents which are to feed station B and to avoid installing a new generating unit at A, two similar motor-generator units will be installed there. These units will temporarily be operated reversed, that is to say, the low-voltage dynamo fed by the continuous current produced at A will run as a motor driving the three-phase motor as a generator and supplying high-tension current to the cables running to B.



DISTRIBUTING SWITCHBOARD, FRONT VIEW, ELECTRICAL INSTALLATION OF THE CITY OF BRUSSELS, BELGIUM.

When the new station is installed, the operation of these units will be reversed, that is to say, the three-phase machines will receive current from the new station and they will operate as motors driving the continuous-current dynamos which will feed the low-tension distributing system from station A. This reversed operation can be effected without necessitating much expense. These machines eventually will be insufficient to feed the distributing system, so that it will be necessary to add a sufficient number of identical units which will take the place of the present steam units.

This advice of the experts as to the manner of meeting the difficulties of the moment was carried out effectively.

TRANSFORMERS.

The addition of a steam unit of 675 kilowatts at A and the transfer of two gas units of about eighty kilowatts each from B to C make the available output of the three stations about 4,235, 550 and 250 kilowatts each, respectively.

The possibility of transmitting 1,125 kilowatts from station A to station B will make the available output of the stations about 3,000, 1,675 and 250 kilowatts, an output sufficient to feed the three sections of the network during the winter seasons of 1903. Consequently, the installation of six groups of identical transformers each of 125 kilowatts, three of which operate the motor-generators at station A (Fig. 1) and the three-phase motors and continuous generators at station B, was called for and decided upon. To satisfy the conditions of identity of all the groups and to make it possible to reverse the operation of three of them, the two machines of each group were ordered with the same normal output of 375 kilowatts or 510 horse-power.

The order for these groups of transformers and the switchboard accompanying them was placed with the Société Anonyme L'Union Electrique, which constructed them and put them in service, complete, in but four months.

These groups are composed of a continuous-current dynamo excited in shunt with an output of 1,500 amperes at 250 volts normal load and of an alternator with an output of 43.3 amperes at 500 volts normal load. These machines are supported on three bearings on a common base and run at 375 revolutions per minute. The dynamo has six poles, the revolving field on the generator has sixteen and produces current at a frequency of sixty cycles per second.

TRANSMISSION.

Consider now under what conditions the total efficiency of transmission from station A to station B will be made. This transmission involves four transformations of energy and includes evidently losses, in addition to those taking place in the machines. That is to say, there are losses in the connections between the machine and the switchboard and in the transforming and measuring apparatus and in the line. In the actual case line losses are negligible, as the two machines are connected by three-phase high-tension cables formed of three conductors of 180 square millimetres. The losses in the connections and in the switchboard are also small.

Finally, to take account of the practical conditions of transmission, a test was made at station A, where all the connections are longer than at B, which gave the final efficiency, by a method analogous to that of Lord Rayleigh and Kapp. Continuous current was fed to the direct-current side of two transforming sets. These were connected in parallel, but operated inversely in such a way as to give a local transmission of energy. The current to supply the losses was drawn from the storage battery, and this evidently represented the total of the internal losses of the machines and in the connections and switchboard.

In this test the normal voltage of the three-phase system, 5,000, was generated, but the machines were fed by a continuous voltage of 220 volts, while the ordinary voltage of service of these machines varies practically between 228 and 232 volts, and the normal voltage by construction is 250. At this reduced continuous-current voltage the currents delivered and absorbed by the dynamos are greater in the neighborhood of thirteen per cent than the normal currents, and the losses are in consequence greater by about twenty-seven per cent to the normal loss. In addition, test was made at a frequency of about eight per cent higher than the normal.

SWITCHBOARDS.

Each of the two switchboards of stations A and B consists of nine large fixed panels, three of which are for the lines, three for the three-phase machines and three for the continuous-current machines. There is in addition a small switching panel, upon which is mounted the synchronizing apparatus.

The principle adopted in the construction of these switchboards is the separation of high-tension apparatus, so

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as this is permitted by the restrictions of space, the idea being to localize trouble. Another principle was the doing away with high-tension apparatus on the front of the board. The measuring and regulating apparatus which must be mounted on these panels is supplied by current or voltage transformers according to the nature of the apparatus.

For the purpose of separating the apparatus, seven vertical brick walls tied to the rear wall of the room, which is about 2.4 metres behind the marble panels, were constructed. Copper bars supported by insulators fixed to horizontal iron angle bars pass through the five intermediate walls, and occupy the lower part of each compartment and are separated from one another by sheets of compressed cork placed between two asbestos boards. Above these bars are the hand switches and the break switches, also separated from the bars and from themselves by similar partitions. The metallic framework forming the upper part of the switchboard is composed of seven bars passing from the angle iron surrounding the panels to the brick partitions. These bars are about 2.4 metres above the floor. On these bars are placed longitudinal iron plates. Partitions of cork and asbestos are placed vertically along the bars, separating the superstructure into compartments. Other vertical partitions placed along on the plates of iron separate the large compartments into smaller compartments. No compartment includes more than two transformers. Each of the larger compartments corresponding to one line includes the terminal of a three-phase cable, an automatic three-pole oil break switch, a hand switch and part of the high-tension bus-bars. The automatic interrupter includes two relays placed on the panels and two current transformers placed on the superstructure. Each of these main compartments at station A includes in addition a current transformer for connecting the load supplied by each line.

Each of these main compartments of the switchboard corresponding to an alternator includes the terminal of a three-phase cable going from the alternator into an automatic three-pole oil break switch, a hand switch and one section of the high-tension bus-bars. As for the lines, the automatic interrupter includes two relays placed on the panel and two transformers placed on the superstructure.

In the middle of each panel is a handle for controlling the oil break switch. These panels also support the field rheostat for its corresponding alternator. The field rheostat of the continuous dynamo is placed at a distance, and the controlling handle is coupled to that of the alternator by means of a sprocket chain.

At station A the panels corresponding to the continuous-current machines include the terminals of the cables passing from these machines, the terminals of the bus-bars and those of the cables passing to the larger switchboard of the

VIEW FROM ABOVE, SWITCHBOARD, ELECTRICAL INSTALLATION, CITY OF BRUSSELS, BELGIUM.

station. In addition there are on the negative board a shunt ammeter and a magnetic blowout circuit-breaker of the Thomson-Houston type. On the positive side there is a switch and a single-pole quick-break interrupter. In shunt with this interrupter is placed a four-point switch which serves to introduce the starting rheostat and to short-circuit sections of this successively.

REAR VIEW, SWITCHBOARD, ELECTRICAL INSTALLATION, CITY OF BRUSSELS, BELGIUM.

At station B bus-bars have been done away with, each dynamo being connected to the terminals of the accumulators and the bars previously serving to feed the exciting circuits of the alternators are connected to a fourth feeder, that on which are produced during the day the small variations of voltage at the station.

The starting rheostats are placed in the rear at some distance from the continuous-current panels, against the wall to which are fastened the brick partition walls forming the six masonry compartments. Each switchboard has six incandescent lamps, one for each panel, whether fixed or movable.

The direct-current instruments are electromagnetic, those for the alternating-current are of the hot-wire type. The phase meters are revolving field instruments.

THE SYNCHRONIZING PANEL.

This panel contains a voltmeter and a switch, to which are run conductors from the three voltage transformers. These transformers are connected in triangle and placed in the switchboard compartment for the third line. There are also two synchronizing lamps which by means of a double-pole switch and a four-pole plug switch may be connected to any set of generator voltmeter leads.

Assuming an alternator to be running at normal speed and in phase with the bus-bars, it is in condition to be connected to these. The secondaries of the two transformers give two electromotive forces which act together. The two lamps are in series with these secondaries and light up. The voltmeter is in shunt and arranged in such a way as to divide the circuit into two symmetrical parts and it stands at zero in this condition. If the speed of the alternator does not correspond to the frequency of the bus-bars, the illumination of the lamps varies. When they are quite dark the two secondary electromotive forces are in opposition and the voltmeter indicates the condition of the bars and the reflectors; that is to say, 5,000 volts. The alternators are connected in parallel on the other hand, when the two lamps burning at their brightest point show that the oscillating needle of the voltmeter stands for an instant at zero. This method is practically very safe.

By the expedients mentioned above, the administration of the city of Brussels can provide for the present needs of the city, which needs consist of 160,000 incandescent lamps, more than 1,000 arc lamps and where a number of small and moderate size stations are fed by electrical energy from one of the three stations.

The new central station which will be erected at Laecken will contain the following machinery: three 2,000-horse-power engines and the three 1,000-horse-power engines now in station A, these will be coupled to alternators with an output of 1,500 and 750 kilo-volt-amperes, respectively. There will also be two 200-

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kilowatt exciters and a suitable battery equipment.

In addition there will be required at station A four motor-generators with an output of 750 kilowatts and a compensator with an output of 200 kilowatts; at B six motor-generators with an output of 375 kilowatts and one 100-kilowatt compensator; at C three motor-generators with an output of 100 kilowatts and one fifty-kilowatt compensator. It will also be necessary to install two new distributing centres, the one D of 300 kilowatts and the other E of 200 kilowatts. The arrangement of these is given in the accompanying diagram.

The annual increase of the maximum demand is computed at 380 kilowatts.

The electric tramways at B possess at present two stations, one on Rue Braguiez and the other on Avenue de L'Hyppodrome, but before long they will operate the following new installations:

A central station at Anderlecth containing four 2,800-horse-power engines driving alternators with a frequency of twenty-five cycles and generating current at 6,600 volts, and three 100-kilowatt exciters with a small battery.

A substation at Rue Brouguiez containing five 550-kilowatt synchronous converters, a seventy-five-kilowatt starter and a small battery.

A substation on Avenue de L'Hyppodrome containing three 550-kilowatt synchronous converters and a seventy-five-kilowatt starter and a small battery.

A substation on Rue Verte is similar to the last mentioned.

The central station will contain later 1,500-kilowatt units. Brouguiez will have six or more converters, Hyppodrome and Verte six converters. These arrangements are provided for doubling in the future the equipment at the central station, giving fourteen 1,500-kilowatt units. The entire installation was made by the Union Elektricitaets Gesellschaft, of Berlin, associated with the Thomson-Houston Company. The switchboards are very interesting and were supplied by the parent company, the General Electric Company of America.

Italian Tramways.

The inspector-general of the Italian tramways has issued a report covering the year 1900. This report has been delayed by the difficulty with which information has been obtained from the various companies. At the close of December, 1900, the total length of tramways in Italy was 3,343.5 kilometres, of this 2,952.9 kilometres operated by steam and 390.6 by electricity. The electrical equipment included 1,043 motor cars and 869 trailers.

Official Automobile Blue Book.

The 1903 edition of the Official Automobile Blue Book brings this valuable guide up to date. This issue covers the states of New Hampshire, Massachusetts, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland and the District of Columbia. The states are divided into sections, and the available routes lying in these sections are carefully tabulated. Each table gives detailed information of each section of the route, the towns passed, the distances covered, the nature and condition of the road and the grades. All supply stations lying on these routes are noted in the table. Supply stations are classified so that the tourist can tell at a glance what character of work can be obtained. These tables have been compiled with great care and have been verified by local representatives. In addition to the charging stations, hotels lying along the route are listed.

As new roads are opened or changes made along old roads, bulletins are issued by the publishers of the Blue Book, which are of such size that they can be inserted in the book, keeping it always up to date and reliable.

The book also contains good indexes, reference to which enables the tourist to locate at once the route he desires to take.

In addition to the information above, the book gives a summary of the state and federal regulations of the territory covered. This book should be a valuable part of the equipment of every automobile tourist. It is edited by Mr. C. H. Gillette and published by the Official Automobile Blue Book Company, 41 West Thirty-second street, New York.

The same company also publishes five touring maps printed in three colors and covering the following districts: Lower New England, eastern New York, western New York, New Jersey and Long Island, Pennsylvania, Baltimore and Washington. When desired, these maps are furnished in a convenient case for holding and protecting them.

Production of Chromite in 1902.

The report to the United States Geological Survey on chromite for 1902, by Dr. Joseph Hyde Pratt, is now in press.

California was the only state producing any chromite during 1902, the quantity being 315 long tons, valued at $4,725. This is a decrease of fifty-three tons in quantity and of $1,065 in value as compared with the production in 1901, which was 368 long tons, valued at $5,790.

The Pacific Coast offers a promising field for the erection of a chemical plant to treat chrome ores in the manufacture of various chromium salts, as these ores can be obtained in California.

With the completion of the railroad from Erwin, Tenn., to Marion, N. C., the chromite deposits of Yancey County, N. C., will undoubtedly be thoroughly exploited and may become producers.

There is a large amount of chromite ore imported each year into this country, the most of which is from Turkey, with smaller amounts from New Caledonia and Canada. The imports of chrome ore and chromic acid in 1902 were valued at $593,712. The principal chromite deposits of Canada are in the vicinity of Black Lake and Coleraine, Quebec Province. The Canadian production for 1902 was 900 long tons, valued at $13,000.

Submarine Cables of the World.

In a recent address before the London Chamber of Congress, Mr. Charles Bright stated that the total length of submarine cables now amounts to over 200,000 nautical miles, representing a total investment of about $250,000,000. The present market value of the combined capital of these cables largely exceeds this figure. The cable construction and shipping output of Great Britain is about 100 nautical miles per day. The cost of construction may be estimated at $750 per mile and the cost of laying at about half as much. A cable carefully manufactured and laid, if the conditions of the sea bottom be favorable, should be expected to last thirty years or more. It might be kept in operation indefinitely by the successive replacement of the parts. The cost of maintenance is usually put down at from $30 to $40 per mile per annum, though there is always the possibility that heavy expenses may be called for to make repairs. Deep-sea cables have generally proved very remunerative. About 6,000,000 cable messages are now sent in a year, having increased out of all proportion to the increased mileage of the cables.

Transactions of the American Institute of Electrical Engineers.

Volume xix of the transactions of the American Institute of Electrical Engineers has been issued. This covers the period from January 1 to July 1, 1902, and contains the papers and discussions presented during that period, including the convention at Great Barrington. In spite of the fact that it was decided to publish the transactions of last year in two volumes, this volume contains over 1,200 pages and does not include the list of members, while the volume for the whole year of 1901, exclusive of the list of members, contains 956 pages. This comparison illustrates the large amount of work which the Institute accomplished under the presidency of Mr. Charles P. Steinmetz. The frontispiece to this volume is an excellent likeness of the secretary, Ralph W. Pope.

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THE CATHODE-RAY ALTERNATING-CURRENT WAVE INDICATOR.[1]

BY HARRIS J. RYAN.

(Concluded.)

I have usually adjusted this circuit so that a current of 0.2 ampere passed L'. and one ampere circulated through the resonant circuit C L'' A c_2 c_2. Thus arranged the third harmonic will be reduced to one-third compared with the fundamental in passing L'; a further reduction of one-third of the third harmonic occurs through L'' which acts as a throttle for all harmonics while the condenser passes the third harmonics with a facility measured three times as easily as for the fundamental. A further reduction factor of five to one. acting alike against the third as well as all higher harmonics is applied by the current multiplying process due to resonance. All current circulated through C L' A c_2 c_2 due to resonance must have the simple sine form so long as the saturation magneto-motive forces utilized by the iron cores are small compared with those used by the air cores in the magnetic circuit of L''. Thus it is seen that there are approximately the following factors which combine to cut out the third harmonic.

$$5 \times 3 \times 3 \times 5 = 135$$

which means that in the above circuit the value of the third harmonic compared with the fundamental circulating through c_2 c_2 has been reduced to one hundred and thirty-fifth of the original value existing in the electromotive-force wave impressed by the source upon this circuit at a' c'. Since even in very bad cases of wave distortion in electromotive-force generation the third harmonic will not exceed one-third of the magnitude, it follows that the ratio of the fundamental and third harmonic values of the current through c_2 c_2 is about four hundred. Since the higher harmonics are eliminated to a greater extent than the third it follows that the deviation of the current wave through the coils, c_2 c_2, that are to produce the standard known motion of the ray, from the cyclic variation of a true sine wave is less than one-quarter per cent, an accuracy that is ample for the purposes involved.

By means of the analytical methods published by Steinmetz, the exact degree of expurgation of irregularities in the wave of the original source is easily computed where "open" magnetic circuits employing straight cores operated at low flux densities are used in making up the inductances L' and L''.

The degree to which the above expurgation of irregularities will occur in actual operation has been examined carefully in a number of ways and found to be about as described above.

When the unknown current through M and the coils at c_1 c_1 and the sine wave current through the coils at c_2 c_2 are established at the same time, the spot of light on the screen in the cathode-ray tube is given a motion that is the resultant of two motions at right angles to each other and proportional to the instantaneous values of their corresponding currents. Owing to the persistence of vision, this results in the production of a closed card upon the screen traced by the spot of light. A record of this card may be made in various ways. I have generally used one of the two following methods:

1. The card may be easily photographed in the ordinary camera using five seconds exposure.

2. It may be traced on a smoked glass mounted in front of the tube by keeping the eye at a fixed point of view.

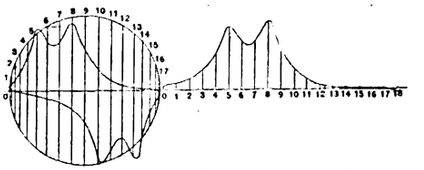

FIG. 5.—METHOD OF TRANSFERRING CARD TO RECTANGULAR COORDINATES.

I have generally preferred to record the cards by photographing them.

Ordinarily the detail of the pressure wave with respect to the current wave that is established is also desired. By means of switches S_1 S_2 and DPDT in Fig. 4, the coils at c_1 c_1 can be disconnected from the circuit a'' M c'' and connected in the circuit which draws current through a non-inductive resistance a''' R c'''. This produces a card due to the pressure wave-form impressed upon the machine or apparatus at M. Obviously, when the currents through M and R differ widely in magnitude, an extra set of coils may be mounted concentric with the coils c_1 c_1 through which to receive the current controlled by the non-inductive resistance R. Both cards may be photographed on the same plate when a true record is obtained of instantaneous values and phase relations of the unknown electromotive force and current applied at M. To enable the values to be plotted in rectangular coordinates, the axis of the standard or sine wave should also be recorded. This is easily done by removing the current from the coils c_1 c_1 and recording the line of light produced by the sine motion that remains due to the standard current in the coils c_2 c_2.

If a polyphase source is employed it is best to apply the sine wave current through the coils, c_2 c_2, from a pressure phase-changing device. This is easily and obviously arranged by means of a set of autos having a number of pressure taps or by means of a movable coil mounted in a revolving field such as is provided by every induction motor that has a wound secondary. Thus the phase position of the sine wave can be adjusted so as to cause the more intricate portions of the unknown wave-form to occur at the time when the sine wave motion is most rapid, *i. e.*, when the sine wave current is passing through zero. In this manner the resulting cards can be so adjusted as to bring out the desired detail to the fullest and clearest extent.

In a simple and obvious manner the values of the unknown wave may be taken from its card and plotted with time in rectangular coordinates. One way of doing this is illustrated in Fig. 5. A circle is drawn using the sine wave as a diameter. Upon this circle a number of equidistant points are located corresponding to the number of points to be used in plotting the wave in rectangular coordinates. Ordinates to the sine wave diameter of this circle will intercept the card at uniform time intervals. The lengths of the ordinates from the card to the diameter are proportional to corresponding instantaneous values of the wave and may be transferred without change to the rectangular diagram to form the actual wave as shown in Fig. 5.

The scale that applies to the instantaneous values is determined by comparing the effective value of the observed wave with the reading of an alternating-current ammeter placed in series with the sine wave coils, c_2 c_2. This ammeter is read at the time that the card formed by the unknown wave is recorded. The ratio between the deflections of the ray produced by the coils c_1 c_1 and c_2 c_2 is easily obtained once for all by means of observations taken with continuous currents and instruments.

The half-tone in Fig. 6 was made from a photograph of a set of cards and their axes as they were formed on the screen of the cathode-ray tube. In making these cards the method was being employed in a study of the conductivity of the atmos-

[1] A paper read at the twentieth annual convention of the American Institute of Electrical Engineers, Niagara Falls, N. Y., July 2, 1903.

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phere about a line conductor subjected to high pressure. The card LC was formed by the line-charging current and the card CC by the charging current supplied to an air condenser for the purpose of determining the electromotive-force wave impressed upon the line. The coils corresponding to c_1 c_1 in Fig. 4 in this instance contained a total of 46,000 turns which would enable cards to be formed with currents of from 0.0006 to 0.006 ampere, *i. e.*, from 0.6 to 6 milliamperes. The effective electromotive force employed was 40,000 volts at 120 cycles.

In order to use this cathode-ray instrument on high-pressure circuits some natural precautions must be taken. The tube, coils, Wimshurst machine and camera must be completely enclosed in a wire cage set upon high-pressure insulators and connected to one terminal of the high-pressure source. The branch L″ A c_2 c_2 delivering the standard sine wave from the low-pressure source must be protected by inserting an insulating transformer so as to separate with an ample dielectric the coils c_2 c_2 and the remainder of the low-pressure circuit L″ A a_1'. Such an insulating transformer is easily provided by mounting primary and secondary annular coils having a transformative ratio of 1:1 upon a straight open-circuit core and separated therefrom by a suitable space to be occupied by the dielectric and then by immersing the whole transformer in ordinary kerosene. Obviously all metallic circuits within the high-pressure cage should be rounded to it. In this manner I have found that many of the interesting atmospheric conduction phenomena that occur in high-pressure work may be studied experimentally in a satisfactory manner.

I think that this apparatus will in the future be found of use in observing the behavior of hunting currents in synchronous machinery, commutation in continuous-current machinery, the characteristic manner of current interruption produced by fuse cutouts, and circuit-breakers and electric surges on long lines.

As was shown above, it is easily applied where cyclic phenomena are to be observed. It can, however, frequently be used effectively for observing values that occur only as sudden impulses, by having the current constituting the sudden impulse through one circuit and a uniformly increasing current through another circuit occur simultaneously and arranged so as to act magnetically upon the cathode ray. A momentary trace showing the nature of the impulse is thus drawn across the fluorescent screen.

When I determined to examine into the fitness of the Braun type of cathode-ray tube for engineering research work I found that the tubes on the market were altogether too small to be of practical use. In the summer of 1900 Mr. Muller-Uhri, of Braunschweig, Germany, undertook to make for us two tubes in which the screens would be as near to six inches in diameter as he could make them. The glass work is difficult and only after a

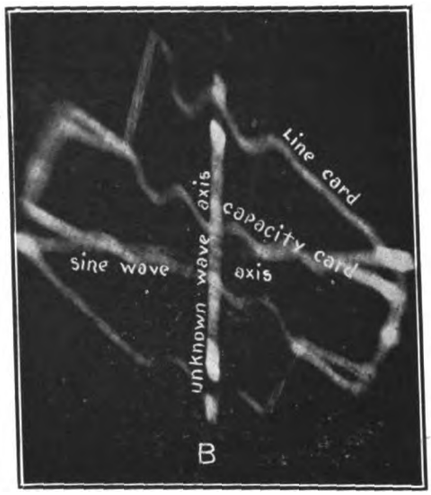

FIG. 6.—CATHODE-RAY ALTERNATING-CURRENT WAVE INDICATOR.

number of trials did he succeed in making two in which screens were five inches in diameter. These landed in my laboratory in safety. A drawing to scale of one of these tubes is given in Fig. 1.

At the outset I was greatly disappointed in the behavior of this large size of tube compared with that noted in the small tubes. The cathode ray produced by the discharge from the influence machine was intermittent and almost wholly unsatisfactory. During the next two years

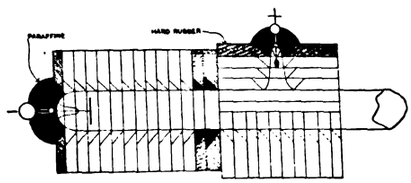

FIG. 7.—TUBE ENCLOSED WITH HARD RUBBER JACKET.

I spent such available time as I could spare in a study of the causes of this intermittent character of the ray. The trouble was finally traced to conductivity of the atmosphere that occurs at the rather high pressure that must be applied between the cathode and anode of the tube. The pressure required will spark a distance of three-eighths of an inch between three-inch balls. As soon as the real cause of the trouble was understood the remedy was easily found and applied.

To cause the formation of a continuous steady ray, therefore, it is necessary to jacket the tube at the cathode and anode portion with an ample solid dielectric. Oil for this purpose is a complete failure because it is too mobile. The best manner as yet that I have found for applying the jacket, so as to keep the air away from the immediate exterior of the electrodes, is shown in Fig. 7. The jacket is built up from quarter-inch hard rubber discs and half discs cemented to the walls of the tube with paraffin in the manner illustrated.

Such a jacket completely overcomes the unsteadiness of the ray, enabling one to operate the tube from an ordinary Wimshurst machine by connecting its cathode and anode direct to the terminals. All metal parts and connections from the Wimshurst to the tube should nowhere have a radius of less than one-eighth of an inch, *i. e.*, the conductor should be at least one-fourth of an inch in diameter.

I have found that a Wimshurst using six pairs of seventeen-inch micanite plates, driven at 200 revolutions per minute, would furnish about all the current that may be passed through the tube without puncturing. This gives a most brilliant spot of fluorescent light upon the screen. While attempting to drive more current through one of the tubes it was punctured when operating the Wimshurst at a speed of about 250 revolutions per minute. This tube will operate satisfactorily with the discharge from a Wimshurst having a single set of eighteen-inch plates. The amount of light at the spot seems to be proportional to the current discharge through the tube, and therefore to the number and size of the plates used in the construction of the Wimshurst.

Mr. Muller-Uhri is now prepared to supply these extra large tubes to the trade at an export price of about $20 at Braunschweig, Germany. The rubber jackets described above must be mounted after the tubes have been received from the maker. Doubtless in the near future some method will be found that will enable the maker to mount upon the tubes a proper and sufficient jacket before sending them out.

I wish to acknowledge the efficient and extensive assistance rendered by Professor J. O. Phelon in the early work done upon these large tubes, whereby I was ultimately able to trace the real cause of the intermittent character of the cathode ray.

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Tungsten, Molybdenum, Uranium and Vanadium in 1902.

According to the report to the United States Geographical Survey for 1902, by Dr. Joseph Hyde Pratt, the production of crude tungsten ores during 1902 amounted to 183.5 tons, of which not more than a few tons were sold. The production of 1901 was 179 tons of concentrated ore, valued at $27,720. The larger part of the production of 1902 was from Colorado, with a smaller amount from Connecticut. No new localities were developed during 1902.

Almost the entire production of commercial molybdenite was by the Crown Point Mining Company, of Seattle, Wash., from its property in the western part of Chelan County. The production amounted to about twelve tons. The value of the ores is very erratic, the prices quoted varying from $1,500 to $100 per ton.

There was a marked increase in the production of uranium and vanadium minerals in 1902, which, as reported to the Survey, amounted to 3,810 tons, valued at $18,125, or $12.63 per ton. This, of course, represents the crude ore. In 1901 the production was 375 tons of crude ore. A portion of the uranium ore was treated, giving a concentrated product of twenty-five tons, which was valued at $8,000, or $320 per ton.

Although it has been determined that these metals have beneficial effects when used in the manufacture of steel, considerable study of them is necessary before their commercial position with respect to one another or to nickel and chromium can be definitely determined. Questions came up as to which of the various irons hardened by them are best adapted for steel drills, for dies and shoes in stamp mills, for car axles, carpenters' tools, etc., as to which will retain the best cutting edge, which will heat the least when in use, and which will make the toughest iron.

Mr. A. B. Frenzel, of Denver, Col., has offered prizes at a number of the schools of mines in the United States for investigations of these ferroalloys in relation to the matters mentioned above, and they would seem to offer an inviting field for investigation by the Carnegie Institute.

Gutta-Percha in the Philippines.

A supplementary report on the gutta-percha supply in the Philippines has been made by Dr. Penoyer L. Sherman, Jr., of the Philippine Forestry Bureau. In this he describes an expedition made in search of gutta-percha trees, and confirms the belief that a considerable supply exists in the Philippines, though as yet the most valuable species of trees has not been recognized there. Explorations of large portions of the Island of Mindanao and the Islands of the Sula Archipelago resulted in the discovery of several species of trees. It is found also that the Chinese have built up a much larger trade in this product than has been indicated by the customs returns. The amount of gutta-percha which paid an export duty to the Philippine authorities during the twelve months ending June 30, 1902, was 373,331 pounds, though but 14,000 pounds were credited to the Philippines. In Mindanao, the natives say that all of the mountain regions of the south contain gutta-percha, and the explorations so far as carried confirm these statements. Dr. Sherman found gutta-percha trees, some of which were felled for him by the natives and the gum extracted by the usual methods. One tree, 160 feet in height and eight feet in circumference, yielded nine and one-half pounds of dry gutta-percha. Had the tree been ringed and precautions taken to get all of the milk, it is thought that it would have yielded twenty pounds; while, had the bark and leaves been secured, it probably would have yielded from 150 to 200 pounds. This illustrates the wasteful method of harvesting now in use. As a result of his first report, the Secretary of the Interior of the Philippines, Dr. Dean C. Worcester, asserts that at the present rate of destruction there will be no gutta-percha trees standing four years hence, and he suggests that the government take over the business with the view to regulating the supply and preventing much of the cheating which is now done by the Chinese merchants. Dr. Sherman also investigated the question of rubber resources. None was found in Mindanao, but in the Sulu Islands he saw an abundance of large rubber vines or creepers, from which the rubber is extracted by cutting them so freely that they soon die. During 1901 and 1902 the exports of gutta-percha on which the duties were paid amounted to 282,996 pounds.

Rubber Production and Trade of Brazil.

The rubber-crop year for the season of 1902-3 closed June 30 under very satisfactory conditions, says K. K. Kenneday, consul at Para, under date of July 7, 1903. Estimates and preparations are now being made for the new season just begun. The crop of 1901-2 was the largest ever produced—29,998 tons. The crop of the season just closed was 29,890, a decrease of only 108 tons, or less than one per cent. This is especially satisfactory to the trade. Of last season's crop Europe took 15,261 tons and the United States 14,566 tons, an increase in shipments to the United States over the previous year of 510 tons, while the shipments to Europe fell off correspondingly.

The product was shipped as follows:

From	To Europe. Pounds.	To United States. Pounds.
Manaos	16,619 381	18,425,657
Para	13,422,609	12,686,142
Iquitos	3,578,739	.....
Serpa	22,583	.....
Total	33,643,312	32,111,799

The stock on hand June 30 was 129 tons.

During the past year prices ruled fairly firm at good figures. The exceedingly high prices which prevailed formerly may never be restored, but producers as well as dealers find there is still a very handsome profit for them once they have accommodated themselves to the new and more healthy conditions.

Never before has so much enthusiasm been shown in the trade, and never before have so many men been employed in the business. Thousands of laborers are pouring into the forests of the interior, and thousands more will follow. New rubber fields will be opened and old ones worked with improved methods and larger forces. As an example of this the case may be quoted of one of the largest rubber producers on the Madeira, who recently informed him that he would take out this year four times as much rubber as ever before.

Business is steadily improving here. One encouraging sign of the times is the fact that several new houses are preparing to embark in the export trade. It seems safe to predict that if there are no further political troubles on the upper river, the crop of this season will be far in advance of any ever before known.

The tunnel under the Simplon Pass of the Alps is about three-quarters completed. It will be the longest tunnel in the world when finished—*viz.*, fourteen miles, or twice as long as the Mont Cenis. Ten thousand men are employed upon the work, and it is hoped that the tunnel will be ready for use in two years. A great obstacle to the prosecution of the work has been the high temperature in the centre of the bore, the men being compelled to work on short shifts, which has necessitated the employment of double gangs. The amount of water flowing out of the south end of the tunnel is fifteen thousand gallons per minute, furnishing ample power for compressing air for the drills and cooling the tunnel itself to some extent. The cost of the tunnel will be about $1,000,000 per mile.

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THE COLLIERY EXHIBITION.

BY SYDNEY F. WALKER.

What probably will be the first of a succession of annual exhibitions was held at the Agricultural Hall (Islington), London, England, from June 30 to July 7, in connection with apparatus used at collieries. It should be interesting to those who contemplate supplying electrical plant to collieries, as every kind of apparatus at a colliery, requiring power, is now driven by electricity in the most up-to-date collieries.

Electricity was very well represented indeed at the Colliery Exhibition. There were about eighty exhibitors in all, and out of these nine were of electrical apparatus. Considering the large number of apparatus of all kinds that are required for colliery working, this is creditable, indeed. Mr. Arthur Koppel, who represents in London the German firm of Balche, had a very good showing of electric locomotives specially designed for collieries, with a model electric railway, in which the German arrangement of "bow" trolley was shown enabling a locomotive to shunt without its being necessary for some one to move the trolley pole from one end of the car to the other. The "bow" trolley adjusts itself, it turns over when the locomotive or car to which it is attached reverses its direction.

Messrs. John Davis & Son, of Derby, who are the English agents for the Jeffrey Manufacturing Company, of Columbus, Ohio, had a good exhibit, including the Jeffrey long wall coal-cutting machine, the Jeffrey coal heading machine, and the Jeffrey air and electric rock drills. They also exhibited the patented safety motor which Mr. Henry Davis brought out some years since in connection with Mr. Stokes, one of H. M. inspectors of mines, in which the brushes are carried inside the commutator instead of outside. The commutator is made hollow, and the brushes rub on the inner surface of the cylinder formed by the commutator segments. This apparatus has not taken on very well. Messrs. Davis also had an exhibit of electrical apparatus suitable for mining work generally.

Messrs. Siemens Brothers had a very good exhibit, consisting of a set of enclosed motors, a rock drill, mining signals, telephones and other apparatus.

Messrs. Mavor & Coulson, of Glasgow, Scotland, who are the makers of the only bar coal-cutting machine at present in use in the United Kingdom, exhibited a sample of this machine, arranged to cut at floor level, or at any height up to that of the machine itself. Messrs. Mavor & Coulson are the advocates of the concentric system of cables for mining work, the outer to be uninsulated, but this was not exhibited.

The Nuneaton Engineering Company, maker of the heading machine known as Stanley's, in which two arms, with cutters attached to the ends of a long bar, sweep out the strata in front of the machine, making a circular hole, along which the machine passes, has adapted its apparatus for driving by electricity, and a heading machine was shown at work; that is to say, merely revolving, driven by an electric motor.

Messrs. Callender had a very good exhibit also of their cables, joint boxes, etc. The cables exhibited consisted of samples of single, two-core and three-core, and their solid system, which has been so much adopted for town lighting and power work.

The other exhibits were of great interest. Messrs. Hadfield had a good exhibit of their special steel castings, and there were exhibits of coal washing and other apparatus.

Alcohol from Acetylene.

Consul J. C. Covert, at Lyons, France, gives the following as the statement of a French chemist in regard to the manufacture of alcohol from acetylene:

Alcohol differs but very little chemically from acetylene and ethylic differs from acetylene only by an excess of hydrogen and oxygen, acetylene being composed of carbon, oxygen and hydrogen. In his first experiments Mr. Berthelet produced acetylene, then combined it with a certain quantity of hydrogen to get the ethylene, and brought sulphuric acid to act upon the latter. He thus procured sulphorinic acid, which, well watered and boiled, produced alcohol.

Mr. Covert states further that at present calcium carbide is sold in France at $29 a ton and from this can be produced 770 pounds of acetylene, which in turn will give about 211 gallons of ninety degrees alcohol. Alcohol obtained in this way will cost about fifteen cents per gallon exclusive of incidental expenses and waste. Mr. George Claude, of Paris, a specialist in this line, estimates that the cost commercially would be about twenty-six cents per gallon. Work is now being carried out to test the suitability of barium carbide instead of calcium for this purpose, but nothing positive is yet known of the value of this material as applied in this way.

Electrical Patents.

Mr. George H. Alton, of Lynn, Mass., has assigned to the General Electric Company, of New York, a patent recently granted on a bearing for electric meters. This invention relates to a bearing for a vertical shaft, and particularly to that class known as "jewel bearings" for electric meter shafts, in which it is necessary to reduce the friction as much as possible in order that the shaft will turn in response to the slightest increase or decrease of the energy or rotate at a rate exactly proportional to the energy that is being supplied. The object of the invention is to provide a durable bearing in which there will be a minimum amount of friction, the parts of which can be adjusted and locked in any position and can be removed and replaced when they become worn. As a means of reducing friction, bearings have hitherto been constructed with the shaft tapered to a fine point, so that only this point bears upon the jewel commonly used as the bearing block; but owing to the small mass of this point, as compared with the mass of the shaft, it has been difficult to get a satisfactory degree of hardness at the point, which on this account wears away quickly. In order to overcome this difficulty, the inventor sets a piece of hard-drawn steel or fine hard wire of the kind commonly known as "piano wire" in the tapered end of the shaft to form the pivot on which the shaft revolves. These pivots can be tempered before being set in the shafts, and because of their small mass can be made much harder than a tapered point on the shaft itself. Moreover, this pivot is drawn and of a fine grain, and therefore the bearing surface can be brought to a much higher polish than would be possible if the shaft were tapered off to form the bearing. As the shaft of a meter often becomes magnetized, the pivot would stick to the shaft, rendering withdrawal difficult when the pivot becomes worn in order to replace it with a new one. Mr. Alton proposes to set the pivot in a plug of non-magnetic material, such as brass having a tapered end and to screw this plug into the end of the shaft. Furthermore, he flattens a portion of the sides of this non-magnetic end-piece or forms a gripping face thereon in some other manner, so that with a tool of small cross section the end-piece and the pivot inserted therein can be withdrawn through the bottom of the meter by only removing the jewel and the screw which supports it. In this way a new pivot can be substituted for one that is worn very quickly

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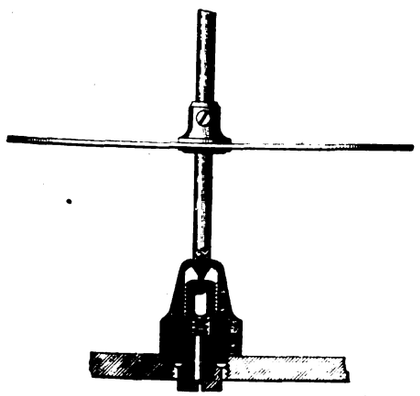
as it is not necessary to open the casing of the meter. After a meter has been in use some time the jewel becomes worn and rough and friction in the bearing increases accordingly. It is then necessary to put in a new jewel or repolish the old one. For this reason it is advantageous so to set the jewel that it can be easily removed. Jewels have commonly been rigidly set in the end of a screw or in a plug that rests on a spring within a hollow screw. In either of these cases it is necessary to destroy the screw to get the jewel out for repolishing. In the new device the jewel is set in a plug or jewel support that fits within a casing or carrier, preferably a hollow screw having a removable head, so that the jewel can be withdrawn by simply unscrewing the head, and a plug containing a new jewel can be substituted while the old one is being repolished. A clearance is also provided between the plug and its containing-shell to prevent dust or dirt from collecting

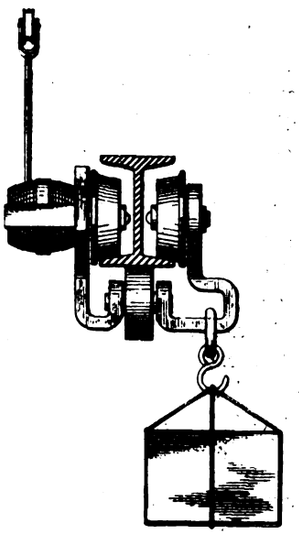


BEARING FOR ELECTRIC METERS.

about the jewel. Directly under the jewel plug and within the hollow screw is placed a spiral spring which takes up any sudden jar and protects the jewel from damage. In order to secure the proper adjustment of the bearing, the jewel is commonly mounted on a screw, as above indicated, so that the bearing can be raised or lowered to the position which allows the shaft to move most freely or to take the weight off the pivot in shipping; but Mr. Alton has found that in use the bearing of a meter frequently works up or down from the position of proper adjustment, and therefore he has provided means for locking the bearing in the desired position, thus obviating the necessity of frequent readjustment. This is accomplished by fitting the screw into an internally and externally threaded sleeve which is adjustable vertically in a threaded bore in the lower horizontal frame of the meter. The sleeve is turned in the bore until in such a position that when the head of the screw bears against its lower end the jewel bearing is in the proper position. Threaded on the sleeve and above the frame is a locking-nut, which is adapted to be screwed down until its lower end bears against the frame of the meter. Thus, movement of the screw is prevented by its head jamming against the sleeve, and movement of the sleeve is prevented by the locking-nut jamming against the frame.

An entirely new process of electroplating has been discovered and patented by Mr. Thomas A. Edison The object of the invention is to produce an adherent coating of metallic nickel or iron or steel by electrolytic deposition. The process can be carried out in connection with sheets or other blank forms, which are subsequently drawn, stamped or pressed into desired shapes, and it can also be carried out for the nickel-plating of iron and steel articles having their ultimate shape. The invention is carried into effect as follows: Iron or steel sheets or articles made from iron or steel, whether in sheet form or cast or wrought, are first electroplated with a thin coating of nickel in an ordinary electrolytic bath. The sheets or articles are then preferably piled or nested together, so as to occupy as small a space as possible, and are placed in a cast-iron chamber or clay retort, which is closely sealed. A non-oxidizing atmosphere is then created in the chamber or retort, preferably by passing hydrogen gas through the same to displace the air therein. The sheets or articles are now subjected to a temperature sufficient to weld the film of nickel to the iron or steel backing while the non-oxidizing gas is passing, after which the chamber or retort and its contents are cooled down below the oxidizing point while the articles or sheets are still surrounded by the gas, whereupon the latter may be removed and a fresh charge introduced into the chamber. The sheets or articles should be heated to a bright yellow, at which point the nickel welds to the iron or steel, so that it becomes integral with it, and at the same time the surface of the nickel becomes very bright. The weld, in fact, between the nickel and iron or steel is so perfect that sheets plated in this way can be formed into various articles by the drawing or stamping process without cracking or flaking the film, which is not the case when the film has not been subjected to the welding process. In fact, no matter how carefully sheets of iron or steel may be electroplated with nickel, any attempt to draw or stamp articles therefrom results in the cracking or flaking of the nickel coating, owing to the condition of tension of the latter, which condition is relieved by the welding process described. The welding process serves also to anneal the sheets for the first operation of drawing. It is said that nickel articles made by the process can be produced more cheaply than those made from tinned iron, since the thickness of the nickel film is very much less than the thickness of the coating on the latter articles.

Improvements are constantly being made in telphers or overhead carriages for packages. These are being employed in factories, warehouses and similar places. One of the latest improvements has been protected by a patent granted to Mr. Henry M. Harding, of New York city. It is the usual custom to have the electric motors placed on one side only of the carriage on account of the limited space



TELPHER.

in which switches and turnouts can be placed. Two motors are used coupled together and the weight of these motors would cause the carriage to tilt were not means taken to prevent this. The track is an I-beam, the motor having wheels that are beveled and engage the offset flanges of the beam. In the present case, the wheels on one side are attached to axles which constitute the motor shafts, and said wheels are secured to a stirrup which passes beneath the I-beam. A guide or friction wheel is journaled on this stirrup and runs under face of the I-beam, this friction wheel being vertically adjustable if desired. The stirrup is provided on the side opposite the motors with an offset portion extending beyond the wheel, and from this offset portion is suspended the package carrier that thus counterbalances the motors and prevents any undue strain upon the telpher,

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Reviews of Current Engineering and Scientific Literature.

Some Substation Dangers and Their Prevention.

In this communication some dangers existing in the usual substation are pointed out, and remedies suggested. One danger is that due to the sparking of the synchronous converters. This is caused largely by the lubrication on the commutator, and the author states that he has not found it necessary to lubricate the commutator if the brushes receive careful attention. The terminals of the machine should be covered to prevent contact with tools. Brush-holders should be so constructed that the brushes on the slip-rings can have their pressure regulated by an easy get-at-able screw. He has seen short-circuits occur due to the metal bolt-heads used in assembling the switchboard panels, and advises that these be enclosed in ebonite or other insulating material susceptible of a good finish. The boosters should be arranged so that when not in use they are not connected to a live circuit. Attention should be given to the construction of circuit-breakers to prevent the flying out of the carbon tips when opening. The station attendant should be cautioned against touching the voltmeters except when absolutely necessary.—*Abstracted from the Electrical Review (London).*

The Garuti Process for the Industrial Electrolysis of Water.

The industrial electrolysis of water necessitates the solution of two problems, that of reducing the electromotive force required to a minimum and the prevention of mixing of the two gases. M. M. Jottrand, in this article, describes the process developed by Garuti. In order to diminish the electromotive force, it is necessary that the electrodes be brought as close together as possible and that they must be separated by a substance, which, while impermeable to the gas, will not prevent the flow of current and the circulation of the electrolyte. To reduce the resistance of the electrolyte sulphuric acid or a caustic alkali may be used. The most satisfactory material for the diaphragm has been found to be a metal material peforated by small holes which, due to the capillary action of the electrolyte, prevent the passage of the gases. The material selected is lead if the sulphuric acid is used and iron if the caustic solution is used. The apparatus consists of a series of compartments side by side, each compartment enclosing one electrode. These are alternately positive and negative and in the upper part the alternate cells are connected together. In this way oxygen in a practically pure condition is obtained in one set of cells and hydrogen in the other. The output of the apparatus is 0.4 cubic metre of hydrogen and 0.2 cubic metre of oxygen per ampere-hour at a voltage of from 2 to 2.5. The gas obtained in this way is cheap, and this makes it suitable for a great number of operations. Sheets of metal may be welded together or welded into pipes. After welding a milder heating may be applied to leave the metal in a good condition. It is stated that copper bonds are in this way easily welded to the tramway rails, thus doing away with drilling, and that even the rails themselves may be welded together.—*Translated and abstracted from Revue de L'Electricite (Berne), July 15.*

Natural Sources of Energy.

In this article Dr. Louis Bell gives an interesting and suggestive view of our available sources of power. He lays stress upon the wasteful use of coal which is now going on. The practical problem that presents itself to the student in economics is, first, how to make the most of the fuel that remains, and second, how to supplement it so as to increase the area of the earth's surface which will remain tenable when the fuel supply fails. The first end is to be reached by deliberate and persistent efforts to increase the efficiency with which fuel is utilized. In spite of every effort of this sort, we are consuming much coal at a rate which will steadily increase, in spite of every effort and improvement. Hence, it is necessary to seek out other means for obtaining power and heat. The first recourse is to water power. Falls like Niagara are quite insignificant features of the world's total power, the bulk of which is in small falls. Every one of these, properly utilized, stops a call for fuel. All the electrical transmission yet accomplished is but a drop in the bucket. Nothing but the dire stress of rising prices of fuel will force enough capital into hydraulic plants to produce a perceptible effect. The difficulty in the use of tides is that the total rise and fall is comparatively small. In very few places would it be possible to rely on more than six feet mean working head. This means that if a storage pond were six feet and one mile square, it would store water to about 5,000 horse-power for a five-hour run. In special cases, while the rising is higher the output would be greater, thus, in the Bay of Fundy more than 200,000,000 horse-power-hours run daily to waste, but to utilize it would require an engineering feat more tremendous than anything yet attempted. The utilization of wind-power is less attractive than that of tidal-power, since the supply is erratic and variable. A possible remaining source is the heat from the sun. This is reckoned at about 10,000 horse-power per acre. From practical results it has been possible to obtain one horse-power for every 100 feet of reflector used in these solar engines, but these are only valuable where there is reasonable steady sunshine. The cost of power so obtained is estimated at about $75 per horse-power per year, including everything. There are large tracts of territory where sun-power would be available, notably in northern Africa. The author thinks eventually when the coal supply has been exhausted, migration will take place toward warmer regions, laying principally between altitudes thirty degrees north and south. Here all ordinary domestic needs are satisfied, where sunshine is available and the demands of power-using industries can be readily met, where hydraulic power is available or by solar power in the sunshine.—*Abstracted from Cassier's Magazine, August.*

A Spectrophotometric Study of the Luminous Radiation from the Nernst Lamp Glower Under Varying Current Density.

This article gives an account of an interesting study carried out by Mr. Leon W. Hartman upon the luminous regulation of the Nernst lamp glower. The Nernst lamp glower has been studied in many aspects, but this particular phase has not been touched upon. The work was carried out with a Kirchhoff spectrometer especially set up for the work and which had a Rowland plane grating substituted for the train of glass prisms. The standard source of light used was the acetylene flame burning under constant pressure in a Naphey burner. The type of Nernst lamp glower used was that for 110 volts alternating current. To convert the known values the results obtained by the use of the acetylene flame, the latter was

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compared with the Hefner-Altneck standard lamp. Results of the work are tabulated and given in a number of diagrams. The work is summarized as follows: At the normal current strength the radiation from the Nernst lamp glower is relatively rich in the more luminous waves of the spectrum, and it exhibits no marked selective radiation, its light intensity apparently increasing with age; its light is relatively less in the short, but richer in the long, waves than that from the acetylene flame, but its radiation becomes more like that from burning acetylene with increasing current strength; at current strength below the rated normal value, the increase in intensity with increasing current strength is most marked in the long waves, and above this rated normal value current strength the increase in intensity is most rapid in the short waves, at current strengths below the normal value the Nernst lamp is relatively less rich in the short waves than the flame of the Hefner lamp, while above this current strength the opposite is true; at rated normal current strength or slightly above this the color of the Nernst lamp radiation is very similar to that of the Hefner lamp. The luminous radiation from the Nernst lamp corresponds very closely to that of incandescent old lime.—*Abstracted from the Physical Review (New York), August.*

The Utilization of Furnace Gases for the Production of Electrical Energy.

During the last few years the progress made and the success of gas engines as applied to automobiles have drawn attention to this type of motor for more serious work. In this article, M. L. Drin discusses the use in gas engines of the waste gases from blast furnaces. The first practical gas engine dates from 1870. For many years their power was limited to twenty horse-power, but to-day gas engines are constructed with outputs of 4,000 and even 5,000 horse-power. At the same time that the size of these motors has been increased, tests have been made with the view to using in these engines a poorer quality of gas. Thus, in 1886, instead of illuminating gas containing from 4,500 to 5,000 calories per cubic metre, Domon gas was substituted, which contains from 1,000 to 1,500 calories per cubic metre, and this allowed the consumption of gas per horse-power-hour in machines with a capacity of 2,000 horse-power to be reduced to one-half kilogramme. The success of these machines has led to the introduction of gas engines to utilize furnace gases. This gas was formerly allowed to go to waste. More recently it has been used to heat the air for the blast and to raise steam for power purposes. This gas is poor, containing only about 1,000 calories, so that its use necessitates large engines. Generally it is necessary to cleanse the gas before use, but this is accomplished simply by passing it through one or more circulating fans where it is washed by a spray of water. This removes practically all the dust. The method of utilizing this gas in engines is discussed briefly. It is stated that builders have, in some cases, secured such a uniformity of rotation that alternators driven by their engines are now operating successfully in parallel with steam-driven units. Economy in the use of gases is considerable. For every ton of blast produced daily 2,400 cubic metres of gas are set free. This volume of gas used under boilers can develop but twelve horse-power, but if used in gas engines it will develop thirty-two horse-power, there is, therefore, available 2,000 horse-power if the daily output of the furnace is 100 tons, this is 3,500 kilowatt-hours per day, which sold at four centimes will give an income of 550,000 francs per year, sufficient to pay all expenses and yield a large profit. This application of the gas engine is being made particularly in Germany and the Grand Duchy of Luxembourg. At the latter place there is a station at Differdange, consisting of six gas engines of 600 horse-power each, and three generators of the same capacity, which generate and transmit power from the furnace to the surrounding country.—*Translated and abstracted from La Revue Practique de L'Electricite (Paris), July 20.*

The Cost of Electric Drilling.

In his annual report, Mr. J. B. Hobson, general manager of the Consolidated Cariboo Hydraulic Company at Bullion, B. C., gives some interesting figures of operating and installing electric drills. The plant is an experimental one and included four Gardner No. 15 drills with two-horse-power, 110-volt, direct-current portable motors, and one Gardner "B" drill with one and one-half horse-power, 110-volt, direct-current portable motor all complete.

The apparatus is able to drill holes eight feet deep. The cost of fuel for running drills ten hours was $2.25, lubricants for machinery thirty-five cents, and engineers' wages $4, making the total cost of power $6.60. To operate the three drills, three drillmen at $4 a day each are required, with three helpers each at $2 a day, one blacksmith at $4, one helper at $2, charcoal and lubricants ninety-five cents, making the total cost of running the three drills for ten hours $31.55.

The work done by these drills averages 312 feet of holes in ten hours. The cost of the same work performed by hand drills is stated at $91, making a saving in favor of power drills of $50.45 for the ten hours.

BOOK REVIEW.

"Electrical Influence Machines." John Gray. New York. D. Van Nostrand Company. Cloth. 296 pages. 5½ by 7 inches. 105 illustrations. Second edition. Supplied by the ELECTRICAL REVIEW at $2.00.

This book purports to bring together, in one volume, all that is useful and interesting about influence machines. The subject is treated in three parts. The first part gives an outline of the elements of static electricity in such a form as to be understood by general readers. Besides the material which is to be found in all ordinary books upon the subject, there is an admirable presentation, in popular language, of the most recent views of the electron theory, of the Zeeman effect, and of the extensive work of J. J. Thomson. The second part consists of a review of the historical development of the influence machine, commencing with the electrophorus. The works of Varley, Toepler, Holtz, Wimshurst, Kelvin and Pidgeon are described in considerable detail. The third part gives the details of construction and hints as to the care and operation of modern Holtz, Wimshurst and Voss machines. There is no description of the very excellent machines which are manufactured in the United States and no notice is taken of them except in the preface, where they are termed "only good practical modifications of the older types." As a matter of fact, these machines are far superior to those mentioned in the book. The giant Toepler, with sixty rotating plates, is mentioned, on page 38, as developing 100,000 volts. Standard American machines with ten plates, such as are commonly used in electrotherapeutics, develop as much as 600,000 volts. In the preface occurs the statement "the practical efficiency of the influence machine is only about five to ten per cent." Experiments made by the reviewer on American ten-plate machines have shown, when the electrical output was measured, an efficiency as high as twenty-seven per cent, and when one machine was run as a motor by a similar machine and when the power of the motor was measured by a strap brake, an efficiency of more than twenty per cent was found on a very humid summer's day. The book will be found of great value to those who are interested in the construction or operation of these interesting machines. There are a great number of results of fruitless experiments, made by early workers in this field, which are mentioned and which will tend to save others the expense of repetition.

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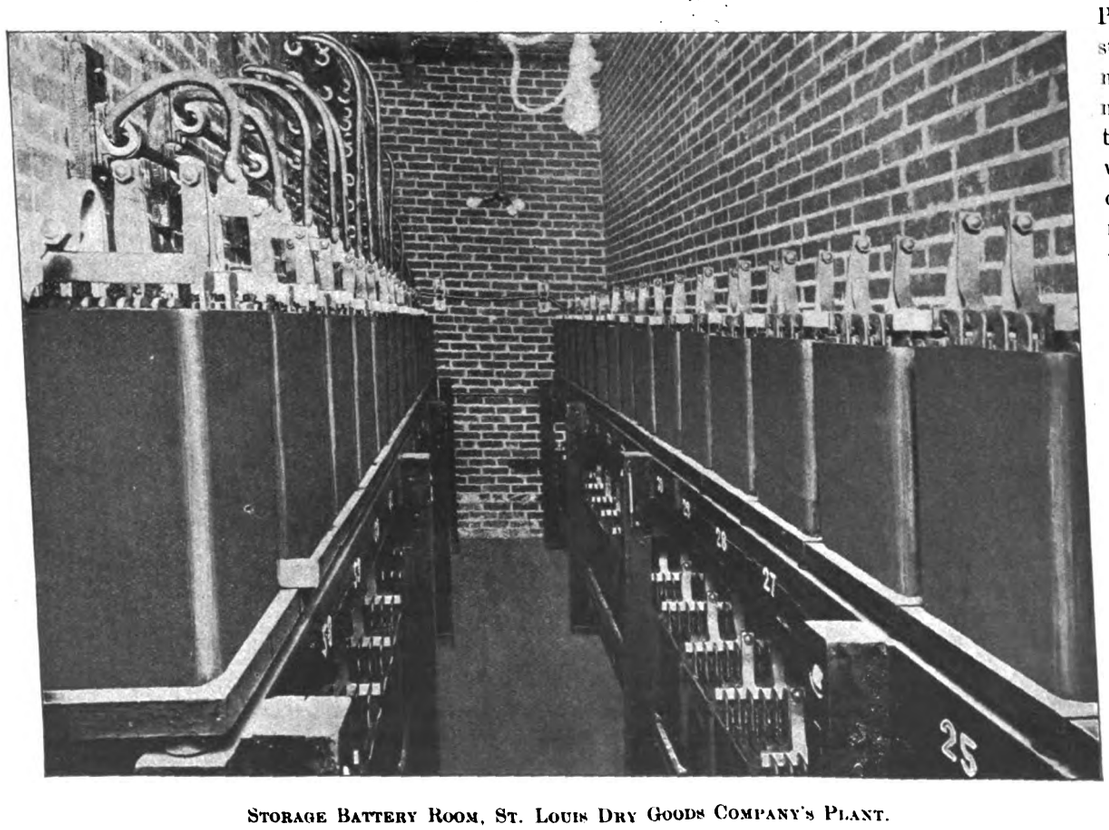
INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

The Storage Battery Equipment in a Large St. Louis Dry Goods Company's Building.

The accompanying illustration shows the storage battery room, which is an important part of the power plant installed for the Ferguson McKinney Dry Goods Company, St. Louis, Mo.

In designing this installation it was realized that the severe elevator service, particularly the starting and stopping of well loaded cars, and the returning of current to the line under certain conditions, would make it difficult to regulate the voltage and that the fluctuations in the arc and incandescent lamps would probably be serious. A storage battery was realized as a desirable addition to the installation as it would ensure uniform voltage, prevent flickering and permit the use of high-efficiency lamps. It would also enable the size of a reserve unit to be decreased and furnish a reasonable amount of light and elevator service outside of working hours, carry the regular load during short interruptions of the generating plant, give the engine more uniform and economical load, and make it unnecessary to have any gas in the building. The contract of this storage battery was filled by the Electric Storage Battery Company, of Philadelphia, consisting of a battery of seventy-two elements of the latest type of chloride accumulator, each element to contain fifteen type-F plates, to have a capacity of seventy amperes for seven hours; ninety amperes for five hours ; 130 amperes for three hours, and 280 amperes for one hour. This contract included two additional switchboard panels, with the necessary instruments and switches, consisting of voltmeters, ammeters, circuit-breakers, rheostat, end-cell switch, and a motor-booster of a capacity of 220 amperes at twenty-five volts. In the battery room there are two rows of cells on each side of the passageway, one above the other. The room is ventilated with a flue running from the south end along the ceiling.



STORAGE BATTERY ROOM, ST. LOUIS DRY GOODS COMPANY'S PLANT.

Electrical Developments in Spain.

During recent years there has been a rapid development in electric railways in Spain. The present systems include 200 English miles, distributed throughout the various provinces. There is also an active development going on in the utilization of water power. In the district of Barcelona alone there are 800 turbines with an aggregate output of 25,000 horse-power. Many towns are adopting electric lights which heretofore have been lighted by oil.

FIG. 1.—SPHERICAL COIL WATTMETER.

Switchboard Indicating Instruments.

The spherical coil wattmeter shown in Fig. 1, manufactured by the Stanley Electric Manufacturing Company, of Pittsfield, Mass., is constructed upon the dynamometer principle. A movable coil attached to the pointer is suspended within the field of a fixed coil. The fixed coil carries the main current of the circuit and through the movable coil the pressure is taken. The winding of the fixed coil is of a hollow, spherical form, from which the instrument takes its name. The movable coil and pointer are delicately suspended in jeweled bearings and their motions are dampened by an air dash-pot, making the instrument dead-beat. It is not affected by frequency or wave-form nor by inductive or leading loads of any power-factor. This instrument has a resistance of approximately thirty ohms per volt in the pressure circuit. Station instruments of 150 amperes or less capacity and for use on circuits of less than 3,000 volts have the resistance

self-contained in their cases and the total current is introduced into the fixed coil. With instruments of a greater capacity or for use on circuits of a higher voltage than this series transformers are regularly used. If instead of the instrument taking the total current through its fixed coil the series transformer is used it must be calibrated on the frequency for which it is intended, as the introduction of a series transformer makes the instrument subject to slight frequency errors.

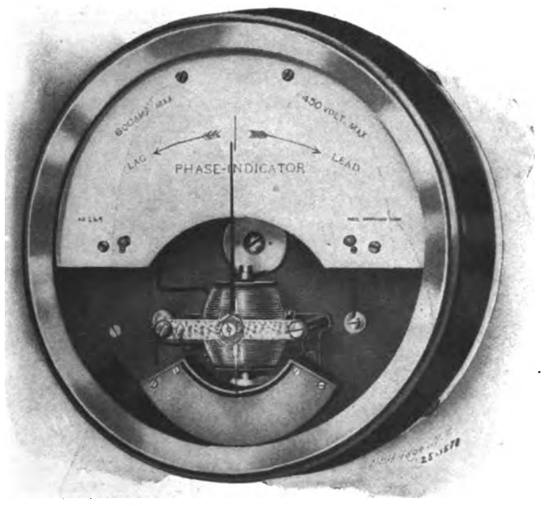


FIG. 2.—PHASE INDICATOR.

Fig. 2 shows a phase indicator manufactured by the Stanley company. This indicator gives correctly the condition of the phase relation of current and the electromotive force of its circuit. The pointer deflects to the left if the current lags behind the electromotive force, remains at zero when the current is in phase, and deflects to the right if the current leads the electromotive force. For stations where motors are being run from the same machines which supply the lighting load it is obvious that such an instrument is of great value, as by its indications the point of proper excitation of the synchronous motors is quickly and exactly determined, and the regulation of the whole system materially increased.

This phase indicating instrument is a modified spherical-coil wattmeter, having its zero in the centre. Two arrows, pointing respectively to the right and left, take the place of the wattmeter scale. The instrument depends for its action upon the principle that no force is exerted between two coils carrying currents ninety degrees apart, hence if a wattmeter is taken and a current is introduced in its fixed or series coils and through its movable or pressure coil another current is introduced differing in phase to the series current by ninety degrees the pointer will stay at zero. If, however, the current in the series coil should change its phase relation to that in the pressure coil by more than ninety degrees the pointer would deflect to the left, indicating a lag. If less than ninety degrees a deflection to the right would result, indicating a lead.

Fig. 3 shows a static ground detector made by the Stanley company. These static-current detectors are made for voltages from 600 up.

The instrument case is entirely of hard rubber moulded to the required form. Inside the case four fixed vanes are arranged around a movable vane. The movable vane is made of aluminum, is carried on a jeweled bearing and attached to the pointer. The fixed vanes are connected diagonally in pairs and each pair is charged statically by one of the line wires through the medium of a condenser. When the condensers are independent of the instrument they are generally mounted behind the switchboard. The instrument has three binding-posts, from which connection studs extend back and serve to support it on the marble. The binding-posts at the sides of each connect a pair of fixed vanes with the secondary of one of the condensers. The lower binding-post serves to connect the movable vane to the earth. The movable vane is acted upon inductively by the fixed vane so that the stress produced by each pair is equal but opposite. The movable vane in consequence takes a position equally between the fixed vane, which position is the same whether the instrument is charged or not, and the pointer stays at zero, indicating no ground.

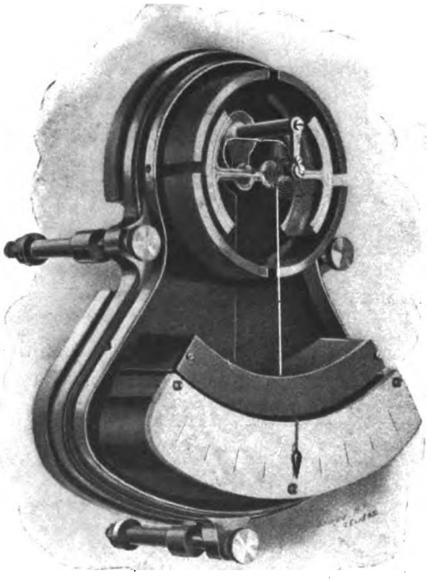


FIG. 3.—STATIC GROUND DETECTOR.

If, however, the primary plate of one of the condensers and the movable vane becomes electrically connected, as happens in the event of a ground, immediately the pair of fixed vanes which lead to that condenser assume a like polarity with the movable vane and the latter is repelled. At the same time the action of the other fixed vane is to attract. The two forces acting in the same direction, the movable vane takes a position entirely within the vanes oppositely charged to it, and the pointer takes a position indicating ground on the side of its deflection.

Fig. 4 shows the static voltmeter manufactured by this company. The movable vane is mounted on knife-edged jewels and its movement is controlled by a spring, the movable parts are carefully balanced so that slight changes from the perpendicular do not affect the readings of the instrument. The fixed vanes are imbedded in hard rubber. This covering of hard rubber confines the charge and prevents it from leaking through to the other parts of the instrument. Two fans are attached to the pointer and are enclosed in the damping boxes shown in the lower part of the illustration, making the instrument dead-beat. All the working parts are mounted on hard rubber, securing the highest insulation.

These instruments are carried in stock for use on 1,000 to 3,000-volt circuits.

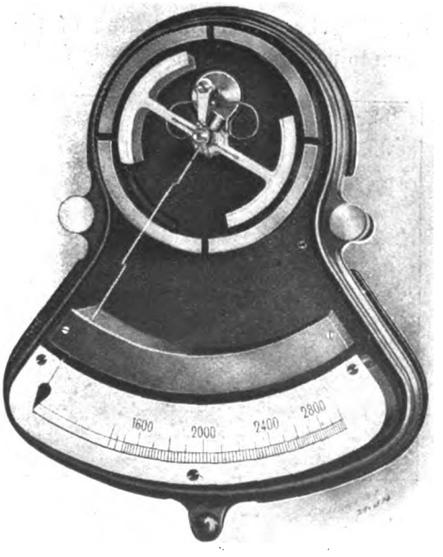


FIG. 4.—STATIC VOLTMETER.

The scale of the 1,000-volt instruments ranges from 750 to 1,400 volts, and the scale of the 3,000-volt instruments from 1,400 to 3,8000 volts.

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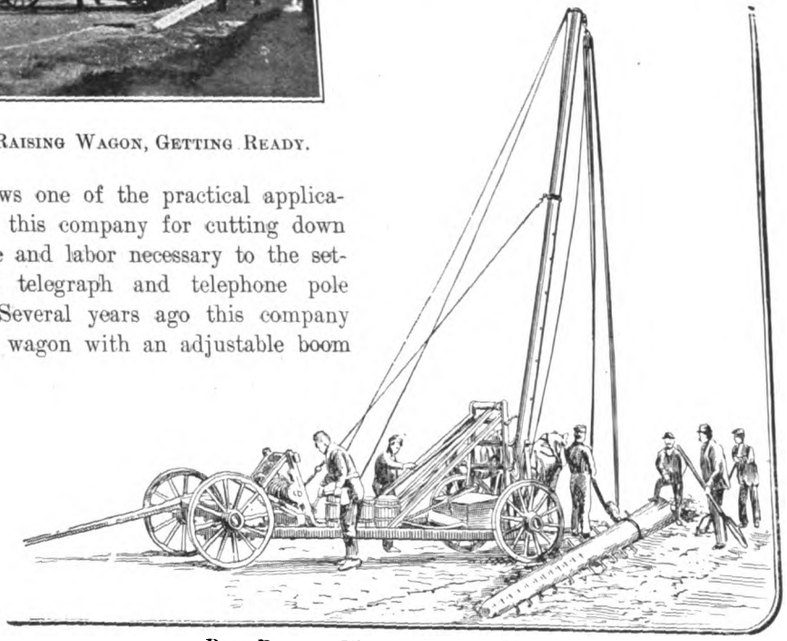
Pole-Raising Wagon and Construction Apparatus.

Messrs. W. H. Anderson & Sons, of Detroit, Mich., are the manufacturers of a line of construction tools of every description. The accompanying illustration shows one of the practical applications of this company for cutting down the time and labor necessary to the setting of telegraph and telephone pole lines. Several years ago this company fitted a wagon with an adjustable boom or derrick, by which the lifting of the poles into position would be greatly facilitated. Many improvements in the details of construction since building the first wagon have been made, and the company now furnish an apparatus which they claim is one of the best and most economical for the setting of poles. The wagon is composed of an extra heavy drop-platform truck, upon the rear of which is placed a trunnion supporting an extension arm or boom. This boom is made of steel tubing, with a hardwood spar inserted, which is so fitted that it can easily be set or extended to any desired length suitable to lift telephone and telegraph poles from thirty-five feet to seventy feet long. On the front end of the wagon is mounted a hoisting winch which operates the guy line supporting the boom, so arranged that the boom can be moved to any desired angle, even when the load is in suspension. The boom is fitted with suitable tackle, and this is so arranged that the team which hauls the wagon is used, by means of a snatch block, to raise the pole into place. It is not necessary for the team to be hitched to the wagon to move from pole to pole, for arrangements are made whereby the team is hitched to the rear end, and one of the crew taking hold of the wagon tongue steers the wagon to the desired location, while the team pulls it along.

The wagon also contains a tool box suitable for holding pole rings, steps, washers and the small tools which are always necessary to pole-raising crews.

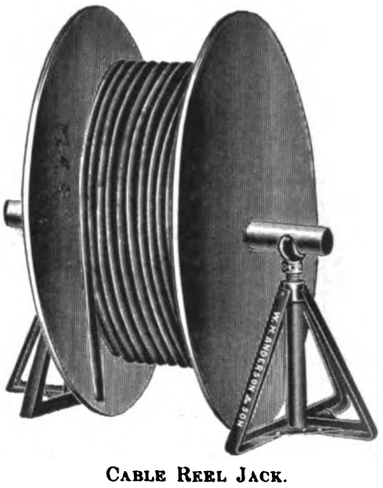
POLE-RAISING WAGON, GETTING READY.



POLE-RAISING WAGON, TAKING HOLD.

POLE-RAISING WAGON, LIFTING POLE.

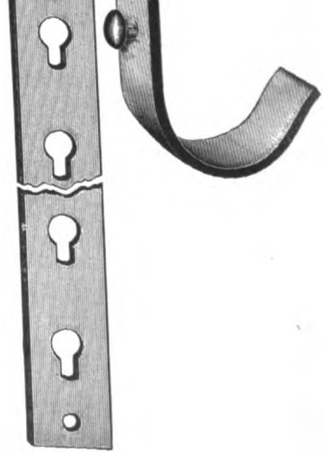
POLE-RAISING WAGON, LANDING POLE.



CABLE REEL JACK.

The cable reel jack shown in the illu tration is made in two styles, one with heavy angle iron frame and steel scre capable of handling the heaviest reels underground cable. In the other the bo is made of cast steel with a machine steel screw, capable of handling reels to four feet six inches in diameter.

The manhole cable hanger shown the accompanying illustration is of improved design, and can be easily tached to the side of the manhole to ca the cables. The strip is attached to manhole by means of an expansion at the top and bottom, and eliminates necessity of building in pieces of pip



MANHOLE CABLE HANGER.

rod. The hook is easily attached serting the button head into the h a level with the conduit in whi cable is laid. The strips are made desired length suitable for two hooks. The holes are punched th distance apart as the conduits are

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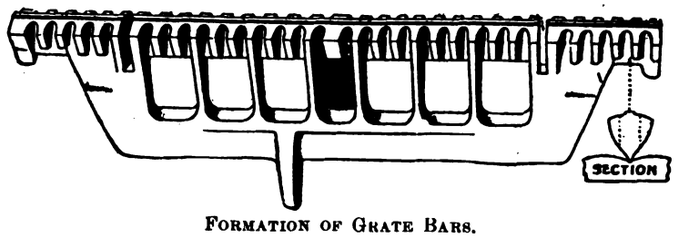
A New Form of Grate.

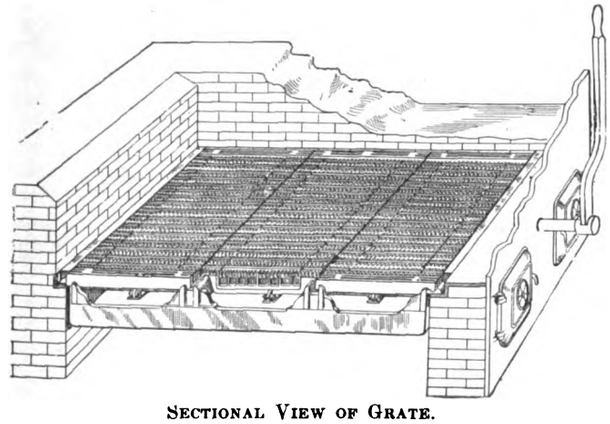
One of the most serious objections to the ordinary form of furnace grate is the difficulty which is experienced in burning any other than a high grade of fuel. A large proportion of the coal from our western mines is what is known as slack and screenings, this grade of coal not being as salable as lump or mine run is sold at a much less price per ton. The recent improvement made in grate construction and the developments in rocking or shaking grates have made a great deal of this



FORMATION OF GRATE BARS.

hitherto objectionable form of fuel quite practicable.

The Martin Grate Company has developed a form of rocking grate which is claimed to have especial merit in this direction. The grate bars extend lengthwise of the furnace and the service grate is as small as a plain grate. The grate bar is only one and one-half inches wide, including teeth, and is about five and one-half inches deep, and as they will rock in the same direction and at the same time the spaces between are not enlarged and it is not possible for a clinker to drop between and clog the grate, obviating the difficulty of leaving fingers sticking up which may be burnt off in a hot fire or presenting



SECTIONAL VIEW OF GRATE.

irregularities which might interfere with the manipulation of a slice bar.

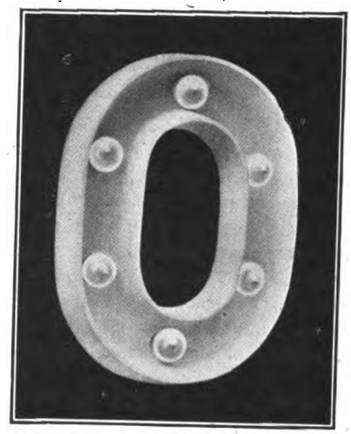
This grate is one of the heaviest on the market, weighing about eighty pounds to the square foot. The heavy part of the grate bar is quite a distance below the fire line and does not become hot. This fact, with the free circulation of air through the grate bars horizontally, and the slot at the ends, allowing for expansion and contraction, gives this grate considerable durability.

The grate bars rest like an inverted cone on the bearing bars, making the operation of the grate almost frictionless. A number of testimonials have been received by the company commendatory of the excellent service which these grates have given. The Martin Grate Company has its headquarters at 85 Van Buren street, Chicago, Ill.

An Attractive Electric Sign.

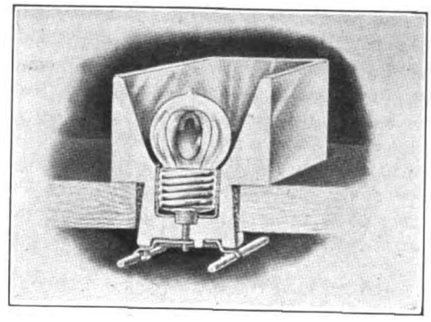
The accompanying illustrations show a form of electric sign which possesses a number of features of more than usual merit. The Colonial Sign Company, of Akron, Ohio, is the manufacturer of this apparatus and the aim in its design has been to provide an electric sign that would not blur at a distance, would retain its color, would be attractive by daylight, water-proof, and one that would not cost much to operate.

In making up these signs the letters are manufactured of a vitreous china, which takes on a brilliant hard glaze. The company is making several sizes of letters and it is its intention to build these letters up to heights reaching some ten feet. The porcelain from which these letters are made is not affected by heat, moisture or the action of electrical current. Except for the renewal of lamps the sign has an indefinite life. The letters may be shaded in any color desired, or made pure white. The colors are burned into the china and are permanent. The letters and sockets are composed of one continuous piece of porcelain and there is no material of a combustible nature used in the construction which comes anywhere near to the lamp or wiring. If these signs become dirty through exposure to the elements they can be washed. The patent for this sign covers a concave letter of such form that it will reflect the light in parallel rays, enabling the sign to be read at a great distance and at almost any angle. The design is such that it will give a high illuminating effect with



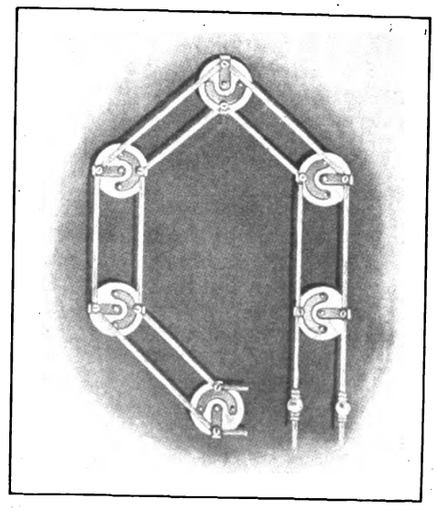
ELECTRIC SIGN LETTER.

a small amount of light, reducing the number of lamps and the candle-power of each, at the same time producing a bright, sharply defined letter.



CONSTRUCTION OF LETTER.

The Colonial Sign Company is about to occupy a large new factory at South Akron, Ohio. This will enable it to handle a largely increasing business and



WIRING OF SIGN LETTER.

give it facilities for manufacturing other specialties in this line. H. B. Camp is president of the company; G. P. Good, vice-president; C. R. Quinn, secretary; J. E. Good, treasurer, and G. D. Chapman, general manager.

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CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

ELECTRIC COMPANIES AT ALTON, ILL., TO MERGE—The Alton Railway, Gas and Electric Company, owning and controlling the Alton street railway, gas and electric plants, will have a capital stock of $1,000,000. The Alton & East Alton Railway and Power Company, owning the projected line to East Alton and all franchises pertaining thereto, is to be merged with the older company. The consolidation is for the purpose of carrying out some big projects the Alton company has on hand, including an extension of the East Alton line to East St. Louis and the building of additional electric lines in Alton.

MR. AUGUST BELMONT AFTER LONG ISLAND ELECTRIC—Negotiations are said to be under way between the Belmont syndicate which purchased the New York & Queens County Railway system, President Porter and the other Philadelphia capitalists in control of the Long Island Electric Railroad. President Porter has been over the line with the intending buyers at different times during the past week, and it is said that although the parties are $200,000 apart at present the gap will grow considerably smaller before the summer is over. The Long Island Electric line is about eight miles in length between Jamaica and Far Rockaway, five miles between Jamaica and the terminus of the Kings County Elevated Railroad at Crescent street and Liberty avenue, and three and one-half miles between Grand street, in the village of Jamaica and Queens, and work is now under way for the extension of the line over the Jamaica and Hempstead turnpike along the front of big Belmont Park race tracks, where $2,000,000 is being expended in making one of the greatest racing parks in the country.

GREAT NORTHERN POWER COMPANY, DULUTH, MINN.—Dynamos of 10,000 horse-power, with a twenty-five per cent overload, operated by water-wheels of 12,500 horse-power, is what, it is stated, the Great Northern Power Company, of Duluth, is preparing to install. Three or four of these machines will be the initial installation, to be followed by others as power consumers require, till 150,000 horse-power available is utilized. The scheme is one of the largest under way in this country, and is all ready for the contractors. Preliminary engineering work has been under way for more than two years and the plan has been inspected by many of the foremost electrical and hydraulic engineers of this country and Europe, who pronounce it simple, feasible and of great economic possibilities A fall of more than 350 feet, vertical, is secured above the wheels, by bringing the water down a steep hill in a pipe. Slight dams for storage, a canal two miles long, a steel gravity dam forty feet high, lead to the pipe. Below the waste weir are rapids and in a mile or more of distance is an additional fall of seventy feet. This will be used for direct hydraulic power by another steel dam, and several mills, requiring much water direct, will be located there. The main power plant, above, will furnish energy for many industries at Duluth, and probably for a score of iron mines on the Mesaba range. It is reported that preliminary negotiations have been in progress between the company and the United States Steel Corporation for this power for its mines. The Steel Corporation alone has twenty mines in operation on the Mesaba range, for which coal is now brought from Ohio. Electrochemical industries will also utilize this power, which is to be brought by wire into a transforming and transmitting station at Duluth. This distance is but ten miles, while to the most distant Mesaba mines it is only sixty miles from the power plant. Pulp and paper mills will use the direct hydraulic power at the lower dam. This company has been financed in Chicago and one eastern city outside New York. Its plans call for an expenditure of about $3,500,000 for the installation now contemplated, and an ultimate cost much greater. Much of the power to be developed has already been sold under long-time contracts.

PERSONAL MENTION.

MR. GEORGE P. ROUX, of Havana, Cuba, a well-known electrical engineer, is in the United States and will make his headquarters at Ardmore, Pa., for a time.

MR. E. D. NELSON, who has served as superintendent of motive power for the Pennsylvania Railroad at Williamsport, Pa., will make his headquarters at Altoona, where he will at once begin his new duties as superintendent of mechanical and electrical tests.

MR. HUGH L. COOPER, of New York, special consulting engineer of the Montreal Light, Heat and Power Company, has left for Winnipeg at the request of Messrs. Mackenzie & Maner, to superintend the installation of the plant of the Winnipeg Power Company.

PRIVY COUNCILLOR RATHENAU, one of the leading men in electrical interests in Germany and managing director of the Allegemeine Elektricitäts, of Berlin, is to visit the United States soon. He will study electrical progress here, and probably negotiate with some of our largest electrical manufacturers.

MR. J. S. BADGER, general manager of the Brisbane-Queensland electric traction system, is now in the United States, and will sail soon for England for the purpose of conferring with the directors of the Brisbane Tramways Company, Limited, which company operates the road and whose headquarters are in London. He will return to Australia *via* the States.

MR. J. A. BUCKNELL, for the past four years local agent at Jackson, Mich., for the Grand Trunk Railway, has resigned his position to take the newly created post of general freight and passenger agent of the Jackson & Battle Creek Traction Company. This company is a consolidation of the Jackson-Albion-Calhoun Railway, and the Marshall & Battle Creek Railway.

MR. CHARLES E. PHELPS, of Baltimore, Md., consulting engineer for underground work at Cleveland, Ohio, and Johnstown, Pa., is busy with plans for the underground system of subways for Montreal, Canada. Mr. Phelps has had a great deal of experience in subway work and is well qualified to equip Montreal with a first-class system of conduits. He is still in charge of the municipal subway system at Baltimore, Md., where several million feet of conduit is being installed.

MR. THOMAS M. MOORE, chief, department of machinery, World's Fair, St. Louis, Mo., is visiting the eastern states. The outlook for a most remarkable machinery exhibit is very promising and the only concern now is for to find room for all applicants. This is all the more remarkable when the extent of the space allotted to this department is realized. The foreign exhibit will be especially interesting. Lieutenant Godfrey L. Carden, R.N., who recently made an extended tour in Great Britain and the Continent in the interest of this department, is enthusiastic over the splendid spirit with which the foreign manufacturers are taking hold of the exhibit idea.

MR. WILLIAM PASTELL has resigned his position as superintendent of motive power of the Worcester Consolidated Street Railway Company, and will join the railway engineering staff of Messrs. J. G. White & Company. Mr. Pastell is one of the well-known electric railway engineers in New England, and has had wide experience in this field of engineering. He was assistant engineer to the Lynn & Boston Railroad from 1893 until 1899, when he became its chief engineer. He held this position until May, 1901, when he resigned to take the one he is just leaving in Worcester. During his two years in Worcester, Mr. Pastell has effected a great improvement in the physical condition of its railway property. Mr. Pastel is perhaps the best-posted engineer in the country on the subject of signals for electric railways.

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ELECTRIC RAILWAYS.

AUGUSTA, ME.—It is stated that an electric road will be built to connect Oakland and this city. The proposed route is eighteen miles in length.

DES MOINES, IOWA—It is reported that eastern capitalists will build an electric road from Independence to Quasqueton, at a cost of $200,000.

GRAND RAPIDS, MICH.—It is stated that an electric line is proposed to run from Grand Rapids to Muir, Hubbardston, Carson and Ionia, terminating at Crystal Lake. The cost of the road is estimated at $230,000.

PHILADELPHIA, PA.—Work has been begun on an electric railway to run from Christiansburg on the Norfolk & Western main line to the United States arsenic mines in Floyd County, Virginia, a distance of twenty miles. The road will cost $700,000.

PITTSBURG, PA.—It is stated that the Pittsburg Railways Company will build a line extending from Trafford City to Larimer, Irwin, Jeannette and Manor. The right of way has been secured and it is hoped to have the road completed by early fall.

REYNOLDSVILLE, PA.—The Jefferson Traction Company has obtained the necessary privileges to build its road through Prescottville and thence to Soldier and Sykesville, and will at once begin work. Another line will extend from Sykesville to DuBois.

BELTON, TEX.—The city council has granted a franchise to W. H. Taylor, W. R. Barefoot, H. P. Kulp, W. E. Davis and J. H. Hauser, of Pennsylvania, to build a street railway and interurban road between Belton and Temple. Work is to commence within six months.

DAVENPORT, IOWA—The Davenport & Clinton Traction Company has been incorporated with a capital stock of $500,000, with the privilege of increasing to $3,000,000. Ulysses D. Eddy, president of Flint, Eddy & Company, of New York, will be president of the company.

ITHACA, N. Y.—It is reported that two companies have under consideration the matter of connecting Auburn and Ithaca by trolley. The first road will run over the line formerly occupied by the Auburn, Ithaca & Western Railway Company, while the other will be further to the eastward.

FOND DU LAC, WIS.—Surveys have been started on a proposed electric railroad from this city to Ripton and Green Lake. The proposed road will be twenty-seven miles long and will pass through a thickly settled farming country. A road is also contemplated to Milwaukee, by way of West Bend.

SCRANTON, PA.—It is stated that another trackless trolley is projected to run from Buttermilk Falls, on the Lehigh Valley Road, by way of Lake Winola to Factoryville, a distance of about nine miles. The projectors of the plan have arranged to obtain the necessary power by erecting a power-house at the falls.

CHARLESTON, W. VA.—The Ohio Valley Street Railway Company, of Chester, W. Va., has been incorporated to construct and operate a railroad from Wellsburg to Hollidays Cove, thence to New Cumberland, to Chester, thence over a bridge across the Ohio River to East Liverpool. The capital stock is $25,000.

HAGERSTOWN, MD.—The Hagerstown Street Railway Company will extend its system from Boonsboro to Myersville, to connect with the Frederick road. The extension will cost at the rate of $10,000 a mile, or $50,000. Part of the right of way has been secured, but it is probable that work will not commence until next year.

COLUMBUS, OHIO—The Scioto Valley Traction Company, with headquarters in this city, has filed articles with the Secretary of State increasing its capital stock from $1,000,000 to $3,000,000. The Lebanon & Franklin Traction Company, with its principal offices at Dayton, has also increased its capital stock from $10,000 to $160,000.

MARLBORO, MASS.—The Marlboro Street Railway, with cars and equipment, was sold at auction recently to William A. Quigley, of Boston, for $102,775. Mr. Quigley represented the Boston & Worcester Electric Company. The sale was the result of an order issued by the courts, and was conducted by George W. Estabrook, the receiver.

CUMBERLAND, MD.—The Frostburg & State Line Electric Railway, Light and Power Company has been incorporated with a capital of $120,000, to build an electric road from Frostburg to the Pennsylvania line, six miles, to connect with the Meyersdale and Salisbury line, now building. It is part of the system to connect Cumberland and Johnstown.

LINCOLN, NEB.—Articles of incorporation for the Sioux City, Homer & Southern Railway Company have been filed. It is stated that Omaha, Sioux City and other capitalists are back of the project, the purpose of the company being to connect Homer with Sioux City. The capital stock is given at $500,000, with the privilege of increasing to $1,000,000.

GREENSBURG, PA.—The connection of the Pittsburg, McKeesport & Connellsville street railway between Connellsville and Uniontown, at Dunbar, has been completed and cars are now running. The entire line from Mount Pleasant to Fairchance—thirty miles in length—is now completed with the exception of the bridge between Scottdale and Everson.

NASHVILLE, TENN.—It is said that the Kentucky Traction Company, recently organized, will build an electric line from Louisville to Nashville. Connection will be made with Bowling Green, Russellville and the entire Green River section, extending as far as West Point and Leitchfield. Freight and express will be handled in addition to the regular passenger service.

LA PORTE, IND.—The Northern Indiana Traction Company, formerly the Hobart & Western, which contemplates building an electric road connecting South Bend and Valparaiso, *via* La Porte, has been granted a fifty-year franchise by the commissioners of St. Joseph County. The company must begin work within four months and have cars running before November 1, 1904.

ROCKVILLE, CT.—The officials of the Rockville, Broad Brook & East Windsor Street Railway Company, organized to build a trolley line from Rockville through Ellington and Broad Brook to Scantic, where connection will be made with the Hartford & Springfield Street Railway Company's system, have arranged for an immediate survey of the route. The line will be about ten miles in length.

BOSTON, MASS.—The Middlesex Street Railway Company proposes to build and equip a line between Billerica and Arlington Heights, the intention of the company being to operate a fast line between Boston and Lowell, connecting at Arlington Heights with the elevated and at Billerica for Lowell with an existing route. The road will run almost wholly on private land, and will be entirely enclosed. High speeds will be maintained.

PLATTSBURG, N. Y.—It is stated that an electric road is to be built through the Saranac Valley, and that it will be completed and in operation within a year. It is the intention of the promoters of the road to run it principally along the line of the old plank road from Clayburg to Plattsburg, a distance of about twenty-four miles. Starting from Plattsburg the road will touch the villages of Morrisonville, Cadyville, Saranac, Moffitsville, Redford and Clayburg.

HUNTINGTON, W. VA.—Prominent capitalists have organized a company to build a street car line from the Big Sandy River, near Kenova, to Barboursville, paralleling the line of the Camden Interstate Railway through Central City and Huntington. The new line, as projected, is eighteen miles long, but it is believed that the ultimate aim of the new company is to extend the line on to Charleston, thence to Mount Carbon, in the Kanawha coal fields, a distance of sixty miles. Senator Stephen B. Elkins and Hon. J. L. Caldwell are said to be identified with the enterprise.

PITTSBURG, PA.—A party of Pittsburg and Youngstown business men are planning a traction trunk line to connect Pittsburg with the Mahoning Valley Traction system, which they now control. Six new connecting street railways have been chartered to close a gap of twenty-one miles. They are as follows: West Side & Mahoningtown Street Railway Company, Mahoningtown & Moravia Street Railway Company, Moravia & Wampum Street Railway Company, Wampum Street Railway Company, Wampum & Hoytdale Street Railway Company, Hoytdale & Beaver Falls Street Railway Company. The new line will form a continuous system from Warren, Ohio, through Youngstown, New Castle, Beaver Falls, Coraopolis and McKees Rocks or through Allegheny to Pittsburg.

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ELECTRIC LIGHTING.

JACKSON, KY.—The Jackson Electric Light and Power Company will erect a power-house in this place.

JERSEY CITY, N. J.—Work has been started on a new $60,000 power-house for the Public Service Corporation.

CLINTON, IOWA—It is stated that D. A. McKellar will construct an electric lighting system at Rock Valley.

DES MOINES, IOWA—P. K. Tyng has purchased the plant of the Valley Junction Water and Light Company for $15,953.

STAMFORD, CT.—The power plant of the Middleburg & Schoharie Light, Heat and Power Company was destroyed by fire recently.

DENVER, COL.—The Denver City Tramway Company has put in operation its new power-house. This cost $1,500,000, and is equipped with the latest types of apparatus throughout.

GREENCASTLE, PA.—The Waynesboro Electric Light and Power Company has passed into the hands of the Chambersburg, Greencastle & Waynesboro Electric Street Railway Company.

BERLIN, PA.—The borough council has decided to purchase for the city the Berlin Electric Light Company's plant for $8,800. The plant will be improved and operated by the municipality.

CONCORD, N. H.—The plant of the Laconia Electric Lighting Company, at Lakeport, will be rebuilt, and a new plant will be erected at East Tilton by the Winnipesaukee Gas and Electric Company.

PORTLAND, ORE.—The Puget Sound Power Company, which is constructing a large power plant at Election, in Pierce County, Wash., has bonded its properties to the Old Colony Trust Company, of Boston, for $4,000,000.

BRIDGEPORT, CT.—The certificate of organization of the Pequonnock Commercial Corporation has been filed in the town clerk's office. The capitalization is given at $150,000. The company will carry on an electrical business.

GADSDEN, ALA.—Captain W. P. Lay, who recently purchased water privileges on Wills Creek, near Attalla, announces that he will erect a plant for the purpose of supplying electric light and power to Gadsden, Attalla and Alabama City.

CARROLLTON, OHIO—A. H. Snively, of Carrollton, and Dr. C. Bolon, of Sherodsville, have been granted a franchise for an electric light plant at Sherodsville. Arrangements have been made whereby they will light the streets of the town.

GRIFFIN, GA.—The Towaliga Falls Company has been organized in this city with a capital of $100,000, with the privilege of increasing it to $300,000. The company proposes to furnish electricity for Griffin and other smaller places in this section of the state.

COLUMBUS, OHIO—The Citizens' Heat, Light and Power Company has been incorporated to operate in Dayton. The capital stock of the company is $10,000, which will shortly be increased. The incorporators are Thomas A. Selz, M. J. Houck, S. Rufus Jones, H. J. Meyers and R. E. Kline.

TROY, N. Y.—It is stated that Bash Bish Falls and many acres surrounding them near Chatham, Columbia County, have been purchased by a New York syndicate which will develop power and transmit same to Great Barrington, Philmont, Chatham and other villages, to operate the street railways in these towns.

WHATCOM, WASH.—It is stated that Mr. Charles H. Baker, the owner of the Snoqualmie Falls Power Company, near Seattle, has become interested in the Stave Lake Power Company, and that a large sum will be spent in putting in a complete electric power plant at Stave Lake, with a view of supplying electric energy to the cities of New Westminster and Vancouver. It is expected that 20,000 horse-power can be developed.

BAKER CITY, ORE.—A syndicate composed of Colonel W. F. Butcher, W. H. Shumaker, J. T. Donnelly, W. H. Gilbert, A. Welch and A. Lenox has purchased the stock and property of the Rock Creek Power Company, a corporation recently organized for the purpose of erecting a power plant on Rock Creek, about twelve miles northwest of this city. The consideration named is $60,000. The plant, when completed, will supply several hundred electrical horse-power, which will be transmitted to this city for light and power purposes.

TELEPHONE AND TELEGRAPH.

COLUMBIA, N. J.—A new telephone line is being built from Columbia to Blairstown, Warren County.

MARINETTE, WIS.—The Wausaukee Telephone Company has been granted a franchise to enter the city.

GREENSBURG, PA.—The Federal Telephone Company has been granted permission to operate in this city.

WINONA, MINN.—The Winona Telephone Company has begun work on a line to extend north of Rollingstone.

READING, PA.—The Pennsylvania Telephone Company is constructing a new line from Reading to Boyerstown.

NEWPORT NEWS, VA.—Extensive improvements will be made to the Citizens' Telephone Company's plant in this city.

MUSCATINE, IOWA—The American Telephone and Telegraph Company is building a line from St. Paul to Davenport.

TRUMANSBURG, N. Y.—The Trumbulls Corners Telephone pany has been incorporated with a capital stock of $2,000.

LIBERTYTOWN, MD.—The Frederick Telephone Company is at work on an extension of its lines from this place to Unionville.

JONESVILLE, N. Y.—Clifton Park Telephone Company. $5,000. Incorporators: Erastus R. Forte, John R. McElroy and Robert Jump.

GREEN BAY, WIS.—The Wisconsin Telephone Company is said to be planning extensive improvements to its Green Bay system.

OXFORD, MISS.—J. W. Clark and F. L. Toale, of Hamilton, Mo., have purchased the Oxford Telephone Company from W. H. Harvey.

CHICKASHA, I. T.—The new telephone system inaugurated by the Topeka & El Reno Telephone Company has been put into service.

DENISON, TEX.—The Southwestern Telegraph and Telephone Company is making extensive improvements to its system in Grayson County.

LANSING, MICH.—Arrangements have been made to connect the Citizens' Telephone Company with the Cooperative Telephone Company, of Detroit.

CONCORD, N. H.—The Citizens' Telephone Company, of Laconia, has notified the Secretary of State of an increase in its capital stock to $160,000.

COOPERSTOWN, N. Y.—Cooperstown, Cherry Valley & Sharon Springs Telegraph Company. $5,000. Incorporators: F. C. Ward, M. D. Eckler and Frederick E. Hopkins.

ALBANY, N. Y.—Colonie Electric Company. $10,000. Incorporators: Henry M. Sage, Menand, N. Y.; John H. Jackson, Menand, N. Y., and Charles W. Little, Albany, N. Y.

INDIANAPOLIS, IND.—The Big Raccoon Telephone Company, which will operate a telephone system in Vigo and Parke counties, has been incorporated with a capital of $4,000.

WORTHINGTON, IND.—The Lyons Cooperative Telephone Company held a meeting and elected the following officers: J. Davidson, Dr. B. F. Chambers and S. N. Yeoman.

DONORA, PA.—The Citizens' Electric Light and Manufacturing Company. $20,000. Directors: R. L. Biddle, G. W. Allen, W. Altman, W. Kirkwood and F. C. Welgus, of Donora.

JANESVILLE, WIS.—A new telephone exchange will be put in by the Western Telephone and Construction Company for the Kenosha Citizens' Telegraph and Telephone Company.

ANSONIA, CT.—The Southern New England Telephone Company has arranged to make many improvements to its system in the vicinity of Ansonia during the late summer and fall.

WARSAW, N. Y.—The Bell Telephone Company is building additional toll lines connecting Warsaw with Wyoming, Pike and Attica, and will also make improvements in its local system.

LEWISTON, ME.—The East Bethel Local Telegraph and Telephone Company has been organized at Bethel for the purpose of carrying on a telegraph and telephone business. The capital of the company is $5,000, and the officers are Z. W. Bartlett and D. W. Colby.

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ELECTRICAL SECURITIES.

That there is more inherent strength in many financial institutions than is generally supposed, was proven last week during as sickly a condition of affairs as one might conjure up. With a demoralizing shrinkage in values and several suspensions the total range of Stock Exchange failures only runs up to six. In addition to this, notwithstanding almost a year of depressing values, the July failure returns are encouraging, showing fewer commercial embarrassments and a smaller aggregate of liabilities than in June, and fewer failures than in the same month a year ago. Possibly there may be further disasters during the week, but notwithstanding rumors to this effect and undoubted pessimism in some quarters, there is an evidence of solidity and a faith in the ultimate reversal of the present depression that will be a splendid start from which to launch an upward boom as soon as a favorable opportunity renders this possible.

ELECTRICAL SECURITIES FOR THE WEEK ENDING AUGUST 8.

New York:	*Closing.*
Brooklyn Rapid Transit	39
Consolidated Gas	168
General Electric	150
Kings County Electric	155
Manhattan Elevated	129
Metropolitan Street Railway	108⅞
New York & New Jersey Telephone	161
Westinghouse Manufacturing Company	160

All of the electrical securities suffered declines on the New York Stock Exchange. A raid on Consolidated Gas brought this down 19 points.

Boston:	*Closing.*
American Telephone and Telegraph	131½
Edison Electric Illuminating	225
Massachusetts Electric	82
New England Telephone	120
Western Telephone & Telegraph preferred	82

The Boston market was very dull, and, as is generally the case with downward prices, but little change was manifested.

Gross earnings of the Boston Elevated for July increased $120,000 over July last year, the largest increase in any one month since the present management has been in charge of the road.

Philadelphia:	*Closing.*
Electric Company of America	7¾
Electric Storage Battery common	60
Electric Storage Battery preferred	60
Philadelphia Electric	5½
Union Traction	43
United Gas Improvement	83

The *Wall Street Journal* credits a broker with large interests in the Bell Telephone, of Philadelphia, with saying: "The recent appointment of U. N. Bethel, now president and general manager of the Chesapeake & Potomac Telephone Company and vice-president and general manager of the New York Telephone Company to the additional office of president and general manager of the Bell Telephone Company, of Philadelphia, is an important step in the unification policy of the American Telephone & Telegraph Company. The executive management of the Philadelphia company in reality is not changed, James E. Mitchell, as chairman of the board of directors, remaining the ranking officer. The American company, by this appointment, however, unifies the operating departments of its system in New York, Philadelphia, Baltimore and Washington. Notwithstanding the large increase in the business of the Bell Telephone Company, of Philadelphia, I understand that no increase in the dividend rate is in contemplation. None of the other thirty-five subsidiary companies of the American Telephone and Telegraph Company, according to my information, pays a higher dividend rate, and many of them pay considerably less. The methods of the management are excellent in many respects, but they are open to criticism, I think, in representing to stockholders of the company as scantily as they do the important figures of each year's business. The annual report should be much fuller, I think, in this respect."

Chicago:	*Closing.*
Chicago Telephone	120
Chicago Edison Light	142
Metropolitan Elevated preferred	53
National Carbon common	22
National Carbon preferred	91¼
Union Traction common	3½
Union Traction preferred	30

Chicago Telephone fell off 5 points, Chicago Edison losing 6 points, Metropolitan Elevated lost only 1 point, National Carbon common holding strongly at 22, while National Carbon preferred gained 1¼ points. Union Traction common lost 1½ points, Union Traction preferred holding firm at 30.

NEW INCORPORATIONS.

MICAVILLE, N. C.—Estahoe Electric Company. $125,000.

DES MOINES, IOWA—The Otley Telephone Company. $5,000.

GALVESTON, TEX.—The Modern Telephone Company. $300,000.

SCHOOLCRAFT, MICH.—The Citizens' Telephone Company. $5,000.

ZEBULON, GA.—Neal Power and Manufacturing Company. $500,000.

READING, PA.—Trexlertown & Alburtis Street Railway Company. $18,000.

PINE HILL, N. Y.—The Slide Mountain & Pine Hill Telephone Company. $500.

HOMESTEAD, NEB.—Monroe Independent Telephone Company. Increased to $10,000.

GRAFTON, W. VA.—Taylor County Electric Street Railway and Supply Company. $500,000.

ITHACA, N. Y.—The Ithaca Electric Light and Power Company. Reduced from $500,000 to $300,000.

AUSTIN, TEX.—Western Telephone Company. $15,000. Incorporators: C. L. Alderman, R. H. Kemp and P. Pettit.

MADISON, WIS.—Borre Mills Telephone Company. $30,000. Incorporators: G. D. Sprain, W. C. Miller and others.

BEASON, ILL.—The Beason Telephone Company. $2,500. Incorporators: J. T. Gelsthrop, J. E. Bumcrots, G. A. Curry.

GLIDDEN, IOWA—The Glidden Telephone Company. $2,500. Incorporators: J. K. McNaught, C. A. Noble and S. T. Waldron.

BROCKPORT, N. Y.—Brockport Telephone Company. $10,000. Incorporators: F. A. Winne, James Brennan and Thomas H. Dobson.

DENVER, COL.—Trinidad Electric Railroad Company. $300,000. Incorporators: F. P. Read, N. M. Read, P. M. Harlan, G. T. Turner.

ELY, MO.—Union Valley Telephone Company. $3,000. Incorporators: Will Ihrig, Charles W. Schukmaus, Sidney Corder and others.

RIVER FALLS, WIS.—The St. Croix Valley Telephone Company. $1,200. Incorporators: J. L. Chapman, J. A. Chimock and J. Bailey.

FRANKFORT, KY.—The Independence Telephone Company. $5,000. Incorporators: J. M. Chambers, W. T. Loomis, C. M. Petty and J. L. Vest.

LITTLE ROCK, ARK.—Lawrence County Telephone Company. $3,000. Incorporators: F. W. Tucker, W. De Arman, E. J. Mason and C. H. Martin.

LITTLE ROCK, ARK.—The Western Grove Telephone Company. $25,000. Incorporators: H. R. Magness, J. H. Floyd, C. L. Jones and S. R. Crain.

FRANKFORT, KY.—Northern Kentucky Telephone and Tele-

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graph Company. $100,000. Incorporators: F. L. Ludlow, M. Durrett and S. P. Kisson.

AUSTIN, TEX.—Lone Star Telegraph Company. $20,000. Incorporators: Harry Huey, J. H. Thrasher, John Camp, C. H. Bayless and Eugene Lamore.

BRIDGEWATER, VA.—North River Electric Company. $10,000. Incorporators: G. Richard Berlin, E. L. Berlin, J. J. Shaver, J. A. Riddel and Edward C. Martz.

MADISON, WIS.—Menomonee & Marinette Light and Traction Company. $560,000. Incorporators: Augustus Spies, Samuel M. Stephenson, John Henes and Gustavus Blesh.

ALBANY, N. Y.—New Paltz, Highland & Poughkeepsie Traction Company. $100,000. Directors: J. A. Duffy and T. G. Huids, Jersey City; G. H. Patterson, Jr., New York city.

LANCASTER, OHIO—The Lancaster, Logan & Nelsonville Traction Company. $10,000. Incorporators: A. Magoon, W. Jones, D. A. Rannells, F. M. McKay and F. E. Pierpont.

ALMA, MICH.—Gratiot County Telephone and Messenger Company. $15,000. Directors: T. W. Whitney, H. Randolph, of St. Louis; W. A. Leet, Ray Maloney, of Ithaca; A. E. Mulholland, Bert Hayes and George Sharrar, of Alma.

INDUSTRIAL ITEMS.

THE WALLACE BARNES COMPANY, Bristol, Ct., manufacturer of small springs of every description and dealer in wire and cold rolled steel, has an elaborate catalogue in preparation. This will be mailed upon issue to any one who may be interested.

EUGENE MUNSELL & COMPANY, New York city, is carrying a large stock of high-grade mica. The Munsell company has options on the best mica producers in the world, and the firm's long experience in this line gives it facilities for quoting on any quantities and in any size.

THE ELECTRIC APPLIANCE COMPANY, Chicago, is enthusiastic over the increasing sales of A B lamps. The company states that in the series alternating arc light system, which is becoming so popular, regulators are furnished in twenty-five, thirty-five and fifty-light capacities.

THE ELECTRIC FLASH LIGHT COMPANY, Denver, Col., manufacturer of incandescent lamps, has placed on the market a flasher that operates without a motor or commutator. A special form of lamp and socket is used and the flashing is done automatically. Circulars will be mailed by the company on request.

THE SWEDISH-AMERICAN TELEPHONE COMPANY, Chicago, Ill., is sending to friends and patrons a unique souvenir in the form of a watch charm receiver. The original supply of these has almost been exhausted owing to the great demand made for them. It is stated, however, that there are a few left, and these will be sent on request.

THE THOMAS E. CLARK WIRELESS TELEGRAPH AND TELEPHONE COMPANY, Detroit, Mich., announces that its apparatus has been installed in the big store of J. L. Hudson, one of the prominent merchants of Detroit. Messages are being sent constantly between two stations for the benefit of customers who are attracted by the novel exhibition.

THE H. W. JOHNS-MANVILLE COMPANY, New York city, has issued a novel folder descriptive of the "Electrotherm," the electrical substitute for the hot water bag. The "Electrotherm" is composed of wires, insulated and protected by asbestos, woven into a light and flexible sheet or pad, which when attached to the ordinary incandescent lamp socket offers sufficient resistance to the current to produce a constant and uniform degree of heat.

THE CORRESPONDENCE INSTITUTE OF AMERICA, Scranton, Pa., has issued an illustrative pamphlet describing the course in electricity as taught in that institution. Instruction is entirely by mail, and covers all branches of theoretical and applied electricity and the subjects necessary as a preparation to take up this course. The editor-in-chief of this course is Professor George F. Sever, of Columbia University, New York, and the chief instructor is Mr. J. Arthur Morgan.

THE WARREN ELECTRIC MANUFACTURING COMPANY, Sandusky, Ohio, is well known for its inductor type of alternating-current generator. The company has a reputation also for its advertising literature. A recent bulletin shows some good views of the Warren alternator in several stages of assembly. A graphic illustration is given of the growth of the company since 1894. The analysis shows a remarkable progression, with the possibility of carrying the year line for 1903 beyond the limits of the margin on the bulletin.

H. S. BURROUGHS, New York city, electrical and mechanical engineer, in addition to preparing specifications and reports on lighting and power plants, mill and factory equipments, railway and transmission plants, is representing as sales agent several well-known specialties. Among these are Columbia Electric and Manufacturing Company, enclosed series and multiple arc lamps; Mansfield Engineering Company, high-speed engines and electric cranes; Mutual Electric and Machine Company, knife switches, panelboards and switchboards.

MESSRS. F. BERG & COMPANY'S new hat factory at Orange, N. J., will be run entirely by electricity, an isolated plant now being installed for this purpose. A recent contract with the Westinghouse Electric and Manufacturing Company, Pittsburg, Pa., calls for twenty-seven alternating-current, two-phase motors, twenty of which will be belted to shafting to run the machinery used in the process of making hats; the remaining seven are each to be provided with an extended shaft eight inches long and will be direct-connected to blowers used for collecting the fine felt used in the process of manufacture.

THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, Chicago, Ill., and Rochester, N. Y., is installing a 200-capacity, generator call, visual signal switchboard at Hart, Mich., for the Oceana Telephone Company. The Stromberg-Carlson company is also installing intercommunicating systems in Chicago, Ill., for the Brunswick-Balke-Collender Company, the Library Bureau, and Brown & Sharpe. A generator call, visual signal switchboard, 140 lines, is being installed for the Citizens' Telephone Company, of Grand Rapids, at Fremont, Mich. The company has recently sold a 300-capacity switchboard together with telephones and a complete equipment to the Rushville Telephone Company, of Rushville, Ill.

A. D. GRANGER COMPANY, agent, 95 Liberty street, New York city, is distributing several fine catalogues descriptive of steel tanks, safety water-tube boilers and Skinner engines respectively. The catalogue describing steel tanks contains illustrations and specifications on circular black steel tanks for gas, air and water, for use as blow-off, receiving, drip, pressure or hot water tanks. The catalogue descriptive of water-tube boilers contains illustrations and specifications on "Star" safety water-tube boilers for power, steam heating and hot-water heating. The engine catalogue is very handsomely made up. This contains a number of splendid half-tone reproductions of Skinner engine with automatic systems of lubrication, built by the Skinner Engine Company, Erie, Pa. Any or all of these catalogues will be sent on application.

THE PETERBOROUGH HYDRAULIC POWER COMPANY, of which Senator George A. Cox is president, is building a new power plant on the Otonabee River in the town of Peterborough, Ontario, Canada, which will be equipped with the following apparatus recently purchased from the Westinghouse Electric and Manufacturing Company: A 1,500-kilowatt, 2,240-volt generator, having 7,200 alternations and running at 150 revolutions per minute, to be direct-connected to water-wheels; also two 125-volt, direct-current, direct-coupled to exciters of seventy-five kilowatts capacity each, together with switchboard consisting of a large generator panel and two exciter panels. The power-house, when completed, will be an unusually fine one and is to furnish power to the Peterborough mill of the American Cereal Company, owned by the Quaker Oats Company; power will be supplied to several other manufacturing plants in the town, and also to the Peterborough Light and Power Company, which does the electric lighting and small power business in Peterborough.

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CHARLES W. PRICE . . . . PRESIDENT and EDITOR
STEPHEN H. GODDARD . SECRETARY and MANAGER
WM. HAND BROWNE, JR. . . . TECHNICAL EDITOR
AINSLIE A. GRAY . . . . . ASSISTANT EDITOR

WESTERN OFFICE—40 Dearborn Street, Chicago, Ill. CHARLES FRENCH, Manager.

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TO ADVERTISERS

CHANGES for advertisements should be in this office by Friday noon for the following week's issue.

NEW ADVERTISEMENTS should be in the office not later than Monday noon to assure publication in that week's issue.

IMPORTANT PROPERTIES OF N-RAYS.

One of the important properties of N-rays, the new radiation discovered recently by Blondlot, is that they can be reflected and refracted while they have penetrative powers similar to Rœntgen rays. They do not, however, affect a photographic plate and are, of course, invisible. But when a screen has been devised which will render them visible it will then be possible to obtain perspective images of hidden bodies, such as a diseased bone, and this will give these rays as great an advantage over the X-rays as the photograph has over the old black-and-white silhouette.

N-Rays May Aid in Illumination.

Another fact connected with N-rays has been discovered by Blondlot and since confirmed by Reubens, which may prove to be of great importance in another field of application. This is the fact that these rays enhance the luminosity of a glowing solid or gas without increasing its temperature. The explanation of this effect has not yet been offered, but any means which will enable us to increase the luminosity of a body without increasing its temperature promises to be of great importance in solving the problem of an efficient light.

MATTER AND ELECTRICITY.

We are used to hearing enthusiasts expatiate upon the wonders of electricity, what great things it has done; what greater wonders it will yet do; what revolutionary forces have been set to work as the result of a patient study of apparently an uncommon physical phenomenon. After working his readers up to a state of almost reverential respect for the physicist and his brother, the engineer, the author not unfrequently gives way to the temptation to add to the bewilderment of his readers by saying "And yet no one knows what electricity is."

Knowledge of Electricity Comparatively Full.

This is, of course, true enough, but there are other branches of physical science in which we are more ignorant than in that called "electricity." Doubtless most of us are under the impression that we know something about the materials surrounding us and with which we come into such constant and intimate contact. It will, therefore, come as a surprise to many to read the statement made by Sir Oliver Lodge during a recent address entitled "Modern Views on Matter" bearing on this subject. Sir Oliver said: "It is possible, but to me very unlikely, that the electron, as we know it, contains a material nucleus in addition to its charge, so in that case it need not be so concentrated because a portion of its mass would be otherwise accounted for. I say 'accounted for,' but it would be equally true to say unaccounted for. The mass which is explicable electrically is to a considerable extent understood, but the mass which is merely material (whatever that may mean) is not understood at all. We know more about electricity than about matter; and the way in which electrical inertia is accounted for electromagnetically and localized in the ether immediately surrounding the nucleus of charge is comparatively clear and distinct." In other words, we know more about the laws which govern this invisible agent than we do about the most commonplace matter.

Possible Relation Between Electricity and Matter.

This statement is, of course, strictly true. It needs only to be made to be acquiesced in. We are, or rather we think we are, so familiar with things which we can see and handle that they seem commonplace, but to be able to control an invisible agent seems most wonderful. It is possible that before many years we will discover that we really know more about matter than we now think we do; at least this will be the case if the suggestions made by Sir Oliver Lodge should be sustained by later discoveries. He has thrown himself enthusiastically into the study of the new theories of electricity, and as a result of these studies he has been led to certain ideas which are not entirely assented to by his brother physicists. But it should be remembered that Sir Oliver Lodge is ever most careful to distinguish between theories which seem to be well supported by facts and mere hypothesis thrown out to stimulate research and discussion. Sir Oliver's idea is that an atom of matter is made of a staple group of electrons, and electrons themselves are merely electrical charges. He thinks that all the properties of matter can be accounted for in this way and are merely the result of electrical forces. Should this be true we may then begin to feel that we know something about matter, for an atom of matter may be nothing more than a crystal of electricity.

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PARIS TUNNEL DISASTER.

In the news columns of this issue will be found details of the terrible disaster in the Paris subway in which a large number of lives were lost. It is well nigh impossible to locate the blame for this calamity or to give a precise explanation of the cause of the fire. Tunnel disasters have always been looked upon with particular dread, and an accident occurring in a tunnel where train service is frequent and speeds fairly high and where the passengers are plunged suddenly into total darkness by the simultaneous extinguishing of all the train and tunnel lights is likely to cause a panic among the coolest heads. Add to this condition the blunder which enables another train to plunge into the crowd of passengers seeking to escape from the burning train and suffocating smoke by grouping their way along a dark tunnel, and it is hard to conceive of a more terrifying situation.

What Is the Possibility of an Accident Here?

The immediate effect of this lamentable accident has been to raise the question of the possibility of a similar occurrence taking place in one of the subways which are now being constructed or to be constructed in a number of our larger cities. There is, of course, always present the danger of collision whether above the ground or underground, but with the improved appliances for safeguarding trains this danger is becoming less and less.

Fire Protection.

To protect against fires the train should be as nearly fireproof as it is possible to make it. This danger exists on all lighted trains to a more or less extent, but it has been very greatly reduced by the introduction of electric lights. The cars which will be used by the Interborough Transit Company on the New York subway will be protected by metal and asbestos, and the combustible material reduced to a minimum, and means are provided for shutting off the current in case of an accident. When the power is shut off there will be nothing to cause a fire. All these questions have been under discussion by the officials of the Interborough Transit Company for several years, and all possible safeguards have received careful attention.

Greatest Danger in Panics.

There is one other point which should be remembered in this connection. Although the Paris accident happened to electrically operated trains, it does not follow that the blame should be laid to this kind of motor power. The conditions were such that it was almost impossible to determine just what happened, but the disaster emphasizes the need already recognized by those responsible for the New York subway of taking every precaution possible to avoid any such occurrence here. In an accident of this kind the greatest danger lies in a panic among the passengers and that many of the train officials escaped from the Paris wreck seems to indicate that more of the passengers might have escaped had they kept cool. In electrically operated trains there may be flashes of light and perhaps an occasional blowing of a fuse with something of a report and perhaps some smoke, but this must be expected and does not indicate danger. A fuse is nothing more than an electrical safety valve and no one is frightened when a locomotive blows off steam.

Public Should Have Confidence.

It is our belief that whatever can be done to promote the safety and comfort of passengers on the New York subways will be done. This is the largest electrical development that has ever been undertaken, and not only would it be bad policy to slight the least detail, but the character of the men in authority and the recognized ability of their engineers should inspire public confidence.

EXPIRATION OF THE BRITISH PATENT ON THE PARSONS STEAM TURBINE.

In 1884 the British patent was granted to the Hon. C. A. Parsons on a new type of prime mover now known as the steam turbine. Due to the importance of this invention and the difficulties met in bringing it to a satisfactory commercial standing, the patent was extended five years and this extension has now expired, throwing open this field of work to the public.

It is interesting to note at this time the opinion of Lord Kelvin, who has described the invention of the steam turbine as the greatest advance made in steam engineering practice since the time of James Watt. As was true of Watt was also true of Parsons, that he was thoroughly equipped with theoretical knowledge and was an expert mechanic. In developing the turbine, there was thus combined, theoretical knowledge, mechanical skill and capital. The result has been a machine which bids fair to become most important, but it can hardly be said that the inventor, even with the extension of his patent, has received the full reward of his labors.

RADIUM FOR TREATING CONSUMPTION.

In a recent issue of the British *Medical Journal* Mr. Frederick Soddy suggests the use of radioactive materials to treat consumptives. It has been demonstrated by Crookes and others that the radiation from radium is a powerful germicide and it has been shown by Rutherford and Soddy that this material gives off a gas which is itself radioactive. Thus to treat a consumptive patient it will only be necessary to cause him to inhale this emanation in order to reach at once the diseased tissues. Thorium may also be used for this purpose and although it is less powerful than radium, its emanation is given off much more rapidly. These emanations tend also to excite a secondary radioactivity of the surface with which they come in contact, which will prolong the germicidal action. It is possible that these important discoveries in the sciences of physics and chemistry may have as great importance in that of medicine. Thus to quote Mr. Soddy in the above communication: "The immunity of these processes from external interference, the simple nature of the treatment proposed, the infinitesimal quality of the active agents employed, the manner in which the emanations may be inhaled to do their work at the very seat of the disease, leaving behind in their place the secondary activity to continue to work in a gentle manner after they have been exhaled, make out a strong case why the attention of medical men should be directed to these new weapons which physics and chemistry have placed at their disposal."

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SWITCHING TRANSMISSION CIRCUITS.

BY ALTON D. ADAMS.

Electrical transmission has worked a revolution in the art of switching. As long as the distances to be covered by distribution lines required pressures of only a few hundred volts the switch contacts for generators and feeders could well be exposed in a row on the surface of vertical marble slabs and separated from each other by distances of only a few inches. These switches were capable of manual operation even at times of heavy overload without danger of personal injury to the operator or of destructive arcing between the parts of a single switch or from one switch to another near-by. On the back of these marble slabs one or more sets of bare bus-bars could be located without much probability that an accidental contact between them would start an arc capable of destroying the entire switchboard structure and shutting down the station.

The rise of electric pressures to thousands and tens of thousands of volts in distribution and transmission systems has vastly increased the difficulty of safe and effective control with open air switches. The higher the voltage of the circuit to be opened under load the greater must be the distance between the contact parts of each switch, and also between adjacent switches. Such switches must also be further removed from the operators as the voltages of their circuits go up, as a person can not safely stand very close to an electric arc of several feet or even yards in length. In the West where long transmissions are most common long break stick switches have been much used with high voltages. These switches depend on the length of the break to open the circuit and on the length of the stick that moves the switch jaw or plug to ensure the safety of the operator. Where switches of this sort are used it is highly important to have ample distances between the contact points of each switch and also between the several switches. On circuits of not more than 10,000 volts an arc as much as a yard long will in some cases follow the opening switch blade and hold on for several seconds. On the 33,000-volt transmission system at Los Angeles a peculiar form of switch is used which makes a break between a pair of curved wire horns that are ten inches apart at their nearest points. When the contact between these horns is broken the arc travels up between portions of the horns that curve apart and is thus finally ruptured. Besides the very large space required for open switches on circuits of 5,000 to 10,000 volts or more, there is the further objection that the arcs developed by opening such switches under heavy loads rapidly destroy the contact parts and produce large quantities of metallic vapor that is objectionable in a central station. In some experiments performed at Kalamazoo (A. I. E. E., Vol. xviii, p. 407) with open air switches the voltages ranged from 25,000 to 40,000. The loads on circuits broken by the switches were highly inductive and amounted from 1,200 to 1,300 kilovolt-amperes. At 25,000 volts the arc produced by the open air switch held on for several seconds. At 40,000 volts the arc following the opening of this switch was over thirty feet long, and being out of doors near the pole line the arc struck the line wires and short-circuited the system. It has been shown that the oscillations of voltage occurring when a circuit under heavy load is opened by an open air switch may be very dangerous to insulation (A. I. E. E., Vol. xviii, p. 383). In the Kalamazoo test the oscillations of this sort were reported to have reached two or three times the normal voltage of the system when the open air switch was used.

Facts of the nature just outlined have led to the development of oil switches. The general characteristic of oil switches is that the contact parts are immersed in and the break between these contacts takes place under oil. Two distinct types of the oil switch are made, one having all of its contact parts in the same bath of oil and the other having a separate oil bath for each contact. Compared with those of the open air type, oil switches effect a great saving of space, develop no exposed arcs or metallic vapors, cause little if any oscillation or rise of voltage in an alternating circuit and can be depended on to open circuits of any voltage and capacity now in use. In the tests above mentioned at Kalamazoo a three-phase oil switch making two breaks in each phase and with all the six contacts in a single oil bath was used to open circuits of 25,000 volts and 1,200 to 1,300 kilovolt-arcs with satisfactory results. At 40,000 volts, however, this type of switch spat fire and emitted smoke, indicating that it was working near its ultimate capacity. A three-phase switch with each of its six contacts in a separate cylindrical oil chamber was used to open the 40,000-volt 1,300 kilovolt-arc circuit at Kalamazoo with perfect success even under conditions of short-circuit and without the appearance of fire or smoke at the switch. The three-phase switch used in the tests at Kalamazoo and having each of its contacts in a separate oil chamber was similar in construction to the switches used in the Metropolitan and Manhattan railway stations in New York city. In each of these switches the two leads of each phase terminate in two upright brass cylinders. These cylinders have fibre linings to prevent side jumping of the arcs when the switch is opened, and each cylinder is filled with oil. Into the two brass cylinders of each phase dips a ∩-shaped contact piece through insulating bushings, and the ends of this contact piece fit into terminals at the bottom of the oil pots. A wooden rod joins the centre or upper part of the ∩ contact piece, and the three rods of a three-phase switch pass up through the switch compartment to the operating mechanism outside. The six brass cylinders and their three ∩ contact pieces are usually mounted in a switch cell built entirely of brickwork and stone slabs. For a three-phase switch the brick and stone cell has three entirely separate compartments and each compartment contains the two brass cylinders that form the terminals of a single phase. On top of and outside the cell the mechanism for moving the wooden switch rods is mounted. In the Metropolitan station, where the voltage is 6,000, the vertical movement of the ∩-shaped contact piece with its rod is twelve inches. At the Manhattan station, where the operating voltage is 12,000, the vertical movement of the ∩ contacts in opening a switch is seventeen inches. The total break in each phase in a switch at the Metropolitan station is thus twenty-four inches or four inches per 1,000 volts, and the total break per phase in switches at the Manhattan station is thirty-four inches or 2.66 inches per 1,000 volts total pressure.

Oil switches are now very generally employed on alternating circuits that operate at 2,000 volts or more for purposes of general distribution. On circuits of moderate voltage like that just named, and even much higher, it is common practice to use oil switches that have only a single reservoir of oil each, the entire six contacts in the case of a three-phase switch being immersed in this single reservoir. Such switches are usually operated directly by hand and are located on the backs of or close to the slate or marble boards on which the handles that actuate the switch mechanism are located. A

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good example of this sort of work may be seen at the substation in Manchester, N. H., where energy from four water power stations is delivered over seven transmission lines and then distributed by an even larger number of local circuits at 2,000 volts three-phase. At the Garvins Falls station, one of the water power plants that delivers energy to the substation in Manchester, the generators operate at 12,000 volts three-phase and these generators connect directlv with the bus-bars through hand-operated oil switches located on the back of the marble switchboard. These last-named switches, like those at the Manchester substation, have all the contacts of each in a single reservoir of oil.

With very high voltages, where only a few hundred kilowatts are concerned, and also with powers running into thousands of kilowatts at as low a pressure as 2,000 volts, it is very desirable to remove even oil switches from the switchboard and the vicinity of the bus-bars. Great powers as well as very high voltages not only increase the element of personal danger to an attendant who must stand close to a switch while operating it, but also render the damage to other apparatus that may result from any failure of or short-circuit in a switch much more serious.

As soon as switches are removed to a distance from the operating board the necessity for some method of power control becomes evident, since the operator at the switchboard should be able to make or break connections of any part of the apparatus quickly. The necessity for the removal of switches for very large powers to a distance from the operating boards and for the application of mechanical power to make and break connections was met before the development of oil switches. Thus at the first Niagara (A. I. E. E., Vol. xviii, p. 489) power-house, in 1893, the switches for the 3,750-kilowatt, 12,200-volt generators, though of the open air type, were located in a special switch compartment erected in the generator room and over a cable subway at some distance from the operating board. These switches were actuated through compressed-air cylinders into which air was admitted by the movement of levers near the switchboard. Evidently a switch of this capacity—1,000 amperes per pole and 2,200 volts, two-phase—could not well be operated by hand power wherever located, because of the large effort required. In the second generating station at Niagara Falls oil switches similar to those used at the Manhattan Elevated Railway plant in New York, but two-phase, were employed. Each oil switch at Niagara Falls has a capacity of 5,000 horse-power, like the previous open air switches, and is electrically actuated.

In these electrically operated oil switches a small motor is located on top of the brick cell that contains the contact parts, and this motor releases and compresses springs that open and close the switch. While it is not desirable to employ open air switches to open circuits of several thousand or even hundreds of kilowatts at voltages of 2,000 or more, it is nevertheless possible to do so. This is shown by the experience at the first Niagara Falls station, where the 2,200-volt two-phase switches are reported to have opened repeatedly currents of more than 600 amperes per phase without injurious sparking. The great rise of voltage that was shown by the experiments at Kalamazoo to follow the opening of a simple open air switch was avoided at the first Niagara switches by a simple expedient. In these 5,000-horse-power open air switches a shunt of high resistance was so connected between each pair of contacts that the blades and jaws that carried the main body of the current never completely opened the circuit. When the main jaws of one of these switches were opened the shunt resistance continued in circuit until subsequently broken at auxiliary terminals. That no excessive rise of voltage took place when one of these switches was open was shown by connecting two sharp terminals in parallel with the switch and by adjusting these terminals to a certain distance apart. Had the voltage risen on opening the switch above the predetermined amount there would have been an arc formed by a spark jumping the distance between the pointed terminals.

Safety and reliability of operation at very high voltages, say of 5,000 or more, require that each element of the equipment be so isolated as well as insulated from every other element that the failure or even destruction of one element will not seriously endanger the others. With this end in view the cables from each generator to its switch should be laid in a conduit of brick or concrete that contains no other cables. The brick or stone compartment for each phase of each switch should be so substantial that the contacts of that phase may arc to destruction without injury to the contacts of another phase. Bus-bars, like switches, should be removed from the operating switchboard, because an arc between them might destroy other apparatus thereon and even the board itself. It is not enough to remove bus-bars from the switchboard where very high voltages are to be controlled, but each bar should be located in a separate brick compartment so that an arc can not be started by accidental contact between two or more of the bars. It is convenient to have the brick and stone compartments for bus-bars built horizontally one above the other. The top and bottom of each compartment may conveniently be formed of stone slabs with brick piers on one side and a continuous brick wall on the other to hold the stone slabs in position. Connections to the bus-bars should pass through the continuous brick wall that forms what may be termed the back of the compartments. To close the openings between the brick piers at the front of the compartments movable slabs of stone may be used. Feeders passing away from the bus-bars, like dynamo cables running to these bars, should not be grouped close together in a single compartment but each cable or circuit should be laid in a separate fireproof conduit to the point where it passes out of the station.

The folly of grouping a large number of feeders that transmit great powers together in a single conduit was well illustrated by the accident that destroyed the cables that connected the first Niagara Falls power station with the transformer house on January 29, 1903. On the evening of that day lightning short-circuited one of the cables in the short bridge that connects No. 1 station with the transformer house, and all the cables in this bridge, supplying local consumers as well as railways and lighting in Buffalo, were destroyed. This bridge contained probably more than thirty-six cables, as that number of new cables were put in position within twenty-four hours after the accident, and these cables covered with inflammable insulation were huddled closely together. The result was not only the loss of the cables, but also of many times their value in the damage to power users. If these cables had been located in separate fireproof conduits, it is highly probable that only the one directly affected by lightning would have been destroyed.

The brick and stone compartments for bus-bars may be located in the basement underneath the switchboard, as at the Portsmouth station of the New Hampshire Traction Company, or at any other place in a station where they are sufficiently removed from the other apparatus. In power-house No. 2 at Niagara Falls a cable subway beneath the floor level runs the entire length, parallel with

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the row of generators (A. I. E. E., Vol. xlx, p. 537). In this subway, which is thirteen feet nine and three-quarter inches wide and ten feet six inches high, the two structures for bus-bar compartments are located. Each of these structures measures about 6.6 feet high and 1.8 feet wide, and contains four bus-bar compartments. In each compartment is a single bar, and the four bars form two sets for two-phase working. Above the bus-bar compartments and rising from the floor level are the oil switches. A space over the cable subway midway of its length and between the two groups of oil switches is occupied by the switchboard gallery which is raised to some elevation above the floor and carries eleven generator, twenty-two feeder, two interconnecting and one exciter panels. In power-house No. 1 the bus-bars are located in a common space above the 5,000-horse-power open air switches already mentioned and each bar has an insulation of vulcanized rubber covered with braid and outside of this a wrapping of twine. Of course, an insulation of this sort would amount to nothing if by any accident an arc were started between the bars. Where each bus-bar is located in a separate fire-proof compartment, as at Niagara power-house No. 2, the application of insulation directly to each bar is neither necessary nor desirable. Consequently the general practice where each bar has its own fire-proof compartment is to construct the bars of bare copper rods.

With main switches for generators and feeders removed from the operating board and actuated by electric motors or magnets, the small switches at the board with which the operator is directly concerned must of course control these magnets or motors. The small switches at the operating board are often called relay switches, and the current in the circuits opened and closed by these switches and used to operate the magnets or motors of the oil switches may be conveniently obtained from a storage battery or from one of the exciting dynamos if a battery is not to be had.

Probably the best arrangement of the relay switches is in connection with dummy bus-bars on the face of the switchboard, so that the connections on the face of the board constitute at all times a diagram of the actual connections of the generator and feeder circuits. It is also desirable for quick and correct changes in the connections of the main apparatus that all the relay switches and instruments necessary for the control of any one generator or any one feeder be brought together on a single panel of the switchboard. If this plan is followed the operator at any time will have before him on a single panel all of the switches and instruments involved in the connections then to be made, and the chance for mistakes is thus reduced to a minimum. The plan just outlined was that adopted at the Niagara power plant No. 2, where a separate panel is provided for each of eleven generators and each of twenty-two feeders. On each of the eleven generator panels there are two selector relay switches, one generator relay switch and one relay generator field switch. On each of the twenty-two feeder panels there are two relay selector switches. The relay switches on the two interconnecting panels serve to make connections between the two groups of five and six generators, respectively, in power-house No. 2 and the ten generators of power-house No. 1. On each panel there are relay indicators to show whether the oil switches that carry the main currents respond to the movements of their relay switches.

Where the electric generators operate at the maximum voltage of the system, as at Garvins Falls and in the power-house of the Manhattan Elevated Railway, there may be said to be only one general plan of connections possible. That is, the generators must connect directly with the main bus-bars at the voltage of the system, and the feeders or transmission lines must also connect to these same bars. Of course there may be several sets of bus-bars for different circuits or classes of work, but this does not change the general plan of through connections from generators to lines. So, too, the arrangement of switches is subject to variations, as by placing two switches in series with each other in each dynamo or feeder cable, or by connecting a group of feeders through their several switches to a particular set of bus-bars and then supplying this set of bars from the generator bus-bars through a single switch.

Where the voltage of transmission is obtained by the use of step-up transformers, the connections of these transformers may be such as to require nearly all switching to be done on either the high or low-tension circuits. The more general practice is to do all switching in the generator circuits and on the low-tension side of transformers, except in the connection and disconnection of transformers and transmission lines with the high-tension bus-bars, when not in operation. Where generators operate at the maximum voltage of the system only two main groups of switches are necessary, one group connecting generators to bus-bars, and the other group connecting bus-bars to the transmission lines. As soon as step-up transformers are introduced the number of switch groups must be increased to four if the usual method of connection is followed, and there must be both a high voltage and a low voltage set of bus-bars. That is, one group of switches must connect generators with low-tension bus-bars, another group must connect low-tension bars with the primary coils of transformers, a third group joins the secondary coils of transformers with the high-tension bars, and the fourth group of switches joins the transmission lines to the high-tension bus-bars. As long as switches were not available to break circuits of large power at the voltages of transmission there seemed to be no escape from the four groups of switches just mentioned. These switches connecting the secondary coils of step-up transformers to the high-tension bus-bars and also the transmission lines to these same bars have often been of the simple open air type with short knife-blade construction. These switches have been used to disconnect the secondary coils of transformers and also the transmission lines from the high-tension bus-bars when no current was flowing, and switches of the simple knife-blade construction with short breaks could of course be used for no other purpose. With switches of this sort on the high-tension side of apparatus the practice is to do all switching of line circuits on the low-tension side.

It is possible, however, to avoid some of this complication and multiplication of switches if each generator with its transformers is treated for switching purposes as a unit and the switching for this unit is done on the secondary or high-voltage side of the step-up transformers. The adoption of this plan, of course, implies the use of switches that are competent to break the secondary circuit of any group of transformers under overload conditions and at the maximum voltage of the system, but oil switches as now made are competent to meet this requirement. When all switching of line circuits is confined to those of high voltage there is also the incidental advantage that heavy contact parts carrying very large currents are avoided in the operating switches. Where each generator is connected directly to its own group of transformers the secondary coils of these transformers will pass through oil switches to high-tension bus-bars, and the use of low-tension bus-bars may be avoided. From these high-tension bus-bars the transmission

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lines will pass through oil switches, so that on this plan there are only two sets of main switches, namely, those connecting the secondary coils of transformers and the transmission lines to the high-tension bus-bars, that are concerned in the operation of the generating station. Each group of two or three transformers, according as two or three are used with each generator, should be connected to its generator through short break, open air knife switches for convenience in disconnecting and changing transformers that are not in operation, but these switches are not intended or required to open the circuits of the generators and primary coils when in operation.

A plan similar to that just outlined was followed at the station of the Independent Electric Light and Power Company, San Francisco, where each of the 550-volt generators is ordinarily connected directly to the primary coils of two transformers that change the current from two-phase to three-phase and then deliver it through oil switches to the high-tension bus-bars at 11,000 volts. To these bus-bars the 11,000-volt feeders for five substations are connected through switches. At this station there is a set of 550-volt bus-bars to which any one of the generators may be connected, but to which no generator is connected in ordinary operation. The generators alone have switches connecting with these bars. When it is desirable to operate any particular generator on some pair of transformers other than its own, that generator is disconnected from its own transformers and connected to the 550-volt bus-bars. The generator, whose transformers are to be operated by the generator before mentioned, next has its switch connected to the 550-volt bus-bars, while the brushes of the contact rings of the former generator are raised. As the leads from each generator to its two switches are permanently joined, the switching operations just named connect the transformers of one generator with the other generator that has its switch closed on the 550-volt bars.

Where it is desired that a single reserve transformer may be readily substituted for any one of a number of transformers in regular use, the connections to each of these latter transformers may be provided with double-pole double-throw knife switches on both the primary and secondary sides, so that when these switches are thrown one way at any transformer in regular use the reserve transformer will be connected in its place. The result of the experiments with oil switches at Kalamazoo is confirmed by the regular use of such switches on the 40,000-volt transmission lines at the Colgate power-house in California.

Development of the World's Steel Industry.

The *Deutsche Industrie Zeitung* says that of all the countries producing steel in 1902 the United States led, with an output of 15,000,000 tons. These figures grow in importance when it is remembered that the world's production in 1894 was only 12,851,000 tons. Germany's production in 1902 was 7,780,000 tons, one-half that of the United States; while England's was only 5,000,000 tons, or one-third the production of the United States. The world's total steel output for 1902 was estimated at 35,000,000 tons. This would indicate a growth of 700 per cent in twenty-two years, or an increase from a little more than 4,000,000 tons in 1880 to 35,000,000 tons in 1902. The great increase is due to the introduction and improvement of the processes, notably the flame furnace. Pennsylvania leads all parts of the world in the use of this furnace, followed by Illinois, New England, Ohio, etc.

The steel produced by the Bessemer process during the last fifteen years was used mostly for rails. In England more than half of the steel produced by the Bessemer process went into rails. In Germany and the United States the proportion is not so large. While the United States produced 9,306,471 tons of steel ingots in 1902, it turned out only 2,876,293 tons of steel rails, or about thirty per cent of the steel-ingot production. In Germany the amount of Bessemer steel put into rails is proportionately smaller. Because of the resisting power of the steel, the wear and tear on the rails is far less; but the manifold uses to which the steel can be put has taken away somewhat from the importance of steel-rail manufacture. The last twenty years has resulted in an age of steel. Three times as much steel is now produced as in 1894. The universal opinion seems to be that the production of steel is to go on increasing. If, during the next twenty years, the same rate of increase is maintained as marked the past, 1923 will see an advance of from 20,000,000 to 25,000,000 tons in the world's total production. In this enormous increase the United States, according to experts, is to play the important part. At the very least, this opinion seems reasonable. The United States now uses in a year 30,000,000 tons of the very best iron ore. In twenty years this would mean a total of 600,000,000 tons—possibly the exhaustion of the sources of supply.

The American Street Railway Association.

The twenty-second annual meeting of the American Street Railway Association will be held at the Grand Union Hotel, Saratoga Springs, N. Y., Wednesday, Thursday and Friday, September 2, 3 and 4, 1903.

Papers will be presented on the following subjects:

"Electric Welded Joints."

"The Evils of Maintenance and Champerty in Personal Injury Cases."

"Train Orders and Train Signals on Interurban Roads."

"Freight and Express on Electric Railways."

"The Manufacture and Distribution of Alternating Currents for City Systems."

"Comparative Merits of Single and Double-Truck Cars for City Service."

"The Right of Way."

An extensive exhibit of street railway supplies will be made at the hotel headquarters.

The annual banquet will be held on Friday evening, September 4, when the officers-elect will be installed.

The headquarters of the association will be at the Grand Union Hotel. Other hotels are the United States, American-Adelphi, Congress Hall, Worden and Kensington.

Railroad rates will probably be as in former years.

Electric Tramway in Spain.

Consular Agent A. E. Carleton, of Almeria, calls attention to a concession to be granted for the building of an electric tramway between Mondariz and Porvino. A second section is to be constructed later. This will extend the line to Vigo. The entire length is to be twenty-three miles, almost equally divided between the two sections. The first is to be 10.5 miles; the other, 12.5 miles. The electric power is to be obtained and transmitted from two waterfalls on the River Tea, between Mondariz and Puenta Areas, and from a waterfall on the River Mino, about 15.5 miles from the middle of the line. The force at the first falls is 268 horse-power at the axis of the turbines, and of the second 1,375 horse-power. As the road requires only 375 horse-power, the balance will be used by various industries in the enterprising town of Vigo. The consular agent also reports that another electric tramway is to be built at Linares. It would seem as if every mountain land on earth is looking toward a time when its waste waters can be worked up into electrical force or power for industrial, transportation and all kinds of commercial purposes.

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The Recently Installed Saut-Mortier Electrical Power Transmission Plant in France.

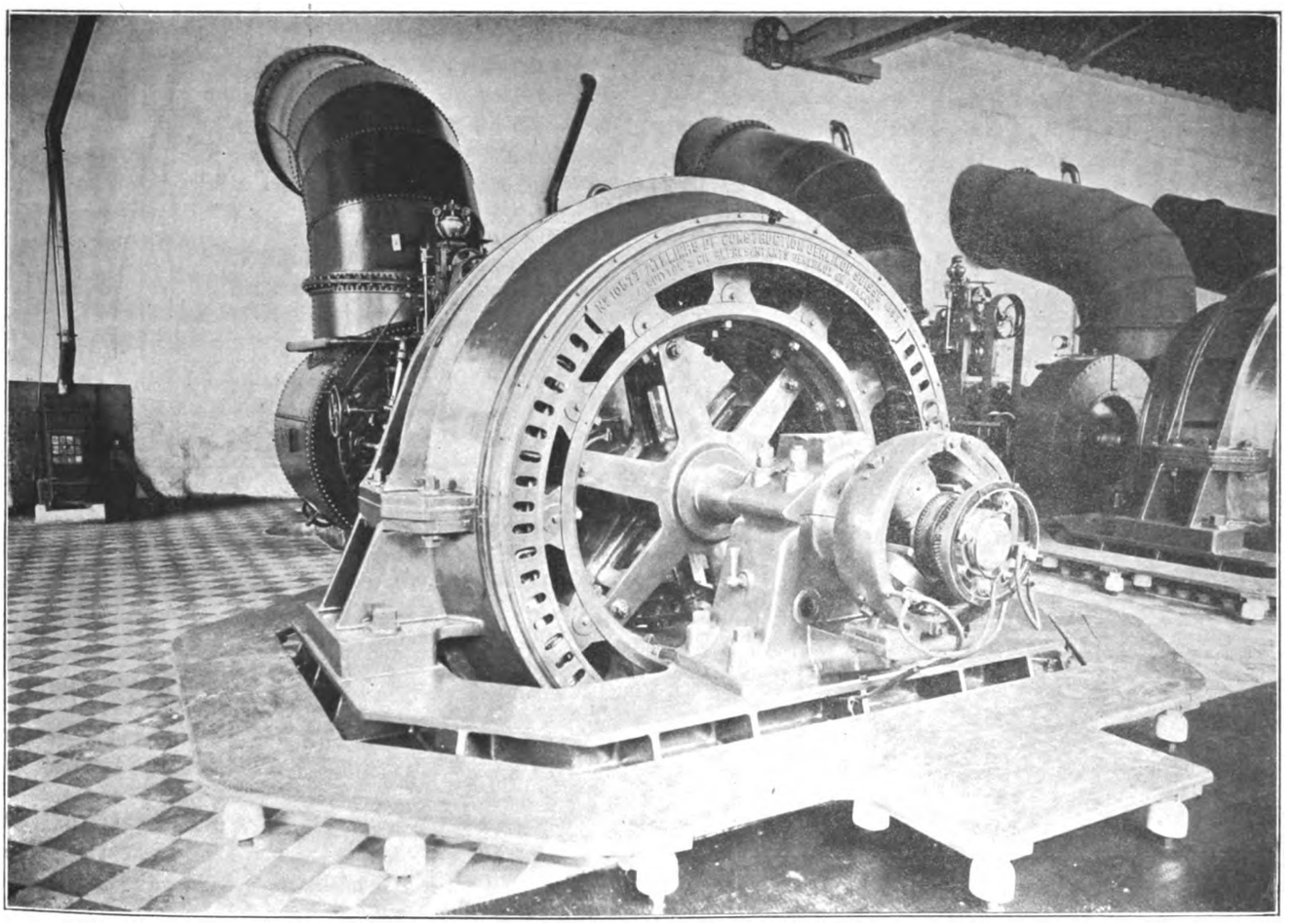
By Frank C. Perkins.

THE Jura is one of the industrial sections of France, and electrical power is utilized to a great extent in connection with the factory work at St. Claude. There is a transformer substation located at St. Claude, which is connected by a power transmission line with the hydroelectric station at Saut-Mortier. The water power is obtained from the River Ain, which rises in the Jura, flowing through that section as well as the Ain, and emptying into the River Rhone. The ordinary flow available from the River Ain is somewhat more than four cubic metres per second, while during high water it rises to about seven cubic metres per second.

The accompanying illustrations show the exterior and interior of the power-house at Saut-Mortier, which was equipped with electrical generator and switchboards by Maschinenfabrik Oerlikon. Advantage is taken of the Lac de Chalain as a reservoir for the water, which provides a reserve of about 20,000,000 cubic metres. The normal discharge is sixteen cubic metres per second, which gives a total of 3,000 horse-power with a fall of 18.4 metres and 2,500 horse-power with a fall of 13.4 metres. The water is conducted to the power-house through a canal 1,500 metres in length and enters the entrance canal at the power-house, which is forty-five metres in length, the weir being ten metres high. There are three sluices, each one metre in height and 1.78 metres in width, connecting with the canal, which is 234 metres in length and eleven metres wide, with a fall of one to twenty-five. The double supply pipes are constructed of steel eight millimetres in thickness and 1,700 millimetres in diameter.

The power-house has a total length of 34.8 metres, while it is 14.5 metres in width, and has a capacity for four units. The turbines are four in number, and each has a capacity of 700 horse-power when operating at a speed of 250 revolutions, and a head of 18.4 metres. These turbines will develop 500 horse-power under a head of 13.4 metres. They are connected to the electrical generators through elastic insulating couplings of the Rafford type. The turbines are equipped with regulators of the system Piccard, which are said to be very close in the governing of the machines.

The electrical generators are of the Oerlikon three-phase type, supplying a current of fifty amperes per phase, at a potential of 7,500 volts. The frequency is fifty periods per second, when the machines are operating at 250 revolutions per minute. The diameter of the field magnet is 1,870 millimetres, the breadth being 920 millimetres. The two parts of the field coil are each wound with eighty-three turns of copper, bound 60 by 2 millimetres and the two coils are connected in series, making a total of 166 turns. The copper of the field magnet weighs



SAUT-MORTIER POWER PLANT, 700-HORSE-POWER TURBINE AND ALTERNATOR.

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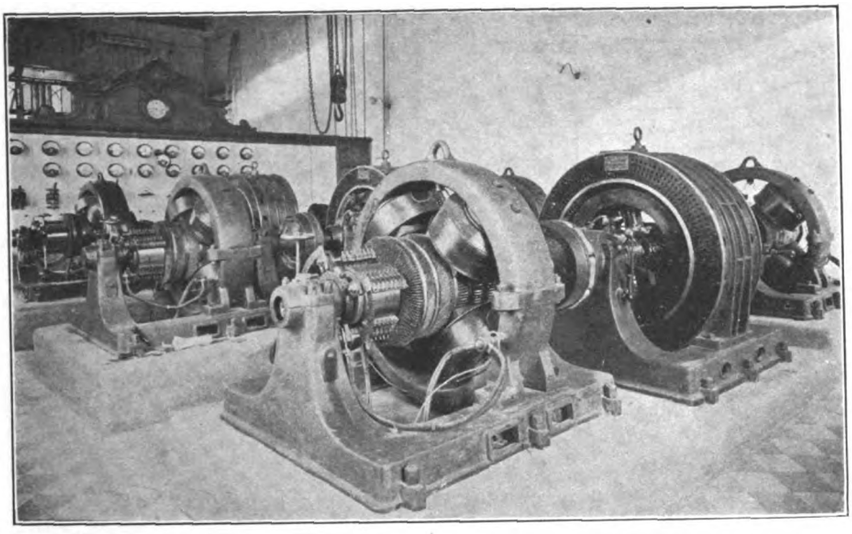


Motor-Generator Sets in St. Claude Transformer Substation.

1,250 kilogrammes. The enclosing frame of the machine has twelve openings for ventilation, and has an exterior diameter of 309 millimetres and a total width of 900 millimetres, while the interior diameter is 2,540 millimetres.

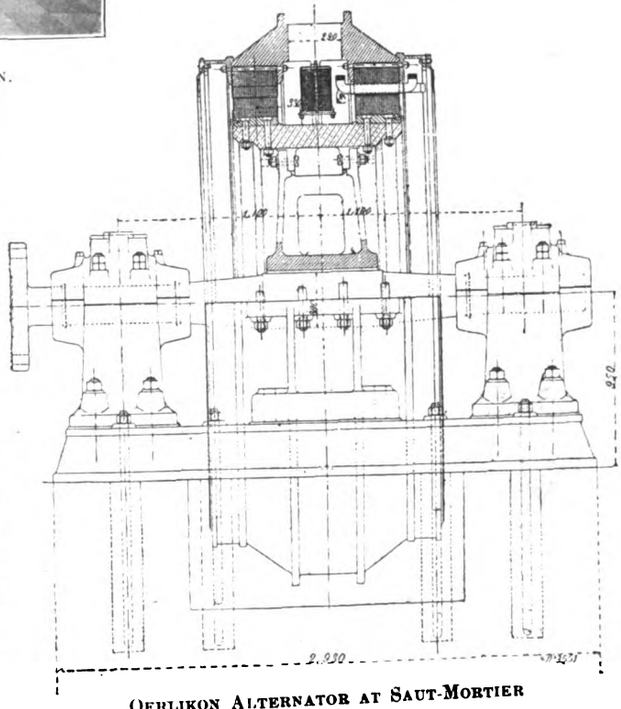
The outer diameter of the armature core is 2,540 millimetres, the rings being 170 millimetres in width. The armature is 250 millimetres in width, and each of the two halves has seventy-two slots, two per pole and phase in which the coils are placed, with mica insulation. Each coil consists of thirty-three turns of two diameters in parallel, each 3.2 millimetres in diameter. The copper of the armature weighs 600 kilogrammes, while the total weight is 1,500 kilogrammes. The normal working current is fifty amperes per phase and a power-factor of 0.8.

The efficiency at normal load and cos. $\phi = 0.8$ is 93.5 per cent. The exciting machines have a capacity of 3,600 watts at a parallel of 300 volts, and are of the four-pole shunt-wound type of drum winding.

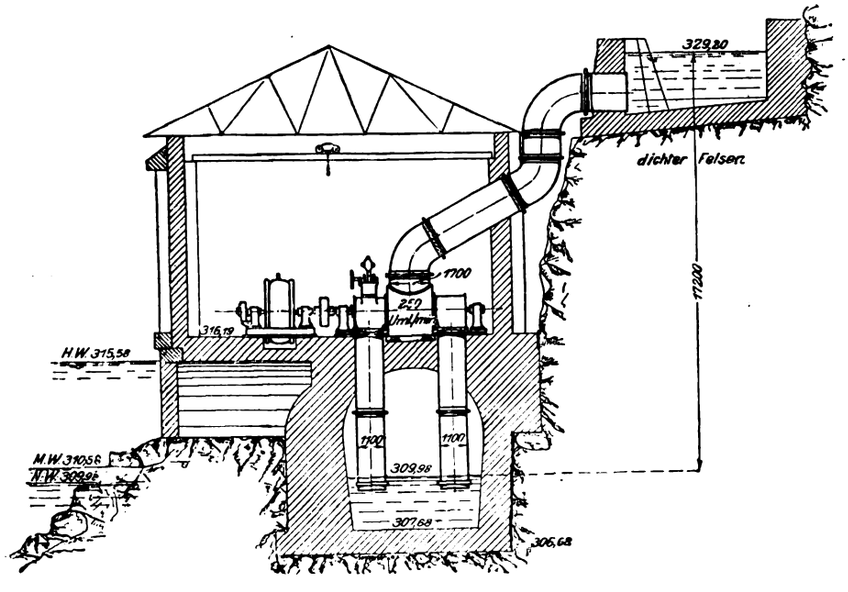
The switchboard gallery of the main power station at Saut-Mortier is 6.7 metres long and 4.28 metres high, the inner height below the gallery being 2.8 metres. The switchboard proper consists of a number of marble panels 2.25 metres in height; the total length of the board being 4.5 metres. The switchboard framework, as well as that of the gallery, is of steel and iron, the flooring being of cement. The rheostats, lightning arresters, fuses and bus-bars are located in a room under the switchboard gallery, and the various ammeters, voltmeters and other measuring instruments, together with the controlling apparatus, are placed on the upper gallery.

The high-tension power transmission lines from the power station at Saut-Mortier to the substation at St. Claude are twenty-six kilometres in length. Two transmission lines are installed, each consisting of three conductors, each having a diameter of eight millimetres. Another transmission line connects the power station with the town of Montau, which is nine kilometres in length, and consists of three wires having each a diameter of eight millimetres. To this line other branch lines are connected of four and six-millimetre conductors supplying current to Oyonnax, Belignat, Montreal and Marchon. The high-tension transmission line from the power-house to Arinthod is eight kilometres in length, while those to Cernon and Morian are five kilometres and ten kilometres, respectively, each of the three conductors measures four millimetres in diameter.

The total length of the high-voltage power transmission lines is 105 kilometres and all of the receiving stations are connected with the power-house by telephone lines, the two wires of which are two millimetres in diameter. The total number of poles used was 3,940, measuring nine, ten and twelve metres



Oerlikon Alternator at Saut-Mortier Power-House.



Turbines and Generator, Saut-Mortier Power-House.

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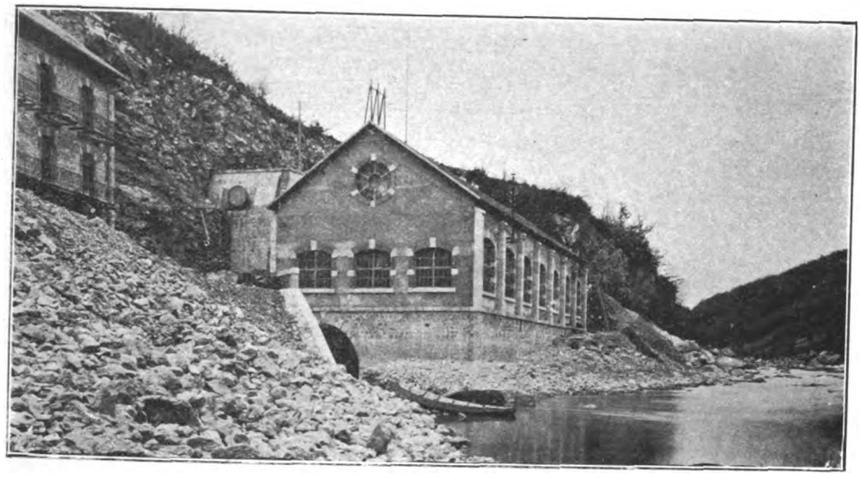
in length, the poles being placed from 1.4 to two metres in the ground.

On the transmission line to St. Claude there is a transformer located in the station at Jeurre, while in the substation at St. Claude there are four transformers each of seventy kilowatts, and further on in the city there are five other transformer installations. The accompanying illustration shows the St. Claude substation which has a floor area of 186 square metres. It is equipped with a seven-ton crane for handling the various machines, making up the motor-generator sets.



SAUT-MORTIER HYDROELECTRIC POWER STATION.

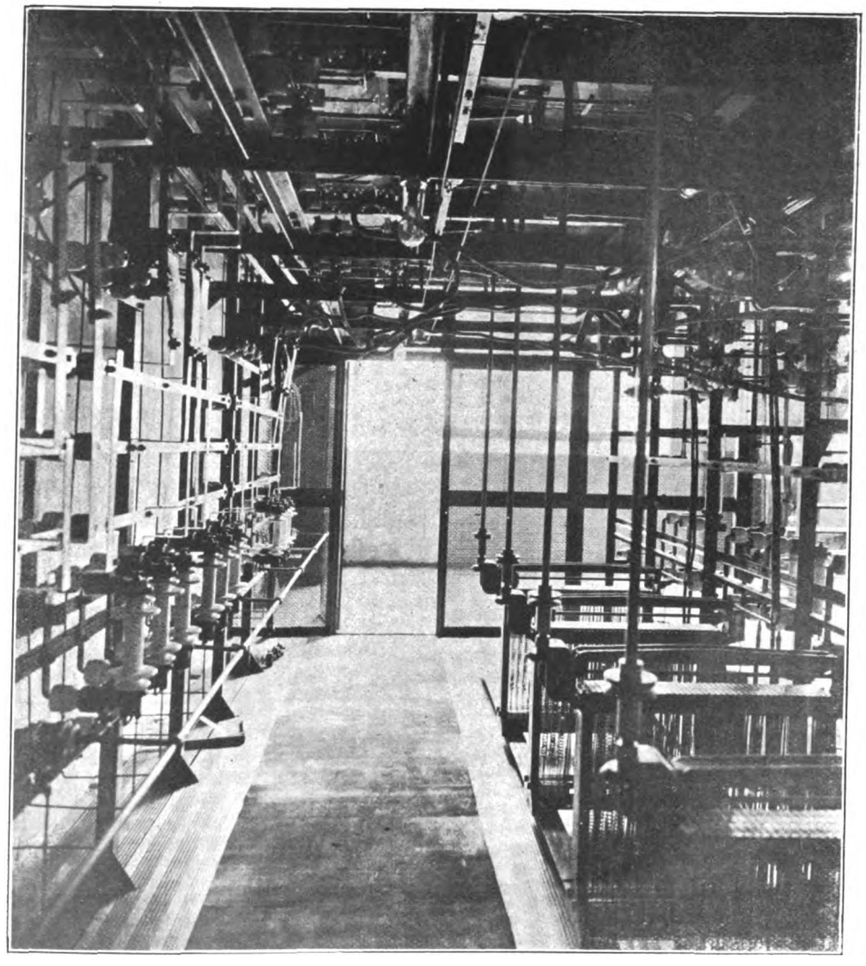
The three-phase motors driving the motor-generator groups are ten-pole Oerlikon machines, each having a capacity of 150 horse-power. They operate at a speed of 590 revolutions per minute, and are supplied by a low-tension three-phase current at 200 volts from the step-down transformers, the frequency being fifty periods per second. The stators are 800 millimetres internal diameter and measure 230 millimetres in width. They are provided with 150 slots, with fourteen parallel copper conductors measuring 3.8 millimetres in diameter. The rotor has an outside diameter of 898 millimetres and has 180 slots, in each of which there are six parallel copper conductors four millimetres in diameter.

Each three-phase motor is directly connected to two direct-current dynamos, one on either side, each having a capacity of seventy-five horse-power. These machines operate at 590 revolutions per minute, supplying a continuous current of 200-volt pressure. The armatures of these machines are 470 millimetres in diameter, and the iron core measures 320 millimetres in width. Each armature has 117 slots of a section, 6 by 30 millimetres, and in each slot there are two conductors, each of which consists of three parallel wires four millimetres in diameter. The commutators of these direct-current machines have each 117 copper segments. The inside diameter of the magnetic field measures 486 millimetres. There are four field-magnet coils, each having 2,450 turns of wire having a section 1.8 by 2.2 millimetres.

The switchboard equipment of the substation at St. Claude is divided into two parts, the one for the high-tension apparatus and the other for the low-tension switches, meters, rheostats, etc.

The low-tension power distribution circuits are operated at a potential of 200 volts on the three-phase lines, the motors varying in size from one-half to thirty-five horse-power each. There are a total of eighty-five three-phase motors working in the various factories, with an output of 684 horse-power.

The arc and incandescent lighting in St. Claude is operated both on the 200-volt, three-phase distribution circuits and also on the 120-volt direct-current lines. In St. Claude there are 3,200 incandescent lamps in operation, with a total of 36,000 candle-power. In the other villages along the transmission lines there are 2,000 incandescent lamps employed on the three-phase low-tension circuits, having a total of 23,500 candle-power.



REAR OF SWITCHBOARD, SAUT-MORTIER POWER PLANT.

Where it is desired to employ water power and a large volume is easily obtainable under comparatively low head, a turbine wheel will be found efficient. High heads and less volume are usually sought, but not always readily obtainable. The relative cost of installation depends entirely upon the surroundings, character of stream and other factors.

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POWER MEASUREMENT ON ALTERNATING-CURRENT CIRCUITS.

R. B. WILLIAMSON.

(Concluded.)

POWER MEASUREMENT IN TWO-PHASE CIRCUITS.

The ordinary two-phase circuit employs four wires, as shown in Fig. 4, and is equivalent to two single-phase circuits so far as power measurement is concerned. A wattmeter is inserted in each circuit and the sum of the two readings gives the total power supplied. If it were certain that the loads on the two phases were exactly alike, both as to amount and power-factor, it would be sufficient to measure the power on one phase and multiply the result by two. Unfortunately this can not be done in the majority of cases, and if only one wattmeter is at hand the best plan is to keep the load constant between readings and shift the wattmeter from one side to the other, either by means of a special switch or by changing the connections. Fig. 5 shows the same connections for a three-wire two-phase system where the middle wire acts as a common return for the two outer wires. The potential coils are here connected to the middle wire instead of as shown in Fig. 4, but otherwise the connections are the same.

Fig. 6 shows a method of measuring the power on a three-wire two-phase circuit with a single wattmeter. This method can only be used where the load on the two phases is balanced, hence it is not always applicable. In Fig. 7, let the lines $o\ e$ and $o\ d$ represent the equal currents in the outside lines; since these currents differ in phase by ninety degrees, their resultant will be represented by $o\ e = I\sqrt{2}$. The current in the middle wire, *i. e.*, in the current coil of the wattmeter, is therefore represented by $o\ e$. The current II lags behind the electromotive forces EE represented by the lines $o\ a$ and $o\ b$ lag equal angles ϕ, ϕ since a balanced condition has been assumed. A reading of the wattmeter is first taken with the potential coil connected, as shown in Fig. 6, and the connection is then quickly transferred to the other side, as shown by the dotted line; the sum of the two readings gives the total power. The current in the current coil of the wattmeter is $I\sqrt{2}$ in each case. By referring to Fig. 7 it is seen that the current in the wattmeter differs in phase from the electromotive force on one side by $45° + \phi$ and on the other side by $45 - \phi$. Hence on the one side we have $W_1 = EI\sqrt{2}\cos(45° + \phi)$ and on the other side $W_2 = EI\sqrt{2}\cos(45 - \phi)$, and total power $= W_1 + W_2 = EI\sqrt{2}\cos(45° + \phi) + EI\sqrt{2}\cos(45° - \phi)$

$= EI\sqrt{2}(\cos 45° \cos\phi - \sin 45° \sin\phi + \cos 45° \cos\phi + \sin 45° \sin\phi)$

$= EI\sqrt{2}(2\cos 45° \cos\phi)$,

but $\cos 45° = \frac{1}{\sqrt{2}}$ hence

$= 2\,EI\cos\phi$

but $EI\cos\phi$ is the power expended in

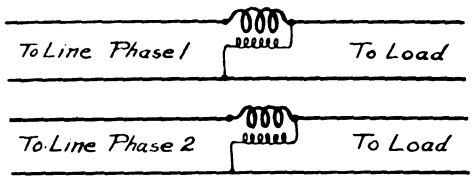

FIG. 4. POWER MEASUREMENT ON ALTERNATING-CURRENT CIRCUITS.

one phase and $2\,EI\cos\phi$ is the total power, hence for a balanced load the above method of using a single wattmeter will give the total power expended. Note that if ϕ becomes 45° or $\cos\phi = \frac{1}{\sqrt{2}} = .707$, one of the readings will become zero

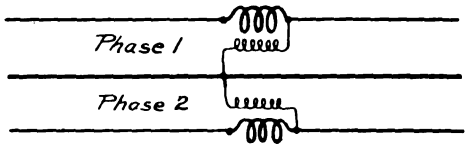

FIG. 5.—POWER MEASUREMENT ON ALTERNATING-CURRENT CIRCUITS.

because $\cos(45° + \phi) = \cos 90° = 0$, and the other reading gives the total power which is $W_2 = EI\sqrt{2}\cos(45° - \phi) = EI\sqrt{2}\cos 0° = EI\sqrt{2}$.

Fig. 8 shows another method of using a single wattmeter for measuring the power on a three-wire two-phase circuit. Like the method shown in Fig. 6 it is

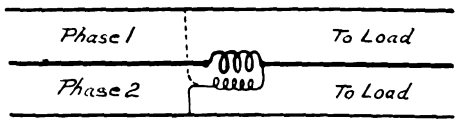

FIG. 6.—POWER MEASUREMENT ON ALTERNATING-CURRENT CIRCUITS.

only allowable on a balanced load. In this case the potential coil of the wattmeter is connected across the two outside lines and the current coil is connected in the middle wire. The resultant electromotive force acting as the potential coil is represented by $o\ f$, Fig. 7. The value of this electromotive force is $E\sqrt{2}$. The current in the current coil is $I\sqrt{2}$ as in the last case, and the angle between the resultant current and resultant electromotive force is the same as the angle of lag ϕ in each phase as can be seen by referring to Fig. 7. The reading of the wattmeter is therefore $I\sqrt{2} \times E\sqrt{2} \times \cos\phi = 2\,EI\cos\phi$. That is a single wattmeter connected as shown in Fig. 8 reads the total power, provided the load is balanced. This method does not require the shifting of any connections, but the potential coil of the wattmeter must be able to stand a pressure $\sqrt{2}$ times as great as the pressure on either phase. On a two-phase system the angle ϕ may be different on the two phases, hence, unless the load is perfectly balanced it could not be said that the power-factor was equal to $\cos\phi$. The power of factor of the load as a whole would, however, be the ratio of the total actual watts as obtained from the wattmeter readings to the total voltamperes as obtained from voltmeter and ammeter readings taken on each phase.

THREE-PHASE MEASUREMENT.

The power supplied to a three-phase receiving device or circuit can be measured with either one, two or three wattmeters. Accurate results can not be obtained with one wattmeter unless the load is balanced on all three phases. Of course one wattmeter could be used if means were provided for changing the connections rapidly, and the load kept constant while the readings are being taken, but in many cases it is inconvenient to do this. Three wattmeters can be used, but as two are sufficient to measure the power no matter how unbalanced the load may be, three wattmeter methods are not generally adopted. We will, however, first consider three wattmeter methods as they lead up to the single wattmeter and two wattmeter methods. Suppose in Fig. 9 that A represents a three-phase Y-connected motor, the power consumption of which is to be measured. If a wattmeter current coil is connected in each main, as shown, and the potential coils connected across corresponding phases, it is evident that wattmeter 1 measures the power supplied to phase 1, wattmeter 2 to phase 2, and wattmeter 3 to phase 3. Hence the total power supplied is the sum of the three wattmeter readings whether the load be balanced or unbalanced, or whether the power-factor be high or low. Evidently, if the load were the same on all three phases and the angle of lag the same, *i. e.*, if the load were exactly balanced, it would be sufficient to use a single wattmeter and multiply the reading by three.

In many cases it would not be possible to get at the neutral point k, Fig. 9, in order to connect the potential coils and thus impress on each coil the voltage of a single

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phase. An artificial neutral may, however, be obtained, as shown in Fig. 10, by connecting three non-inductive resistances across the circuit. If the potential coils of the three wattmeters are exactly alike the auxiliary resistance may be omitted and the ends of the potential coils joined together, as indicated at the neutral point of the auxiliary resistance in Fig. 10.

The most common method of making three-phase power measurements is by means of two wattmeters connected as shown in Fig. 11. The receiving circuit may be balanced or unbalanced, and be connected Y or Δ. Take the instant when the currents in lines a and b are in the positive direction, which we will assume is toward the right as represented by the arrows on lines a b. Then the instantaneous currents i_1, i_2, i_3 in the three receiving circuits will be as shown by the

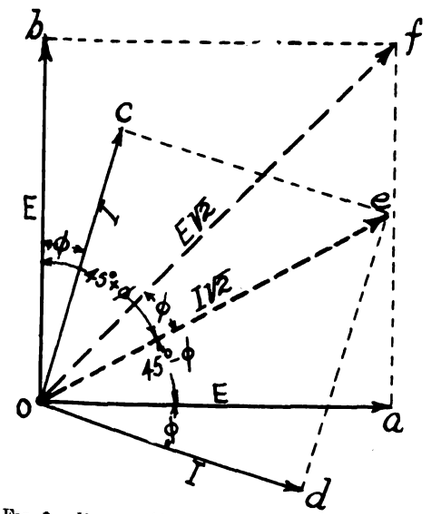

FIG. 7.—POWER MEASUREMENT ON ALTERNATING-CURRENT CIRCUITS.

arrows, wire c acting as the return for wires a and b. The electromotive force acting on the potential coil of wattmeter 1 will be directed as shown by the arrow e_1 and that acting on the potential coil of wattmeter 2 will be directed as shown by the arrow e_2. The current in main a, and hence in the current coil of wattmeter 1, will be at this instant $^ia = i_1 + i_3$. We also have $i_2 = {}^ib + i_3$ or $^ib = i_2 - i_3$.

These currents can be added as indicated, because they are instantaneous values. Now the reading of wattmeter 1 is the average value of all the products of the instantaneous current ^ia which flows through its current coil into the instantaneous values of the electromotive force e_1 which acts on its potential coil. Hence, if W_1 is the reading of wattmeter 1, we have

$$W_1 = \text{average } {}^ia\ e_1$$
$$\text{and } W_2 = \text{average } {}^ib\ e_2$$

but $^ia = i_1 + i_3$ and $b = i_2 - i_3$, hence W_1 = average $(i_1 + i_3)\ e_1$ and W_2 = average $(i_2 - i_3)\ e_2$. The sum of the readings $W_1 + W_2$ = average $e_1\ i_1$ + average $e_2\ i_2$ + average $(e_1 - e_2)\ i_3$.

Now from Fig. 11 it is seen that the difference between e_1 and e_2 is equal to e_3,

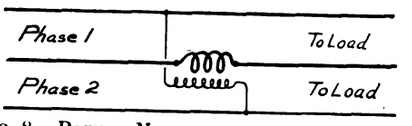

FIG. 8.—POWER MEASUREMENT ON ALTERNATING-CURRENT CIRCUITS.

the instantaneous electromotive force between a and b, hence we have

$$W_1 + W_2 = \text{average } e_1\ i_1 + \text{average } e_2\ i_2 + \text{average } e_3\ i_3$$

that is, the sum of the two wattmeter readings gives the total power supplied to the three receiving circuits.

It is necessary, however, in taking the sum of these readings to pay due attention to the sign of the readings because under certain circumstances the reading of one of the wattmeters must be considered as negative and the numerical difference of the readings taken in order to obtain the actual watts.

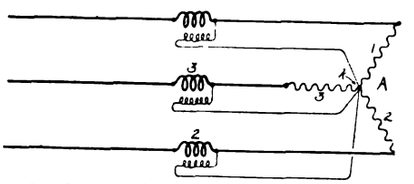

FIG. 9.—POWER MEASUREMENT ON ALTERNATING-CURRENT CIRCUITS.

If the load were non-inductive and balanced, the currents in the wattmeter current coils would be in phase with the Y electromotive forces of the system. For example, in Fig. 12, if $o\ a$, $o\ b$ and $o\ c$ represent the three electromotive forces between the three lines and the neutral point of the system, then the currents in the lines would be in phase with these electromotive forces on non-inductive load. But the coils of the wattmeters are not connected between each of the lines and the neutral point as in Fig. 9. They are connected across the lines and consequently, even on non-inductive load, the current in the potential coil is not in phase with the current in the current coil. The electromotive

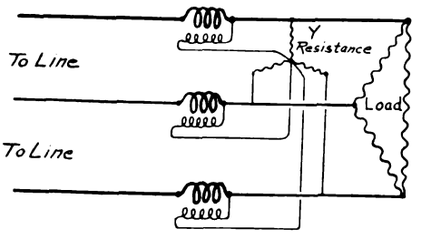

FIG. 10.—POWER MEASUREMENT ON ALTERNATING-CURRENT CIRCUITS.

force impressed on potential coil 1 is $o\ a - o\ c = o\ d$, Fig. 12, and that impressed on potential coil No. 2 is $o\ b - o\ c = o\ e$, or on non-inductive load, the pressure applied to coil 1 is thirty degrees behind the current and that applied to coil 2 is thirty degrees ahead of the current. If E is the pressure per phase, *i. e.*, the pressure between each line and the neutral point, then the pressure between the lines, represented by $o\ d$ or $o\ e$, is $E\sqrt{3}$. Now if we have a balanced load with power-factor less than one the three currents will be no longer in phase with the Y electromotive forces, but will lag by an angle ϕ

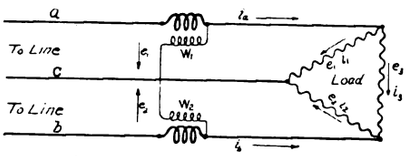

FIG. 11.—POWER MEASUREMENT ON ALTERNATING-CURRENT CIRCUITS.

in each phase as shown in Fig. 12 by the dotted lines $o\ f$, $o\ g$, $o\ h$. The phase difference between the currents in the coils of wattmeter No. 1 then becomes $30° - \phi$ and in No. 2, $30° + \phi$. The indication of wattmeter No. 1 will be $W_1 = \sqrt{3}$ EI cos $(30° - \phi)$ and of No. 2 $W_2 = \sqrt{3}$ EI cos $(30° + \phi)$. Now if $\phi = 0°$, power-factor = 1, the wattmeters read alike and each indicates half the load. If ϕ becomes sixty degrees, *i. e.*, power-

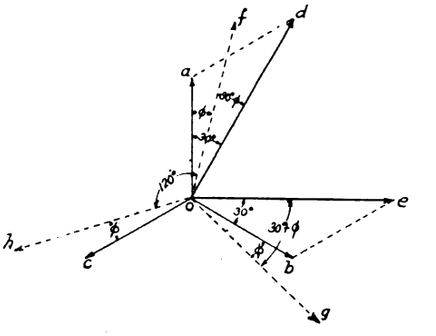

FIG. 12.—POWER MEASUREMENT ON ALTERNATING-CURRENT CIRCUITS.

factor = 0.5 cos $(30° + \phi) = 0$ and the total power is indicated by one wattmeter. If ϕ is greater than sixty degrees, *i. e.*, power-factor less than 0.5, cos $(30° + \phi)$ becomes negative and the difference in the readings of the wattmeters must be taken. If ϕ becomes ninety degrees the readings of the two meters are again alike, but one is positive and the other negative, hence the total power is zero. This is as it should be, because, evidently, if the angle of lag is ninety degrees in each phase no power is being expended.

Sometimes it is difficult to tell whether or not the power-factor of the load is less than 0.5, and whether the sum or the

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difference of the readings should be taken. Generally, the character of the load will give an approximate idea as to the value of the power-factor, but if there is any doubt on the matter a bank of lamps or other non-inductive load can be attached and the reading of the wattmeter noted. If when this load is replaced by the inductive load, without changing the relative connections of the wattmeters, one of the wattmeters tends to read backward, it shows that the power-factor is less than 0.5.

For a balanced load it has been shown that the readings of the meters are $W_1 = \sqrt{3}\ EI \cos(30° + \phi)$ and $W_2 = \sqrt{3}\ EI \cos(30° - \phi)$, where I is the line current and E the Y voltage, or $\sqrt{3}\ E$ the voltage between any two lines. The sum of the readings $W_1 + W_2 =$

$$\sqrt{3}\ EI(\cos 30° + \phi) + \cos(30° - \phi)$$
$$= \sqrt{3}\ EI(\cos 30° \cos\phi - \sin 30° \sin\phi + \cos 30° \cos\phi + \sin 30° \sin\phi)$$
$$= \sqrt{3}\ EI(2 \cos 30° \cos\phi) = 3\ EI,$$

since $\cos 30° = \frac{\sqrt{3}}{2}$. In other words, the sum of the readings is three times the power expended in each phase, and hence gives the total power. This affords another proof that the sum of the two wattmeter readings gives the total power. The former method of proof used instantaneous values of currents and electromotive forces, whereas this method uses virtual or effective values and takes into account the phase relations existing in the wattmeters, assuming that the power-factor is the same in the three phases.

A method of using a single wattmeter for three-phase power measurement is shown in Fig. 6, if we consider the three lines to be those of a three-phase system instead of a three-wire two-phase system as indicated in the figure. A reading is taken with the potential terminal first connected to one outside wire, as shown by the full line. The connection is then transferred, as shown by the dotted line. In one position the meter gives a reading $\sqrt{3}\ EI \cos(30° + \phi)$ and in the other $\sqrt{3}\ EI \cos(30° - \phi)$. This method can be used provided the load is balanced.

In connection with Fig. 11 it should be noted that the readings of the wattmeters vary with the power-factor of the load and that the ratio of the two readings is

$$\frac{\sqrt{3}\ EI(\cos 30° - \phi)}{\sqrt{3}\ EI(\cos 30° + \phi)} = \frac{\cos(30° - \phi)}{\cos(30° - \phi)} = \frac{\sqrt{3}\cos\phi - \sin\phi}{\sqrt{3}\cos\phi + \sin\phi}$$

The same is true of the arrangement in Fig. 6, for a three-phase system if we take the ratio of the readings obtained with the potential coil connected to the two sides. The ratio of the readings depends only on the power-factor, hence by noting the ratio, the power-factor can be determined even if the volts and amperes are not known, assuming of course that we are dealing with a balanced load. For example, if ϕ were sixty degrees we would have

$$\frac{\sqrt{3}\cos 60° - \sin 60°}{\sqrt{3}\cos 60° + \sin 60°} = \frac{\sqrt{3} \times \frac{1}{2} - \frac{\sqrt{3}}{2}}{\sqrt{3} \times \frac{1}{2} + \frac{\sqrt{3}}{2}} = 0.$$

If ϕ were 30°, the ratio would be

$$\frac{\sqrt{3} \times \frac{\sqrt{3}}{2} - \frac{1}{2}}{\sqrt{3} \times \frac{\sqrt{3}}{2} + \frac{1}{2}} = \frac{1}{2}$$

We can then calculate a pair of curves, Fig. 13, one for positive ratios, value of

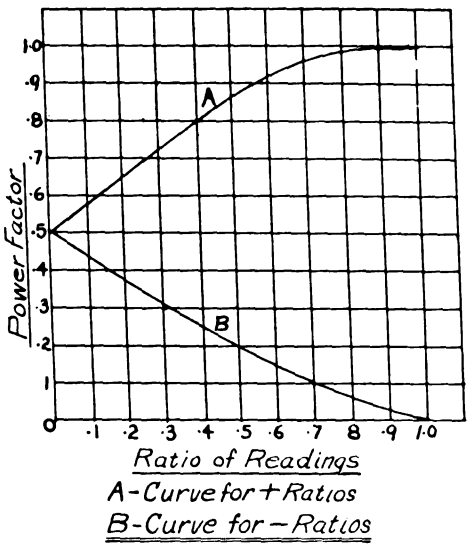

FIG. 13.—POWER MEASUREMENT ON ALTERNATING-CURRENT CIRCUITS.

ϕ less than sixty degrees or power-factor greater than 0.5, and another for negative ratios, values of ϕ greater than sixty degrees or power-factor less than 0.5. By referring to these curves the power-factor of any three-phase load can at once be determined after the ratio of the wattmeter readings is known. The General Electric Company's three-phase power-factor indicator is based on this interesting principle. A fixed current coil is connected in series with one of the wires as shown in Fig. 6 and within it, on a vertical shaft, are mounted two potential coils connected across the sides of the circuit in such a manner that the torques exerted on them are in opposition. This is practically the same arrangement as in Fig. 13, except that instead of shifting the connections of the potential coil, two coils are provided in the same instrument. It is evident that the resultant force acting on the movable coils will vary with the power-factor. Another common type of power-factor indicator is constructed in the same way as an ordinary indicating wattmeter, except that the potential coil has sufficient inductance in series to make the current in the potential circuit lag ninety degrees behind the impressed electromotive force. If such an indicator be connected to a circuit of which the power-factor is one, it will give no deflection, because the current in the current coil will differ in phase by ninety degrees from the current in the swinging coil. If, however, the power-factor of the load is less than one, the currents in the two coils shift more into phase and a deflection results which is to one side of the zero for a leading current and to the other side for a lagging current. The Wagner power-factor indicator is an example of this type.

Indicating and recording wattmeters as designed for commercial use on polyphase circuits often consist of two single-phase meters combined so as to act on a single movable member. Thus these instruments really employ two wattmeters to measure the power as described above, although the two wattmeter elements are combined in a single piece of apparatus.

Gas and Electricity in Spain.

According to the Boletin de la Câmera Oficial de Comercio de Cadiz of March, 1903, the following statistics show the number of gasworks and electric plants in Spain and the amount of taxes collected thereon in the year 1901, the latest year for which statistics have been published:

During the year 1901 there were seventy-nine gasworks in operation in Spain, of which twenty were located in the province of Barcelona. On the other hand, the provinces of Albacete, Avila, Badajos, Caceres, Cuenca, Guadalajara, Huescar, Leon, Lerida, Lugo, Orense, Palencia, Salamanca, Segovia, Soria, Teruel, Toledo, and Zamora and the Canary Islands had none. During the year the production of gas was 136,853,231 cubic metres, which yielded a tax of 2,048,342 pesetas ($395,330).

The electrical plants in operation numbered 961, of which 266 were in the province of Barcelona. The provinces of Huelva and Orense had but two each. The annual production in "hour-kilowatts" reached the figure of 42,248,657, which yielded a tax of 1,955,302 pesetas ($377,383).

Taxes from the manufacture of calcium, 27,834 pesetas ($5,372); customs duties collected on imported calcium, 154 pesetas ($30); taxes from the Basque provinces, 105,180 pesetas ($20,300).

Total taxes collected on gas, electricity and calcium, 4,136,812 pesetas ($798,404).

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The Accident in the Subway of the Paris Metropolitan Electric Railway.

On the evening of August 10 a serious accident occurred in the subway of the Metropolitan Electric Railway, at Paris, France. As near as can be definitely established, the essential points in connection with the disaster were as follows: A train coming from Porte Dauphine, at the entrance to the Bois de Boulogne, in the western part of Paris, and passing under the Place de l'Etoile, circled the northerly quarter of the city. In this northern quarter—a manufacturing centre—the train picked up numbers of workmen who were returning to their homes in the populous eastern district of the city. On reaching the neighborhood of the cemetery of Père la Chaise, the motor failed to act properly, and the train waited at the station of Les Couronnes until the arrival of a second train, which pushed the crippled train forward, making a total of sixteen coaches. After proceeding some distance to the Menilmontant station, the damaged motor set fire to the motor car of the first train. This fire was communicated to the ties, which burned fiercely, raising quantities of smoke. By some unfortunate contingency, the electric lighting system of the car was put out of service, leaving the cars and subway in total darkness. This impeded the progress of the train toward the station, and, during a stop, the frightened passengers got out and tried to grope their way back to the Les Courennes station. It was but a short time after the lights went out of service that a panic was in full sway, and this was added to by a third train butting into the burning train and adding another crowd of panic-stricken passengers to those seeking an outlet. It is said that the first intimation that the officials of the road had of the real situation was due to the clouds of smoke rising from the tunnel and a few of the stronger men and women who had been able to make their way through the dense smoke and darkness and staggered out through the station. It was impossible for a long time to approach anywhere near to the burning train, due to the dense volumes of smoke and the fierce heat which were given up at the entrance to the subway. The latest reports state that some one hundred persons lost their lives, due either to coming in contact with the charged third rail or asphyxiation.

The municipality of Paris and the Metropolitan Electric Railway Company combined to relieve the distress of the citizens, as in many cases the head of the home was the unfortunate one to be caught in the disaster.

The accident at Paris has called into prominence every subway system which is in existence or under construction at the present time. Immediately following the accident, the Berlin Council ordered a commission to investigate the conditions existing in the underground roads in and about Berlin, and the commission reported that such an accident as happened at Paris could not take place.

In published interviews, Mr. August Belmont, president of the Interborough Rapid Transit Company, and Mr. E. P. Bryan, vice-president and general manager of the same company, have stated that it would not be possible for such an accident to happen in the rapid transit subway in New York city. The cars to be used will be given thorough fire protection, and the safety appliances to be installed in the subway system are also of such a nature that a repetition of the fatalities taking place at Paris could not be possible. The subway in New York is much nearer the surface than the Paris subway, and the New York system is thoroughly ventilated by manholes, open stations and ample space outside of the cars. Should the wires become short-circuited in the New York subway and start to burn a car, an automatic cutoff would operate, all power between stations where the accident occurred would be shut off, and with the current off the cause of the fire would be removed. Stand-pipes will be situated along the subway, at distances of 100 yards, and connected with fire hose wound on automatically operating reels, so that when the hose is unreeled the full head of water is on. This hose arrangement is called for in the subway construction contract, signed long before the work was begun on the tunnel.

With respect to the cars, they will weigh some 68,000 pounds and will be of asbestos and transite on the floor, while the sides, from the floors to the windows, will be of copper sheeting. The insulation will be carefully carried out by the Interborough company's engineering staff. If the cars are not absolutely fireproof, they will at least be of slow combustion, and provision for shutting off current in the event of accidents and emergency shutoffs will be set at every station. The lighting of the tunnel will be by a separate system to that of the car lighting, and in addition to this an absolute block system is provided for express trains, which is so arranged that there can not be two trains on any one block at a time.

International Conference on Wireless Telegraphy.

The international conference on wireless telegraphy which met in Berlin, Germany, on August 4 occupied itself chiefly in determining those subjects which would be dealt with at the subsequent international conference. To what extent standardization is possible without monopoly will have to be dealt with at a meeting to be held later. The British delegates to the conference were Colonel R. Hippisley, R. E., and Captain H. L. Heath, R. N. Captain Heath has been in charge of the wireless telegraph arrangements on the Vernon for the past year or more. The delegates for Germany were M. Sydow, under secretary of state to the Minister of Posts; Professor Stredkere and Professor Wacheufeld, superior counselors of the Posts Department; M. Schraeder, counselor of the Posts Department, and Captain Scheer, of the Department of the Marine; Dr. Felisch, counselor for the Admiralty; Major Klussmann, commandant of the Aerostatic Park, and Captain Oschmann. The delegates for Italy were Rear-Admiral Grillo, delegated by the Minister of Marine; MM. Cardalii, chief of Department of Posts and Telegraphs, and Soleri, lieutenant of the navy, delegated by the Minister of Posts and Telegraphs.

It is reported that the largest steam turbine in the world is soon to be installed in the Rheno-Westphalian generating station at Essen. It is needed to run a 5,000-kilowatt alternator and a 1,500-kilowatt direct-current generator at the same time. These two machines have been built by the Brown, Boveri Company which then ordered the turbine that must supply 7,500 kilowatts of output to run the two machines. This will no doubt be the largest turbine yet constructed, and the Essen station will thus contain the largest steam-driven generating unit in the world. A turbine of less power, of the same pattern, has been recently tested at Frankfort and its operation proved very satisfactory. According to these results the makers claim that the new turbine will operate with but 15.5 pounds of steam per net kilowatt-hour. The generating unit will occupy much less space than for a steam engine set. The whole set—turbine, alternator and generator—measures fifty-eight feet long but only ten feet wide and the same height; this includes the length of the turbine which measures only twenty-three feet long for a capacity of 7,500 kilowatts. The foundation is disposed so that the group is not at a great height above the ground level, and it can be taken care of from the floor of the station, so that the usual platforms and staircases will be dispensed with.

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The New Electric Locomotive for the Baltimore & Ohio Railroad.

The most powerful locomotive in the world has just been built by the General Electric Company at Schenectady for the Baltimore & Ohio Railroad for use in its tunnel underneath the city of Baltimore. This locomotive marks a very distinct advance in electric locomotive design. It will handle all the freight traffic of the B. & O. which passes through Baltimore and will operate over the same section as the present electric locomotives built by the General Electric Company and which have been in successful operation for the past eight years.

In designing this locomotive the specifications called for an electric locomotive capable of handling a 1,500-ton train including the steam locomotive but excluding the electric locomotive on a maximum grade of one and one-half per cent at ten miles per hour with corresponding higher speed on lighter grades. This required a locomotive weighing approximately 160 tons on the drivers for purposes of adhesion and the engineers of the General Electric Company decided that the most practicable scheme was to build an articulated locomotive consisting of two complete eighty-ton units operated together as one locomotive by means of the Sprague-General Electric multiple unit control.

The section of the road to be operated runs from Camden street station through the tunnel to the summit of the grade outside the tunnel, a distance of three and one-half miles.

Under practical operating conditions the motors have sufficient capacity to maintain this service hourly, running loaded up the grade and returning light.

On account of the simplicity and accessibility and minimum number of wearing parts, it is believed that the maintenance account of this locomotive will be very low. All wearing surfaces have been made large for the purpose of ensuring long life. At the same time, special provision has been made for their easy replacement whenever it becomes necessary. There is a large space under the cab floor in which a man can stand and inspect the motors or truck gear.

The whole locomotive consists of eight G. E.-65 motors, four on each half. These motors have each a capacity of 225 horsepower, making a total capacity of 1,800 horse-power.

The main body of the truck frame consists of a rectangular framework of cast steel built up of four pieces, two side frames and two end frames, made strong and heavy. The parts are machined at the ends and securely fitted and bolted together, thus forming a very strong and rigid structure capable of withstanding the most severe shocks without injury.

The end pieces form the buffer beams and to these a suitable standard draft gear of approved design is attached.

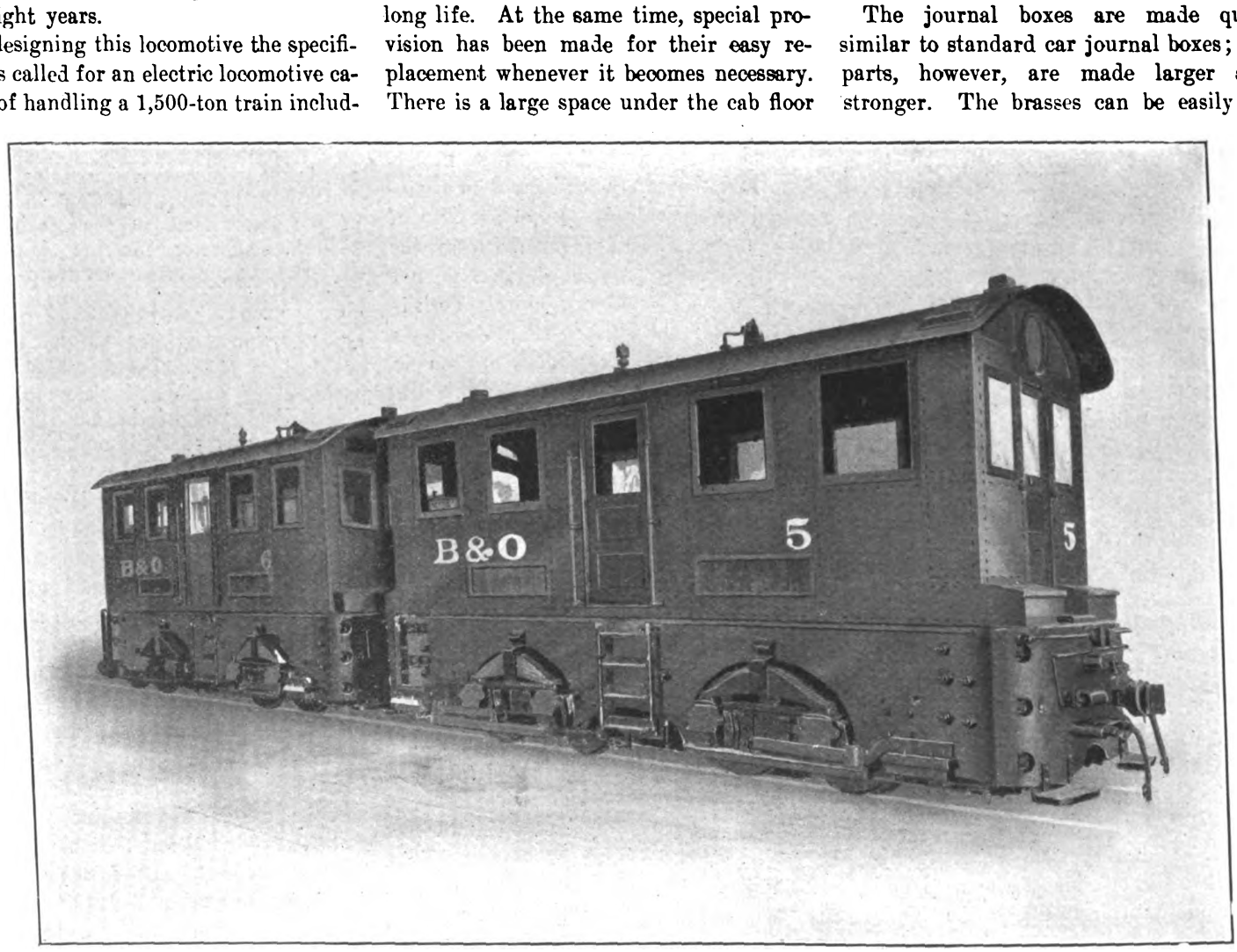
The side frames have machined jaws protected by wearing shoes between which the journal boxes slide.

The truck frames are supported at four points on equalizers. Each equalizer rests on a pair of half elliptic springs, the ends of which are supported on top of the journal boxes through suitable wearing plates. This construction forms a simple and effective arrangement of parts.

The journal boxes are made quite similar to standard car journal boxes; the parts, however, are made larger and stronger. The brasses can be easily removed and by dropping down the wearing shoes it is possible to remove a journal box complete without removing the wheels and axles or other parts of the truck.

In order that the locomotive may round curves easily, the axles are given considerable lateral movement in the journal boxes, it being practical to do this with this design of electric locomotive and thus reduce the effective rigid wheel base.

Wheels, axles or motors can be easily removed from the trucks by dropping into a suitably constructed pit or by raising the truck frame.



New Electric Locomotive, Baltimore & Ohio Railroad.

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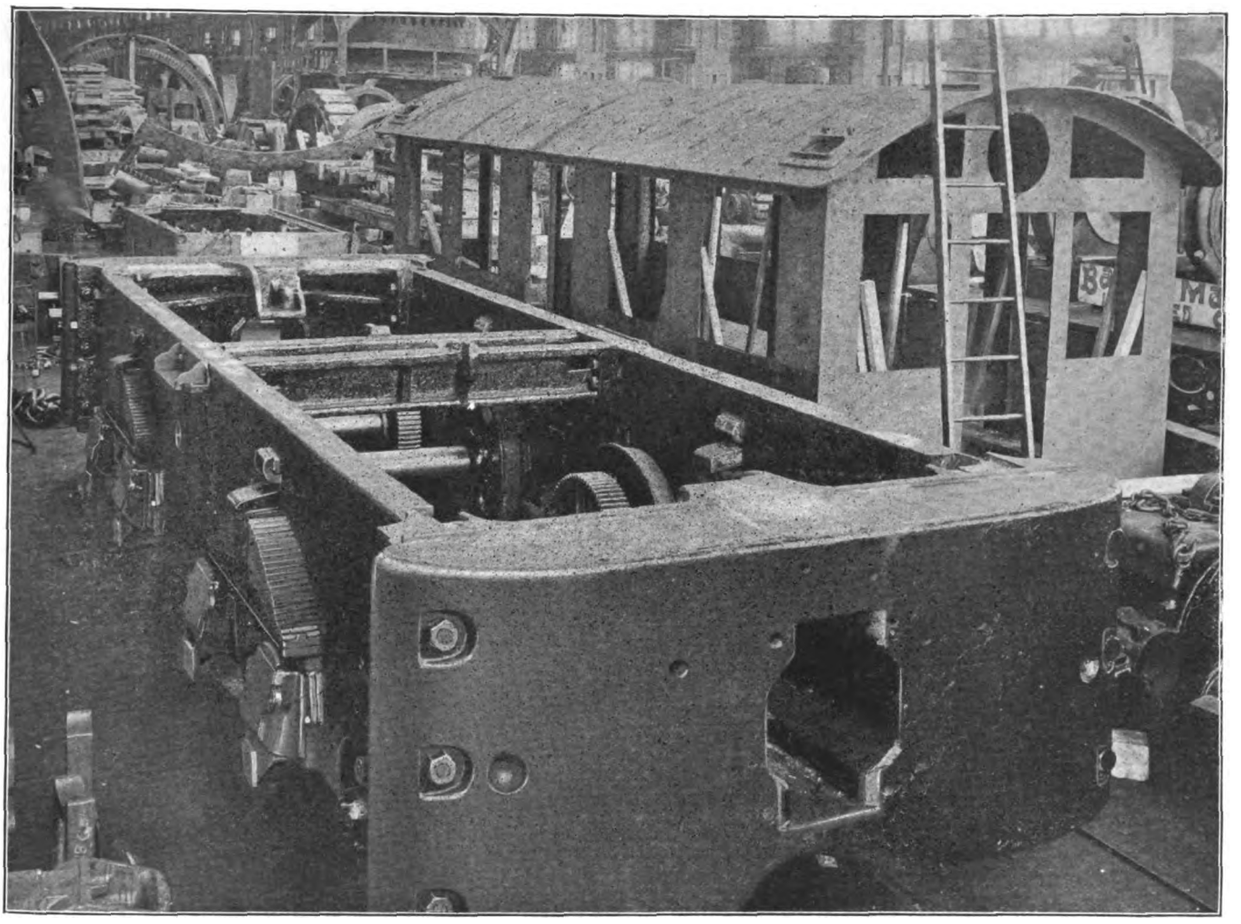
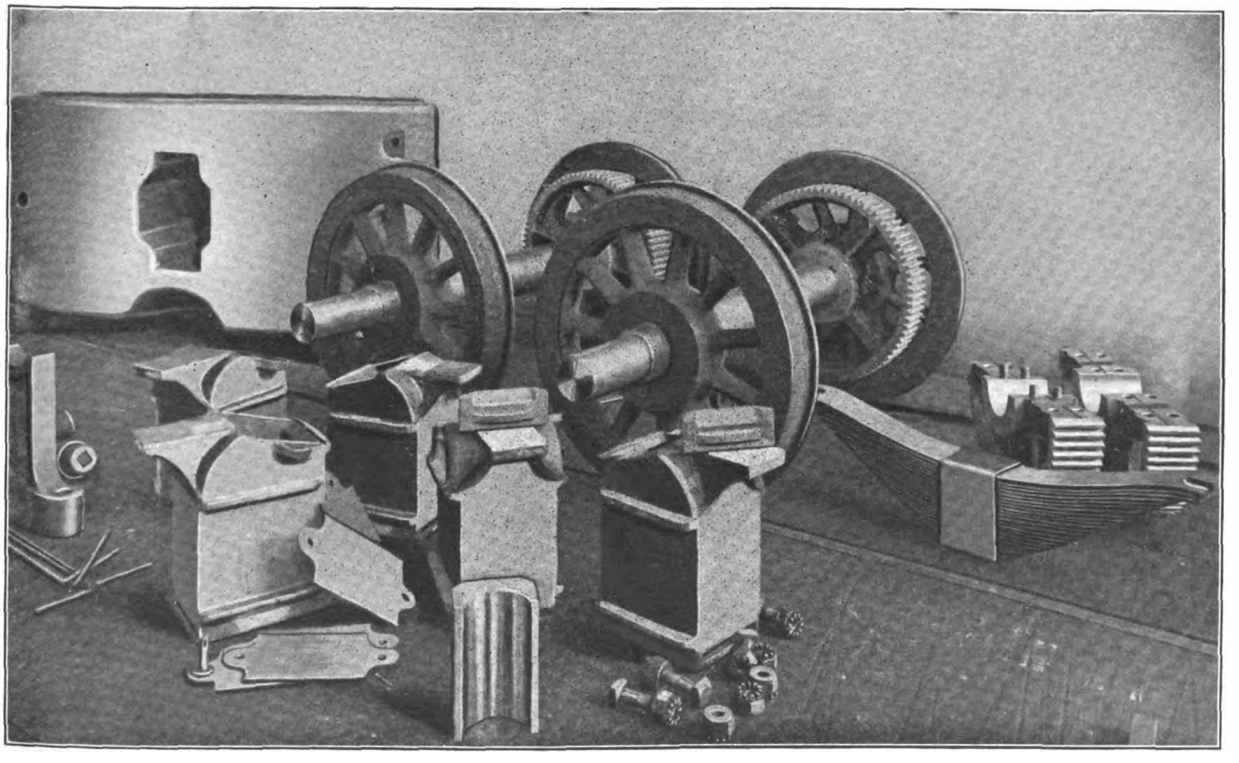
Each section of the locomotive has eight steel-tired spoked wheels. The tires are two and seven-eighths inches thick with M. C. B. standard tread and flange and are securely held in place by approved fastenings. The axles are made of forged steel turned throughout, six by twelve inches in the truck journal bearings, eight inches in the wheel pit and seven and one-half inches in the motor bearings.



TRUCK SECTION, NEW ELECTRIC LOCOMOTIVE, BALTIMORE & OHIO RAILROAD.



ASSEMBLY OF TRUCK AND GEARING, NEW ELECTRIC LOCOMOTIVE, BALTIMORE & OHIO RAILROAD.

The cab is large and roomy. The floor rests on the truck frame. The lining

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floor is made of one and three-quarters inches hard pine tongued and grooved, the upper floor is of hard pine seven-eighths inch thick, tongued and grooved and laid in the opposite direction from the lining floor.

The sides and roof of the cab are made of sheet steel. On each side there is an entrance door, and at each end there is an additional door which permits of ready communication between sections when coupled together. Large windows afford a practically unobstructed view in all directions.

The controlling apparatus, consisting of master controller, engineer's valves, etc., is in duplicate, a complete set being located in diagonally opposite corners of each cab, so that the engineer, when it suits his convenience, can stand in the front end of the locomotive when running in either direction.

Each section of the locomotive is equipped with one bell, one whistle, two locomotive headlights, approved air brake mechanism, including two engineer's valves and air gauges, necessary brake cylinders, foundation brake, air reservoirs, couplers and draw heads; also with pneumatic track sanders.

Each section of the locomotive is equipped with four G. E.-65 motors and Sprague-General Electric multiple unit control, so arranged as to be able to operate each section independently or two or more sections coupled together.

New Galvanic Battery in Germany.

Consul Oliver J. D. Hughes at Coburg reports that a new German patent relating to galvanic batteries of the dry class has been issued. The improvements cover the production of a battery which is capable of being kept in store, of being transported in an absolutely dry condition, and of being rendered fit for use at a moment's notice by the introduction of a suitable liquid or electrolyte into the separate cells constituting the battery. The object aimed at appears to have been secured by certain novel features of construction and combinations of parts.

The dry cells consist each of a zinc or other metallic cylindrical electrode, and of a carbon electrode having a cylindrical or prismatic cross-sectional area placed within the metallic cylinder. The space between the two electrodes is filled up with blotting-paper or other suitable material capable of absorbing the electrolyte. A plurality of these cells is arranged within a suitable socket or frame-shaped casing, the cells being separated from each other and the surrounding casing by asphalt or other insulating material. When required for use the covers are removed from the cells and filled up with the blotting-paper soaked with any convenient electrolyte, such as ammoniac solution, etc. The covers are then replaced and the battery is ready for use. Insulating rings at the open ends of the cells or zinc cylinders prevent short-circuiting of the cells by any overflowing electrolyte.

Electrical Heater and Ventilator.

A new type of electrical heater and ventilator is described in the current issue of *Revue L'Electricite,* Berne.

There are two disadvantages incident to the use of electric heaters. One is that it takes a relatively long time to heat an entire room, particularly those points at a distance from the radiator, and secondly the heat is not uniformly distributed. These difficulties have induced M. de Mare to investigate the problem of electric heaters and his work has resulted in the following new arrangement: In the first place, to heat a room quickly it requires either a large apparatus or the means of increasing the effectiveness of a smaller apparatus. This can be done by rising its temperature and forcing a current of air through it. Any increase in the size of the apparatus is undesirable, because of the increased expense and also because such an apparatus is usually bulky. M. de Mare avoids this necessity by taking advantage of the increased current which can be passed through a conductor when the latter is surrounded by compressed air. A wire which of ordinary temperature will glow with a surrounding current density and which in rarefied air will burn, when in compressed air it may not even become rared. To make use of this effect, the heating wires are placed within a ventilating fan so that they lie in the path of the compressed air. The apparatus consists of a centrifugal blower carrying nickel wires on the revolving part and in the collecting and discharging duct. The air is drawn through the usual openings near the centre and passes through the wire on the fan and that in the discharging duct. The apparatus is effective, easily regulated, but of course is open to the objection of all the electric heating apparatus that cost of power is generally too high for its commercial success.

A Small German Arc Lamp.

A new type of small arc lamp has been recently brought out in Germany by the Sirius Electric Company, of Leipzig. This lamp, known as the "Piccolo," is designed to compete with the small arcs made by the Schuckert and the Siemens & Halske firms, and is claimed to have some advantages over these. The "Piccolo" measures only twelve inches long and has a globe 3.4 inches in diameter. It is used on direct-current circuits and is designed to give a long run. The regulating device for the arc is very simple. The main solenoid has a core whose lower part clamps the upper carbon. One of the main advantages is that it can be placed directly in 110 to 120-volt circuits without using a rheostat. This result is obtained by a special method of winding the solenoid, and thus a rheostat is dispensed with, giving a considerable economy and simplifying the connections. When the lamps are to be mounted two in series across a 220-volt circuit, this is carried out by using an extra rheostat in the circuit. The new lamp is constructed for two values of current, one or two amperes, and both types will run for ten hours. The method of fixing the globe is somewhat new and has been simplified, as the globe is not held as usual by screws, but is kept in place by a spring, and can be removed and replaced by a simple pressure. The globe is well enclosed and thus the lamp can be used to advantage for outside lighting, where the area to be covered is not too great. For inside lighting, it is arranged to be either hung up or mounted on a support, and on account of its small size can be used along with incandescent lamps in chandeliers. The lamp is made to sell very cheaply, and its price is but thirty-five marks, or $8.75.

American Electrotherapeutic Association.

The American Electrotherapeutic Association will hold its thirteenth annual convention in Atlantic City, N. J., September 22, 23 and 24. A large number of papers has been prepared for reading and discussion by prominent members of the medical profession. It is expected that a very large attendance will be present, and that the discussion will go far to establish the status of electricity in therapeutics.

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Electrical Power Installation of the Industrial Works, of Bay City, Mich.

The Industrial Works, of Bay City, Mich., one of the largest manufacturers of railroad wrecking cranes in the world, has recently added to its electrical power equipment four Westinghouse generators and a number of induction motors. In addition to wrecking cranes, the Industrial Works also manufactures smaller cranes and transfer tables.

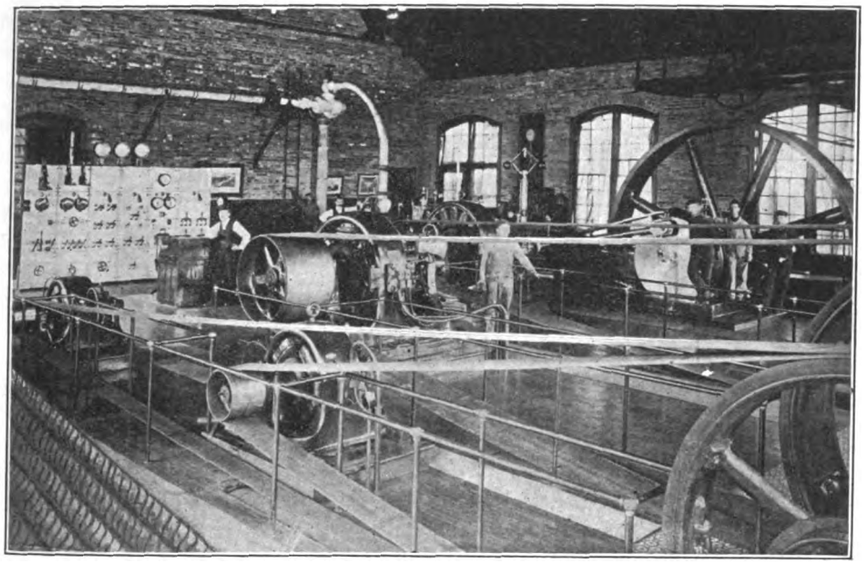

FIG. 1.—MAIN SWITCHBOARD AND ONE OF THE ENGINES, INDUSTRIAL WORKS, BAY CITY, MICH.

The new generators consist of one 150-kilowatt, direct-current, 110-volt multipolar; two thirty-kilowatt, 110-volt multipolar, and one 200-kilowatt, alternating-current, 220-volt, three-phase machine, operating at 7,200 alternations. This combination of machines gives a very flexible power system. The alternating-current machine is used for power purposes entirely; giving the best results for motors located in inaccessible places. The large direct-current generator is also used exclusively for supplying power, and furnishes current for the operation of cranes and transfer tables and testing direct-current motors on cranes. The two thirty-kilowatt, direct-current generators are used for lighting. The switchboard arrangement is such that these two machines may be run either in series or multiple, the latter case being desirable when they are used for testing purposes on a 220-volt circuit.

The distribution of power and light is accomplished by means of distributing switchboards placed in the various shops, these being located at some distance from the power-house.

Communication between power-house and shops is obtained through an underground tunnel, supports being provided in the tunnel for carrying the main feed line. In this manner, while all of the main circuits are controlled from the engine room switchboard, small individual light and motor circuits are at the same time under the control of the foreman in the various shops.

Fig. 1 shows the main switchboard, one of the engines, and other portions of the engine room equipment. The switchboard installation was also furnished by the Westinghouse Electric and Manufacturing Company.

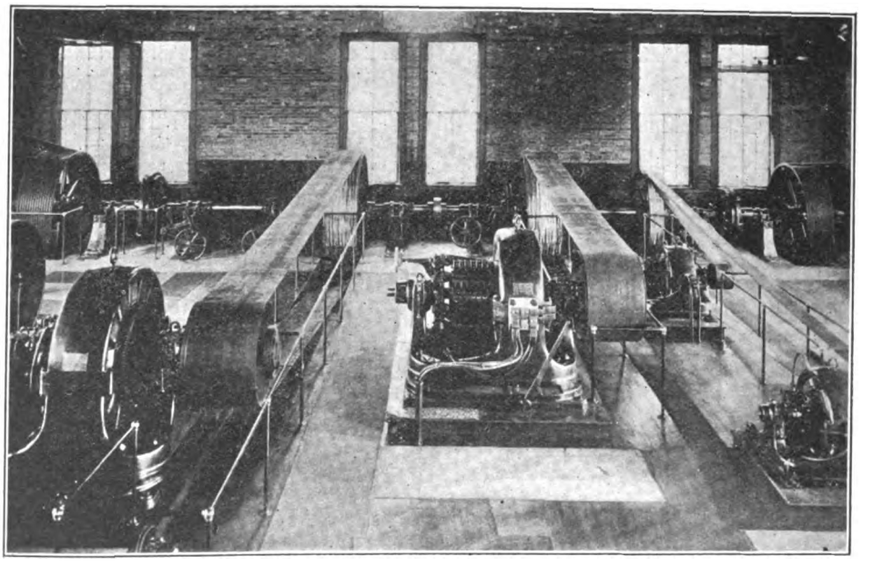

FIG. 2.—INTERIOR VIEW OF POWER-HOUSE, INDUSTRIAL WORKS, BAY CITY, MICH.

Fig. 2 is an interior view of the power-house, showing the four generators and the jack shaft with its connections between engines and generators. The jack shaft with the rope drive, both of which were furnished by the Dodge Manufacturing Company, of Mishawka, Mich., is well shown in Fig. 2. A fact worthy of particular attention is that the shaft may be driven independently or simultaneously from either end, it being possible to cut off either engine by means of the friction clutches, shown in the illustration. Each generator is also furnished with a friction clutch. Furthermore, either half of the shaft may be run separately by removing the plate between the two flanges of the solid couplings, shown in the centre of the shaft. The system shown, while taking a rather large amount of room, is a very flexible one as far as the addition of new machines is concerned, and where room is not a very important item. The Industrial Works considers this arrangement quite as satisfactory as a direct-connected system.

Power is transmitted to the jack shaft by means of two engines, one a 400-horse-power tandem-compound condensing Hamilton-Corliss, connected by rope-drive of the American system. This engine drives the shaft alone, the other engine, a simple Allis-Corliss of 200 horse-power capacity, being held in reserve in case repairs are necessary to the larger engine, or for special work not requiring full amount of power.

Proceedings of the Engineers' Club at Philadelphia.

The June issue of the Proceedings of the Engineers' Club at Philadelphia contains the following papers: "Improvement, Extension and Filtration of the Water Supply of Philadelphia," by John W. Hill; "The Richards Prismatic Stadia as a Range-Finder," by E. K. Landis; "The Obstruction of the Navigation of Southern Rivers by the Growth of the Water Hyacinth," by L. Y. Schermerhorn; "The Military Importance of Naval Engineering Experiments," by Rear-Admiral George W. Melville, U. S. N.

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Electrical Notes from Europe.

From Our Special Correspondent.

THE electric tramway system of Marseilles is now one of the most extensive in France. All the tramways in the city now use electric traction with the exception of one line which is operated by a type of steam locomotive. Most of the lines radiate from the central part of the city and pass out to the suburbs. The total length of the lines is about sixty-five miles. The trolley system is used throughout, with a trolley wire of ten millimetres silicon bronze suspended twenty feet above ground by central or side posts. The feeder system is divided into six groups, corresponding to six substations. The central station of Saint Giniez which supplies all of these has been installed by the Société Alsacienne on the three-phase system, using 5,500 volts and twenty-five cycles. From the central station a series of high-tension feeders is laid underground to the substations, where a set of step-down transformers and rotary converters supplies direct current for the line. The central station is a large one and contains four batteries of five boilers each, or twenty in all, provided with Green economizers. The fuel used is English coal which comes by boat and lignite which is found in the region; a mixture of the two is employed. The main dynamo room contains five direct-coupled alternator groups of 1,000 kilowatts each and five exciters of eighty kilowatts. The compound Corliss engines are provided with thirty-six-ton flywheels. The alternators have a fixed armature ring on the outside, in which revolves a forty-pole internal field. The substations have each a bank of step-down transformers and either two or three rotary converters. In two of the substations the converters have a capacity of 225 kilowatts each, and in the remaining four, 400 kilowatts. Each of the substations is provided with a battery of accumulators which acts as a reserve and are capable of supplying the normal current of the substation for one hour. This battery, which is of the Tudor pattern, is used in case of repairs to the machines. The trolley cars which are used on the different lines have twenty-one places inside and twenty-eight on the platforms, or a total of forty-nine places. They are equipped with Thomson-Houston motors and controllers, using three types of motor varying from nineteen to twenty-five kilowatts. The old horse cars are utilized as trailers, and the lighting current is brought by a cable which connects the cars. Spenz electric brakes are used on the trolley cars. The extent of the Marseilles system will be remarked from the fact that the figures for the year 1902 showed a total of 61,180,191 passengers.

Paris now possesses a physical testing laboratory which will no doubt prove as useful in physical work as the electrical laboratory has been to electricians. The latter has been established for a number of years and is under the immediate direction of the Société Internationale des Electriciens. The extensive laboratories on the Rue de Stäel, under the supervision of Professor Janet, are used to standardize instruments and carry out tests upon various electrical apparatus, especially new inventions which it is desired to have tried. The new physical laboratory which has just been installed will work upon similar lines. It occupies extensive quarters in the buildings of the Conservatoire des Arts et Metiers, which is the headquarters for physical work and contains a large museum. The new laboratory has been established by the city of Paris, having received important contributions from the Chamber of Commerce and from different companies and societies interested in the question. It is designed to carry out physical tests, standardizing of apparatus, etc., when desired, and a small fee is to be paid for such work. A fine equipment of apparatus and machines has already been installed. The laboratory is divided into five sections according to the nature of the tests—physical work in general, metals, metallic construction, machines, vegetable matter. The different industries can thus have rough or manufactured products of all kinds tested here in the most efficient manner, as also various machines and devices. An important part of the work will be the calibration of physical instruments. Professor Perot, a leading physicist, is at the head of the new laboratory.

The French Government is shortly to carry out a series of tests upon different aeriel telegraphy apparatus in order to determine the best conditions and types of apparatus for practical working. To this end M. Berard, one of the chiefs of the State Telegraph Department, has decided to erect two wireless telegraphy stations in the neighborhood of Paris. Here different apparatus will be tested and operators will be trained for the government service. The two stations, one of which is located near Melun, will be about twenty-five miles apart.

Wireless telegraphy will be used to great advantage in the expedition to the North Pole which is now being organized in Munich by Dr. Scholl. He proposes to erect a station on Spitzbergen Island, which will be laid out on a large scale so as to communicate with the exploring vessels. To this end he has made propositions to the Wireless Telegraph Company and proposes to have the Braun-Siemens & Halske system installed. On board the vessel used by the expedition will be a similar station and it is expected that messages can be sent between the two throughout all the course of the vessel. It is stated that the preliminary tests will be soon made by Dr. Scholl in connection with the Telegraph Company.

It is stated that the Italian Government is soon to carry on wireless telegraphy operations on a large scale, and a station of great power is to be erected in Italy which will not only communicate with the interior and the rest of Europe, but also with South America. The government came to this decision after the recent success obtained by Marconi in sending messages across the Atlantic, and it is now proposed to construct an aerial telegraphy post of especially long range. The Italian Congress voted the sum of 800,000 lire ($160,000) to be used for this purpose. According to a decree which has recently been passed, the station is to be laid out with sufficient power to be able to communicate with a similar station to be erected in South America. It will be utilized besides to communicate with the different Marconi stations in Europe. Marconi himself is to have charge of the work and he acts as the representative of the two English and American companies which hold the patents. According to an agreement between the Minister of Posts and the inventor, Marconi is to be charged with the delivery of all the necessary material for the station and is free to choose the position of the latter as well as the apparatus. The work is to be begun within six months after the date of the agreement

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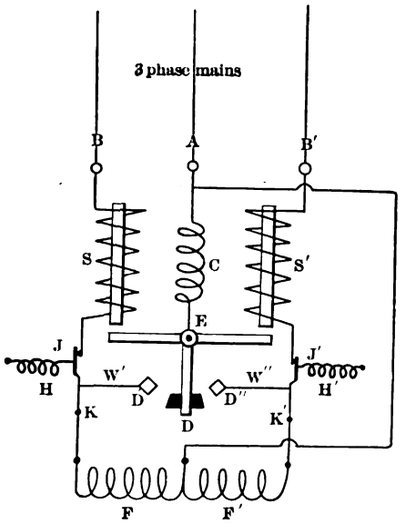
and completed within three years. The post in South America, similar to the former, is to be erected by the British Marconi Company. The station in Italy will communicate with the latter and also with the other stations throughout the globe belonging to the two companies, also with the interior of Italy and the colonies. The government pledges itself to use only the Marconi stations for exchanging messages, except in case of war vessels.

A new form of electric postal wagon lately tried at Milan has met with considerable success. It is used to take the mail from the boxes, stamp it en route and arrange it for distribution, and in this way a considerable saving of time is effected. The wagon which has been built by Turinielli Company has a box body of considerable capacity, with a seat in front for the driver. The inside is fitted up for sorting the mail and has an employé devoted to this work, while the remaining space is reserved for the postman. The wagon is brought to one of the city letter boxes, when the postman descends and takes the mail from the box, passing it to the employé who stamps and sorts the mail according to its destination while the wagon is proceeding to the next box. Each district of the city has an employé who receives the mail from the wagon at specified places and distributes it at once along his mail route, and thus the letters are at once distributed without being obliged to pass through the post office, hence a great saving of time. The wagon has its wheels spaced to standard gauge so that it can travel along the tramway tracks. The two motors of six horse-power, one for each axle, drive it at the rate of four to twelve miles an hour. Suitable controllers and brakes are provided. The new postal wagon was put through a series of trial tests not long ago in presence of the officials and its operation proved quite satisfactory. It is now proposed to extend the system and carry out all the postal distribution in the city of Milan upon this plan.

M. A. Lehotzky, an Austrian engineer, has devised a new automatic cutout apparatus for use with polyphase motors. Supposing a three-wire two-phase motor with the usual short-circuited armature to be running on load, in case one of the field circuits should become broken the armature will burn out if the other half of the field is not cut out by means of its fuse. The fuse in the second circuit will not usually blow out in this case, as these fuses are regulated to stand the heavy starting current of the motor, and there will be no damage to the field circuits, but the short-circuited armature will cease to revolve and burn out. To avoid this possibility a device should be adopted so that in case the fuse on one side of the field should blow or the circuit be otherwise broken the others will follow and the whole field will be cut out. This the inventor accomplishes by a very simple and effective device, whose principle is shown in the diagram. Above are the three-phase mains, A being the common wire and BB′ the outer wires. The middle wire A is connected through a resistance C to a three-branched lever E which can turn about a central pivot. The two side branches are under the solenoids SS′, while the lower branch D can swing to the right or left and thus throw the circuit on the plug D′ or D″. The common wire A is also connected below to the middle point of the motor fields FF′ as usual. The side wires are connected to the ends of the field through the solenoids SS′ and the switches JJ′. The solenoids have movable cores which when the current passes are normally held up at the middle point. The switches JJ′ are pivoted about KK′ and are held closed by the fine steel wires W′ and W″, but should these break they will be opened by the strong springs HH′. When the current passes to the motor normally, the parts remain as shown, but should the circuit B, for instance, and in consequence the current in the solenoid S′ become broken, its core will fall and strike the lever arm below it, and the arm D will be thrown over to D′. A current will then pass by AD′ W′ and the steel wire will melt and allow the spring to operate the switch and break the current of the left-hand circuit. In this way both circuits are broken at once and the armature of the motor receives no damage. In this case the middle circuit A does not carry a fuse, as the current must always pass in it.



CUTOUT FOR POLYPHASE MOTOR.

Electric traction on main railroad lines in Switzerland will no doubt receive a fresh impulse owing to the conference which has been lately held at Berne in order to develop this important question. The conference brought together the presidents of the state and private railroads, together with the directors of the five leading Swiss electrical firms, also the representatives of the Swiss Association of Electricians and other bodies interested in the question. This move is due in the first place to the efforts of M. Tissot, director of the Swiss Electric Company, of Bale, and he first brought out the idea at the general assembly of electrical societies which was held in October, 1901. The proposition was received with favor, and it was recognized that the question should be studied as soon as possible, seeing that it is of such importance for the industrial development of Switzerland, which, although it is completely deprived of coal, is abundantly supplied with hydraulic power. However, to develop the idea properly there should be an understanding between the railroad authorities and the leading Swiss electrical houses in order to bring about the best conditions for utilizing the hydraulic power on existing railroads or in the construction of new lines, so as to unite all the elements which are necessary to bring such a difficult enterprise to a successful conclusion. Accordingly a provisory committee was appointed at that meeting, consisting of leading electrical and railroad men, in order to take the first step in the matter. At last spring's conference the work has been further extended by forming a permanent committee which consists of representatives of the railroad administrations and the leading electrical companies. This committee is to take the matter in hand and will consider what will be the best steps to take in order to apply the hydraulic power upon railroads, and will also lay out a financial project. M. Flury, the president of the state railroads, is at the head of the committee, and Dr. Tissot is vice-president, while the treasury is in charge of Brown, Boveri & Company. Besides, a technical commission will study the different engineering questions relating to the project. By the next meeting the matter will be considerably advanced, and it is probable that most of the Swiss electrical companies will be represented on the committee. Some interesting developments are therefore to be expected in this direction.

C. L. DURAND.

Paris, August 8.

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Transformer Data.

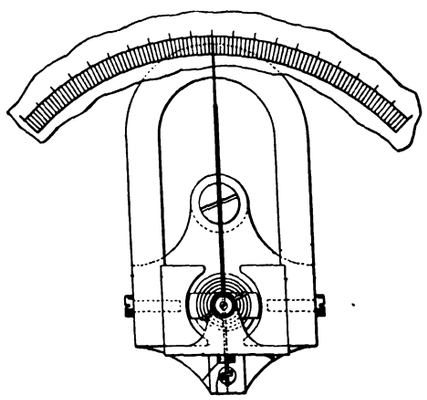
The following table gives the data of a test of one of the transformer groups in the St. Claude substation, Saut-Mortier power station, consisting of an Oerlikon 150-horse-power three-phase motor and two seventy-five-horse-power dynamos. It shows the speed, voltage, current, etc., of the motor, as well as the output of the direct-current machines at various loads, together with the efficiency of these machines.

150 Horse-Power Three-Phase Motor.											Direct-Current Dynamo No. 1.			Direct-Current Dynamo No. 2.				
Revolutions per Minute.	Per. per Second.	Voltage.	Amperes per Phase.	Motor Output—Kilowatts.	Cos.	Slip, Per Cent.	Voltage.	Useful Current—Amperes.	Exciting Current—Amperes.	Voltage.	Useful Current—Amperes.	Exciting Current—Amperes.	Efficiency of Group, Per Cent.	Kilowatt Output of Direct-Current Generators.
598	50	206	75	6.0	0.828	0.3	210	185	1.4	210	180	1.4	86.5	88.0
596		206	80	8.4	0.877		210	185	1.6	214	180	1.5	86.8	89.2
591		213	90	50.9	0.888		206	186	1.6	210	178	1.6	86.8	71.2
587		208	97.5	98.3	0.851	1.9	210	207	1.75	209	243	1.75	86.8	107.0
587	49	215	98.5	123.0	0.867		210	223	2.3	215	178	2.5		

The temperature of the stator of the three-phase motor after operating four and one-half hours at full load was 42.5 degrees centigrade, while that of the rotor was forty-four degrees centigrade and of the stator iron fifty-two degrees centigrade. The armature of one of the direct-current generators reached a temperature of forty-five degrees centigrade and its commutator fifty-five degrees centigrade, while that of the field was thirty-one degrees centigrade. The temperature of the armature of the other machines was fifty-five degrees centigrade, while its commutator was raised in temperature to seventy-four degrees centigrade, and the field to thirty-one degrees centigrade. The temperature of the surrounding air during this test was twenty-four degrees centigrade. As will be noted by the table the efficiency of the entire motor-generator group was 86.8 per cent, with a load of 123 kilowatts on the motor, the two direct-current machines supplying 107 kilowatts.

Electrical Patents.

John Franklin Stevens, of Philadelphia, Pa., has obtained a patent on a new electrical measuring instrument. The principle upon which the instrument depends for its operation is that of the well-known Deprez-D'Arsonval galvanometer, namely, a coil or helix of conducting wire which oscillates between the poles of a permanent magnet. It is well known that if current from any source of electric power be conveyed into and out of a coil of wire when such coil is suspended between the poles of a permanent magnet the coil will tend to deflect until it reaches such a position that the lines of force generated in it due to the passage of the current will coincide in direction with the lines of force generated by the permanent magnet field by which it is surrounded. The extent of movement of



ELECTRICAL MEASURING INSTRUMENT.

the moving coil is very closely proportional to the amount of current flowing in the coil. In early and primitive forms of this instrument it was customary to suspend the moving coil by means of conducting filaments, which provided a conducting path to lead the current into and out of the moving coil, and in addition constituted a restraining force which tended to bring the coil back to its original or zero position when the current flow ceased. In somewhat later times the original construction was modified to the extent that the moving coil was suspended by means of pivots carried in jeweled bearings and the current was conducted into and out of the moving coil by means of flexible filaments which might of themselves constitute a restraining or controlling force or which might be used in connection with springs, which springs would constitute a restraining or controlling force. The extent of movement of the moving coil when such an instrument was properly calibrated by reference to a standard of voltage or current constituted a measure of the current flowing through the coil and in consequence enabled the user to read directly the actual electromotive force or current flow in the circuit under measurement. In order that the field of force generated by the permanent magnet should be uniform within the space traversed by the moving coil, thus giving a movement of the coil directly proportional to the increase or decrease of current flow in the moving coil, it has been customary to curve the pole-pieces to the arc of a circle and to provide a core circular in section, which core was located within the moving coil, but separated from it by an air-space, so that the moving coil moved or oscillated within the annular space within the pole-pieces and core, the core itself being constructed of some substance, such as iron, which is a good magnetic conductor. In all instruments on this principle which have been heretofore constructed the curved pole-pieces, together with the core and the moving coil, together with the pointer, have been secured together, constituting an integral part of the instrument. It was, therefore, necessary in the construction of such instruments to assemble the parts referred to above and then attach to them the permanent magnet by means of screws or pins. This form of construction made it necessary to remove the permanent magnet from the pole-pieces several times during the course of construction and calibration and also whenever it was necessary to take the instrument apart for purposes of repair or recalibration. This was a serious disadvantage, since it involved breaking two magnetic joints and resulted in a change of strength in the field generated by the permanent magnet. With our present knowledge and facilities it is a simple matter to construct the moving coil, together with its conducting filaments, controlling springs, pivot points, and jewels so that they will remain constant and unchanged throughout a practically indefinite period of time. We have not, however, learned as yet to construct a permanent magnet which under all conditions will retain its initial magnetism, and the principal source of error in instruments of this class consists in the gradual loss of magnetism in the permanent magnet field, which results in error in the indications of the instrument. Since the maintained accuracy of this type of instrument is dependent on maintaining the constancy of the permanent magnet field, it follows that any construction tending to preserve the initial constancy of the permanent magnet is of

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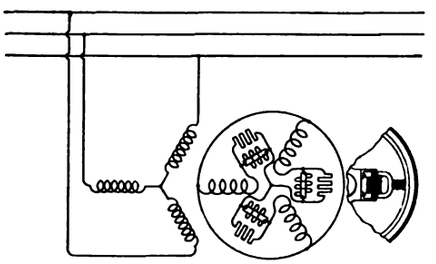
considerable advantage. Mr. Stevens has found that one of the principal causes of decreased field strength is due to the breaking of the magnetic joint existing between the pole-faces of the permanent magnet and the pole-pieces attached thereto. To overcome this defect in construction, he has devised a combination of supporting bracket, core and moving coil so constructed and related to one another that they may be removed from the field of force without disturbing the pole-pieces of the permanent magnet.

The General Electric Company has purchased from Arnaldo P. Zani, an Italian, residing at Berlin, Germany, a patent obtained by him in this country on improvements in controlling induction motors. Mr. Zani describes his invention as follows: In starting induction motors a non-inductive resistance is commonly inserted in circuit with the windings on the induced member of the motor in order to increase the starting torque and at the same time reduce the amount of current supplied to the motor. The resistance has the effect of bringing the currents in the induced member of the motor more nearly into phase with the electromotive forces induced therein and at the same time by reducing the amount of secondary current causes a more than correspondingly large reduction in the primary current. This reduction in the primary current is largely due to the fact that a reduced secondary current reduces the leakage flux between the inducing and induced members of the motor, and consequently reduces the amount of lagging or idle current called for by the self-induction produced by this leakage flux. A further description of the function of the starting resistance is unnecessary, since its operation is well understood by engineers. In practice the non-inductive resistance may be operatively connected to the windings of the induced member in a number of ways. Thus, for example, if the rotor be the induced member the resistance may be carried by the spider of the rotor or may be otherwise mounted within the same, or, if desired, the resistance may be located externally to the motor and connected to the windings of the induced member through collecting-rings on the rotor shaft. If the resistance is mounted within the rotor, it may be cut in or out by means of centrifugally actuated switches carried by the rotor or by means of switches mounted on the rotor and connected by suitable mechanical devices with a switch handle fulcrumed to some portion of the stator in a manner well known in the art. In cases where the resistance is externally located the same may be varied in value by any well-known means. In any case, however, these constructions are seldom absolutely sparkless in operation and are open to all the other objectionable features inherent in sliding contacts. In most cases the sparking produced at the contacts is not of sufficient importance to become seriously objectionable, while in some cases, it is, on the contrary, so dangerous as to be prohibitive—as, for instance, where the motors or other devices are to be used in an atmosphere of an explosive nature, such as exists in flouring mills, oil refineries or the like. He has therefore devised a means for starting induction motors which possesses the advantages of the well-known rheostatic form of control, though acting on a different principle, without its corresponding disadvantages. According to this invention the currents in the induced member of the induction motor are caused to flow through a circuit so organized that at starting it has the effect of a circuit containing a high ohmic resistance and at full speed the effect of a circuit containing a low ohmic resistance. In the preferred embodiment of the invention, the circuit through which the currents in the



CONTROLLING INDUCTION MOTORS.

induced member of the motor are caused to flow is provided with alternative paths, one of high ohmic resistance and little, if any, self-induction and the other of low resistance with a comparatively high self-induction. At starting when the frequency of the currents in the induced member is high the reactance in the path of high inductance is so large as practically to prevent any considerable current from flowing in this path, thus causing nearly all of the currents generated in the induced member to pass through the high-resistance path. The result obtained is nearly the same as though the high-resistance path were the only one presented to the induced currents of the induced member, and the circuit as a whole has the effect of a circuit containing a high ohmic resistance. As the speed of the machine rises, however, the frequency of the currents in the induced member becomes less and less, thus correspondingly decreasing the reactance due to self-induction, and so causing a greater portion of the induced current to pass through the self-inductive path and less through the path of high resistance. When the motor approaches full speed, the frequency of the current in the induced member becomes so low that the counter-electromotive force of self-induction in the inductive path is greatly reduced. Then nearly all of the current will flow through this path, which is of low resistance, and only a small amount through the other path of high resistance, and the circuit as a whole will have the effect of a circuit containing a low ohmic resistance. This operation preserves the proper phase relation between current and electromotive force at all speeds without any mechanical adjustment whatsoever, though, if desired, the amount of reactance due to the inductive path above mentioned may be still further varied, not by depending alone upon a decrease in the frequency of currents flowing in said path, but by also varying the coefficient of self-induction to the inductive device in any desired manner—as, for instance, by varying the reluctance of its magnetic circuit.

Association of Edison Illuminating Companies.

The twenty-fourth convention (nineteenth annual meeting) of the Association of Edison Illuminating Companies will be held at the Frontenac, Thousand Islands, St. Lawrence River, N. Y., commencing Tuesday, September 8, 1903, at 9.30 A. M. A most successful convention from every point of view is expected and the committee wishes to impress upon each member that he should not fail to send at least one delegate to this important meeting. The following list of papers has been prepared:

"Commercial Experience with Nernst and Meridian Lamps," by W. B. Thompson, Detroit, Mich.

"Purchased Electric Power in Factories," by E. W. Lloyd, Chicago, Ill.

"Operating Features of High-Tension Power Stations," by W. F. Wells, New York, N. Y.

"Position of Steam Turbines in Central Station Operation," by August Kreusi, Schenectady, N. Y.

"Overhead Pole Line Construction and Operation," by A. H. Manwaring and J. T. Hutchings, Philadelphia, Pa.

"Comparison of European and American Engineering Practice," by Charles Schwartz, Chicago, Ill.

"Profitable Advertising," by W. H. Johnson, Philadelphia, Pa.

"The Central Station and the Isolated Plant," by Douglass Burnett, New York, N. Y.

"Depreciation in Electric Light Plants—How Estimated and Applied," by H. M. Edwards, New York, N. Y.

"Selection and Installation of High-Tension Switching Apparatus," by Leonard L. Elden, Boston, Mass.

"Illumination," by Charles P. Steinmetz, Schenectady, N. Y.

"Results Obtained with Steam Turbines in Milan, Italy," by Guido Semenza, Milan, Italy.

"The Development of Summer Lighting," by E. A. Leslie, Brooklyn, N. Y.

"Notes on Commercial Features of European Lighting Practice," by Arthur Williams, New York, N. Y.

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Reviews of Current Engineering and Scientific Literature.

Tests of Water-Tube Boilers on Ship Ports.

The British Admiralty has been conducting some elaborate tests as to the suitability of water-tube boilers of the Belleville type for vessels of the navy. Two similar vessels, one equipped with water-tube boilers and the other with the Scotch type, were fitted with propellers which gave them equal speeds. The two were then started from Plymouth to Gibraltar in company for a test of the relative coal and water consumption. The water-tube boilers lost less water and burned less coal than did the other. A trial was then made to determine the least time in which the two vessels could be coaled and got ready for sea. That equipped with the water-tube boilers got ready in twenty-one hours, while the other required forty-five. At a signal being given to light fires and start, the water-tube boilers got up steam in twenty-six minutes, but the other required sixty-four. Recent tests have also been made with these boilers on several vessels of the French Navy which showed results confirming those obtained by the English vessels. The French cruiser Devestation, rated at 8,300 horse-power, burned 1.85 pounds of coal per horse-power-hour when indicating 8,856 horse-power. The French cruiser Dupleix, rated at 17,100 horse-power, consumed 1.75 pounds of coal per horse-power-hour in developing 17,980 horse-power. The cruiser Marseillaise, 20,500 horse-power, consumed 1.53 pounds of coal per horse-power-hour when indicating 14,493 horse-power. These figures show the efficiency of the water-tube boiler.—*Abstracted from the Steamship (Leith), August.*

Measuring the Variation of Current in a Coil During Commutation.

If a coil of fine wire having the same number of turns and being wound side by side with an armature coil is assumed to cut the same total flux as the latter coil, then the electromotive force set up in it will be equal to that in the armature coil. Therefore, if one end of this coil is connected to one end of the armature coil but in such a way that their electromotive forces will be opposed, the difference of potential at any instant between the two free terminals will be equal to the fall of potential in the armature coil, due simply to ohmic resistance. This method has been applied by M. Iliobici to study the variations of current in the coils of a direct-current machine during commutation. The results so far obtained agree with those obtained by other methods and this seems to indicate that the method is reliable. Great care should be exercised in winding the fine wire so as to get it in the best possible position and thus minimize any error which might arise from leakage or an unequal rate of cutting flux. This detail of the method is now being studied by the author with a view to determining the best position for the exploring coil of wire. In order to do this the author purposes to study simultaneously the variation of current by the method just described and by the following: Into each coil of the armature a non-inductive resistance will be introduced. Then by measuring the fall of potential through this resistance at any instant, the intensity of the current at that moment may be determined. The results obtained in this way will be compared with those obtained by the other method, and by winding the exploring coil in various positions the best one will be determined.—*Translated and abstracted from L'Electricien (Paris), August 1.*

The Storage Battery in Its Relation to the United States Fortifications

The value of the storage battery as a reserve for coast defence work, is here discussed by Lieutenant Lee Hagood. For this purpose accumulators are used for the searchlight, for the entire electrical supply, including field lighting and power and in connection with harbor mines. It is indispensable in the use of the telautograph and for signaling systems and as a substation. For the latter purpose batteries may be charged in series at a high voltage and discharged in parallel, and in this way effecting a considerable saving in copper. The function of the storage battery is, primarily, for this service that of a reservoir for electric supply. Several years ago it was decided to install small electric plants in the various fortifications. In the beginning the object was merely to obtain satisfactory light, but so many applications of electricity have since arisen that at present the electric supply has grown to be one of the most important considerations in the equipment of a modern fort. Its use may be divided into two heads; in the fortifications and lighting the post. About the fortification itself the electric supply is for the following purposes: Ignition of fuses, lights for electric night sights, lights for range finder cross-hairs, for telephones, for time interval bell circuits, for master clock circuits, for lighting the battery, for lighting range finder stations, for operation of the night signals, telautographs and searchlights; the motors for control of the guns, ammunition hoists, shot room and ventilating fans. For the above purposes service must be uninterrupted and reliable, and for this work the storage battery is well adapted. The author discusses various types of the storage battery and the systems of applying these and the various booster systems. —*Abstracted from the Journal of the United States Artillery, Fort Munroe, July and August.*

Chelsea Generating Station.

This article gives an outlined description of the Chelsea generating station which is now being constructed by the Underground Electric Railways Company, of London. The site comprises about three and one-half acres of land with a water frontage on the Thames and Chelsea Creek. The building is 454 by 175 feet and 104 feet high to the peak of the roof. The capacity of the building at normal load is 57,000 kilowatts. On this basis the cubic feet per kilowatt, including office building, is 139, and the square feet per kilowatt is 1.36. The building is of steel frame closed with brick and terra-cotta, unornamented. The roof and most of the floors will be concrete. The boiler room will contain eighty water-tube boilers arranged two stories high and equipped with mechanical stokers. The main generating sets each consists of a horizontal turbine engine running at 1,000 revolutions per minute and a three-phase generator wound for 11,000 volts, thirty-three and one-half cycles. There will be ten such sets with floor space for one of half the size. The normal rating of each generator is 5,500 kilowatts, but they will carry an overload of fifty per cent for two hours at practically the same steam consumption per kilowatt-hour. There will be four 155-kilowatt, 125-volt steam-driven exciter sets. The condensing system consists of vertical condensers located in pits between the engine foundations.

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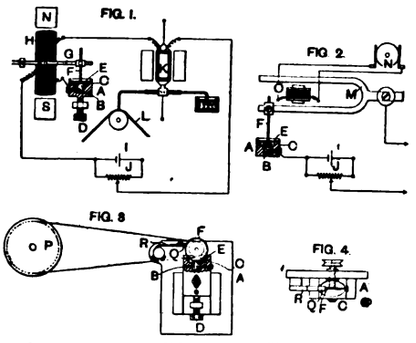
The switchboard is carried on three gallery floors extending across the north side of the engine room. High-tension switches will be motor-operated and the feeder system extending to the twenty-three substations will be in duplicate. A line of sixty-four ducts is being constructed to carry these feeders to the nearest point of the district railway. Coal will be received on lighters and discharged into bunkers which have a capacity of 15,000 tons. The daily consumption will reach 800 tons.—*Abstracted from the Electrical Engineer (London), July* 31.

The Telegraphone.

Some recent improvements in the design of Poulsen's telegraphone are described in this article, the latest types of which are now on exhibition in London, though they have not as yet been placed upon the market. The principle of the instrument remains the same. The current from the secondary of an ordinary microphone and induction coil system passes through a coil surrounding a small magnet under which a continuous steel surface is drawn. The steel is magnetized in a manner corresponding to the variations of current produced by the voice and when the coil is connected to an ordinary telephone receiver and the magnetized steel surface again drawn under the magnet the original words are reproduced. In the original form the record was taken on a steel wire wound spirally upon a drum. One of the present type replaces this wire by a steel disc, making a very compact arrangement. This disc is about five inches in diameter and is held on a rotating plane by a milled nut. As the disc rotates the recording magnet is moved toward the centre of the disc by a micrometer screw driven back by the clockwork which also drives the disc. The speed of rotation is such that a constant velocity of one-half metre per second is maintained under the magnet, the disc speeding up as the magnet approaches the centre. For erasing the record a bar magnet with a flattened end is used. The recording magnet is a pointed needle surrounded with a coil imbedded in insulating composition and held in a small ebonite cylinder. For the larger instrument a steel wire is used which is wound from one wheel to another. This wire passes between the poles of three pairs of magnets. The centre pair is that used in recording and reproducing the message. The other two are used for erasing the message, two pairs being used so that an old record may be erased with the wire passing in either direction. The articulation of these new types is good and there is freedom from foreign noises such as are heard in other types of talking machines. On the other hand the loudness of speech is less with this apparatus than with the others.—*Abstracted from Electrician (London), July* 31.

Coherers for Wireless Telegraphy.

A British patent granted to Sir Oliver Lodge, of Edgbaston, Birmingham, A. Muirhead and E. E. Robinson, and described in the *Mechanical Engineer,* London, relates to improvements in coherers such as are employed as detectors or receivers in systems of wireless telegraphy. In their design the inventors use a more definite kind of film, and obtain the necessary light pressure in a more definite manner than hitherto. Three designs of coherer are illustrated herewith. Fig. 1 shows the coherer attached to a recorder



COHERER FOR WIRELESS TELEGRAPHY.

coil in the "coherer" circuit; Fig. 2 represents it attached to a tuning fork, and Figs. 3 and 4 illustrate the wheel-form of it.

Referring to Fig. 1, F is a platinum needle attached to an arm G carried by a recorder coil H, *i. e.,* a rectangular coil of insulated copper wire pivoted or suspended between the poles of a magnet NS. Beneath the needle is placed a trough C containing mercury B. A layer of paraffin oil is poured upon the mercury B and the trough adjusted by means of the screw D until the needle point F just enters the mercury B. A suitable portion of the voltage of the single cell I is applied to the coherer A by shunting the cell with a resistance J and making connections at one pole of the cell and at an intermediate point on the shunt. The cell I is joined up between the mercury pole B of the coherer and one terminal of the coil K of a siphon recorder. The recorder K is in series with the recorder coil H and the needle F of the coherer connected to one terminal of the cell or battery I. So long as the amount of voltage applied to the coherer is about three-tenths of a volt or less, the thin film of oil between the needle point F and the mercury B will prevent the passage of an appreciable current through the coils H K, but on the arrival of ethereal waves from a distance the voltage between the needle point and the mercury is instantaneously and temporarily increased sufficiently to break down the oil film and allow a current to flow across it from the battery I, the result being a deflection of the recorder coil K, producing a signal on the tape L, and a deflection of the coil H in the direction to raise the needle F out of the mercury B. This withdrawal of the needle point F from the mercury B and reimmersion in the same on the cessation of the current through the coil H restores the continuity of the thin film between the needle point and the mercury and prepares the coherer for a succeeding electric wave or signal.

In Fig. 2 the needle point F is shown attached to one of the prongs of a tuning fork M, which is kept vibrating by means of an alternating or intermittent current (generated by an alternator N) flowing through a bobbin of wire O placed between the prongs of the fork. The vibration of the needle point F in the mercury B thus produced restores the continuity of the film of oil immediately after the breaking down of the latter by ethereal waves from a distance, or a spark in the neighborhood.

In Figs. 3 and 4 the conducting part F is shown in the form of a disc slightly immersed in the mercury B. The constant rotation of the wheels, effected by a clockwork train P, brings about the restoration of the continuity of the oil film between the wheel and the mercury after the cohering action of ethereal waves received from a distance, as in the two former cases. The amount of pressure of the mercury upon the disc or wheel is regulated by means of the screw D. To clean or wipe the edge of the conductor F before it enters the mercury B, and thus obviate the prejudicial effects of stray disturbances upon the recorder slip, a pad of felt Q is employed mounted in light contact with the conductor F, for which purpose it is secured to a spring R.

Mr. E. Hauser has found that the rate of interruption of the Wehnelt interrupter may be greatly increased and its starting potential lowered by employing dilute sulphuric acid and adding to it twenty per cent of its weight of sulphate of magnesia.

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INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

An Automatic Igniter.

The accompanying illustration shows the Apple automatic igniter which is manufactured by the Dayton Electrical Manufacturing Company, of Dayton, Ohio. The weight of this automatic igniter is sixteen and one-half pounds and its extreme dimensions are five by six by eleven inches. The igniter does away with bat-

AUTOMATIC IGNITER.

teries, belts and switches; is simple and compact, and while it is entirely enclosed provision is made for easy accessibility to its working parts. The design, as may be seen from the illustration, makes it dust, dirt and water-proof. The apparatus consists of an Apple dynamo fitted with an Apple friction governor that will maintain the speed of the dynamo at 1,400 revolutions per minute, irrespective of the speed of the engine.

There is now a demand, created by the adoption of gasoline motors to all kinds of power work, for an igniting dynamo which will furnish current for ignition at all times; as modern gasoline motors are subject to considerable changes of speed there is more or less difficulty in getting perfect service from the ignition apparatus. The application of the Apple governor to the igniter, the company claims, obviates any difficulties in this direction and controls absolutely the speed of the dynamo.

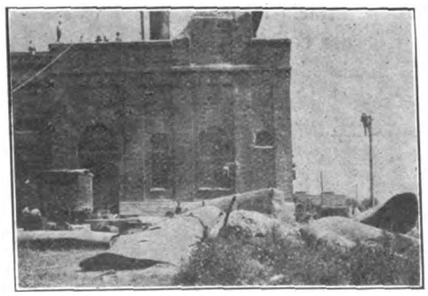
The company guarantees the following features in the operation of the automatic igniter: It will spark an engine at very low speed by reason of the permanent magnetic pole-pieces which are kept strong by the field coils when up to normal speed, and with the friction governor the machine can use extremely small friction without slippage when starting; it will furnish a very great output at reasonable speeds and it can be attached to any gas or gasoline motor by any one without the necessity of having previous experience.

Testing a New Air Brake in Germany.

A consular report states that a recent meeting of a commission composed of representatives of the Imperial Prussian, Bavarian, Saxon and Baden state railroads was held early in July in order to test the new Steiner distance brake, which is said to be an improvement upon those now in use. It is so connected to the air brakes of a train that when the front wheels of a locomotive pass over a danger signal placed upon the tracks it will automatically put on the brakes, at the same time opening the whistle valve. The report says that the apparatus worked with perfect satisfaction at the speed of 83.75 miles per hour, but because of the extraordinary strain to which it was subjected an important part of the brake was broken. The commission has recommended that an extended trial be given the Steiner brakes upon the regular train service.

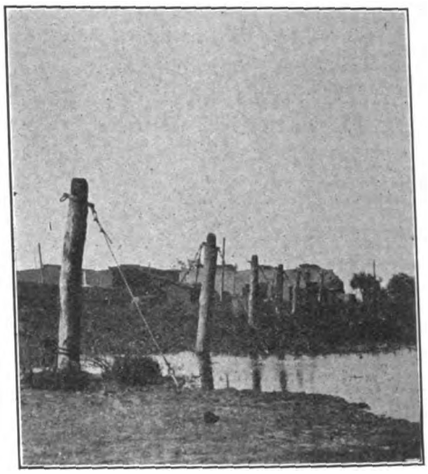
A Severe Test for Guy Anchors.

The accompanying illustrations give a pretty good idea of the great damage which was brought about during the recent storm at East St. Louis. The photographs from which these illustrations were made were taken the day after the storm which wrecked the stacks of the large power-house of the East St. Louis & Suburban Railway Company. These stacks were 6 feet in diameter and 160 feet high. They were guyed with three-quarter-inch steel cables to twenty-four twelve-inch Stombaugh guy anchors bored in their full lengths. In every instance the three-quarter-inch cable was



WRECKED STACKS AT ST. LOUIS. THE GUY ANCHORS UNMOVED.

snapped like so much thread, but the guy anchor did not move an inch. This power-house is one of the largest west of Chicago. The East St. Louis & Suburban Railway Company is using the Stombaugh guy anchor for all its belt-line guying also. The Stombaugh guy anchor was described recently in these columns. It consists essentially of a saddle-shaped plate which was placed vertically in a hole bored four or five feet in the ground in a slanting direction. After the plate has been deposited at the bottom of the hole the earth is tamped in all around it and more solid pressure is then taken upon the guy line which is joined to the plate, and the mechanical moment is of such a nature that the plate is swung



THE GUY STUBS AND ANCHORS STANDING UNMOVED AFTER THE STORM.

around so that it assumes a position at right angles to the direction of the pull.

Messrs. W. N. Matthews & Brothers are the exclusive distributors for these anchors, with headquarters at 600 Carleton Building, St. Louis, Mo.

Money Orders by Wireless Telegraphy.

The Cunard steamship Campania has the honor of establishing the first wireless telegraphy money order office in the middle of the Atlantic Ocean. One of the saloon passengers on the Campania, soon after leaving Queenstown, discovered that he had insufficient ready money to pay numerous expenses, and, not having any friends on board, was under considerable embarrassment as to means for providing himself with cash. He remembered that his mother was a passenger on the Lucania, which left New York the same day that the Campania sailed from Liverpool, so arrangements were made to pick up the Lucania by wireless telegraph and make a request of the gentleman's mother to pay the purser of the Lucania £10, asking him to advise the purser of the Campania to pay the money to her son. Communication was established at fifty miles

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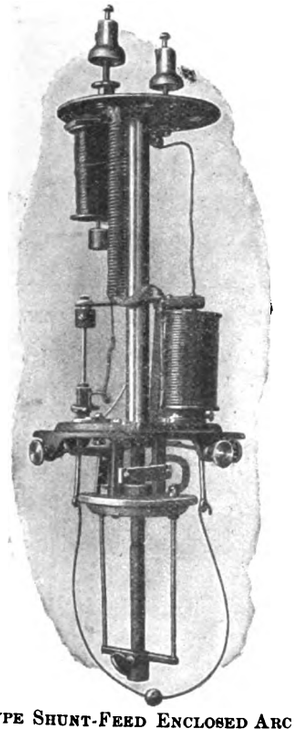
distance, both ships being then in mid-Atlantic. The messages were sent and received with great facility and easily understood. After the message to the lady on board the Lucania was properly understood, the purser of the Lucania telegraphed a message to the purser of the Campania to pay the young man the money, as he had collected it from the mother on board the Lucania.

A New Type of Shunt-Feed Enclosed Arc Lamp.

The accompanying illustration shows a new type of shunt-feed enclosed arc lamp



NEW TYPE SHUNT-FEED ENCLOSED ARC LAMP.

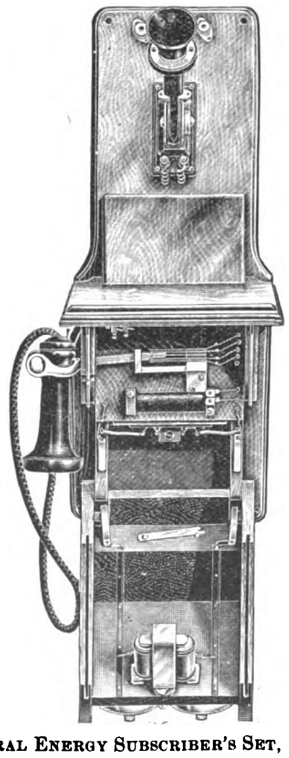
which has been designed by W. F. Warner, of Muncie, Ind. Mr. Warner has been a practical electrical lighting engineer for over twelve years and at present is superintendent of the city lighting plant at Muncie. His experience has given him facilities for understanding the exact requirements of a lamp of this nature. Notwithstanding many advantages which the enclosed arc lamp is claimed to give over the old open type, many operators hesitate in the adoption of the new system because of the expense of making the change, and there has been a demand for some time for a successful enclosed arc lamp which could be operated in connection with the present machine equipment. Mr. Warner began experimenting in this line a number of years ago and worked out the shunt-feed enclosed arc lamp which has been under a constant burning test up to the present time. Its operation has proven so economical and satisfactory that he has decided to place this on the market on a permanent business basis. The illustration shows the working parts of the lamp, the hood and globe being removed. Its operation is positive and simple, and the manufacturer states that the lamp has been adopted for street lighting in several cities.

The Curtis Turbine in Chicago Electric Light Station.

The first 5,000-kilowatt Curtis turbine-generator was run experimentally last week at the Fisk street station of the Commonwealth Electric Company, of Chicago. It carried its rated load about three hours. No economy tests were made, yet there was every indication that the machine when tested in this respect will equal, if not excel, the best compound condensing engine. Further experimental trials are being made. The capacity of the machine is reported to be at least fifty per cent above its rated load. This is believed to be the largest load carried on any turbine-generator.

A New Central Energy Subscriber's Set.

The accompanying illustrations show a new type of central energy subscriber's apparatus designed and placed on the market by the Fahnestock Transmitter Company, 74 Cortlandt street, New York

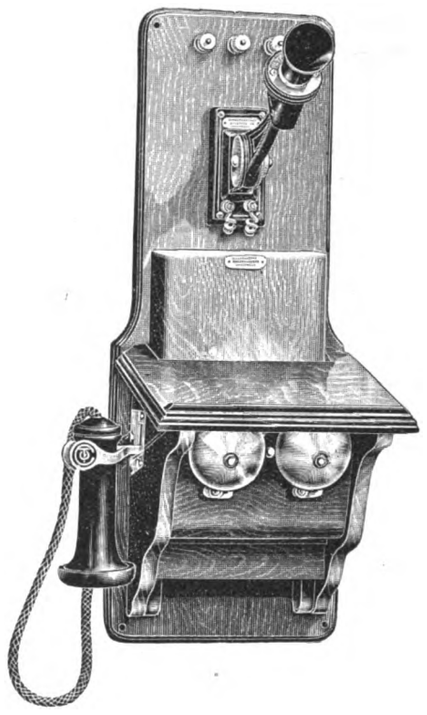


CENTRAL ENERGY SUBSCRIBER'S SET, OPEN.

city. This set embodies considerable novelty in the design of the woodwork, inasmuch as the condenser receptacle occupies the usually vacant space between the writing shelf and the transmitter. This permits of a material shortening of the set and improves its appearance generally.

The lower half of the box covering the hook switch, ringer magnet and coil is arranged to hinge downward and in doing so uncovers the lower end of the condenser receptacle. This permits of the removal of the condenser without disturbing any other part of the set.

When closed the box is fastened by a lock and key which prevents any possibility of its being tampered with. The



CENTRAL ENERGY SUBSCRIBER'S SET, CLOSED.

hook switch and coil are mounted on the condenser receptacle and when the box is open are easily inspected.

This set is equipped with the company's button type of transmitter and its new hook switch.

Proceedings of the Engineer Society of Western Pennsylvania.

The June issue of the Proceedings of the Engineer Society of Western Pennsylvania contains the following papers: "Advance in Modern Steel Construction," by L. F. W. Hildner; "Nickel Steel for Purposes of Construction," by Ralph H. Watson; "Steel Forgings," by T. D. Lynch; "Some Characteristics of Good Forgings and Some Things to Avoid," by James H. Baker; "Drop Forging," by Dwight Goddard; "Castings in Modern Construction," by D. McDougal; "Properties of Wire in Telephone Work," by R. A. L. Snyder, giving briefly the properties of various kinds of wire and the sizes generally used; "Cold Rolled Steel," by J. J. Crane; "Power Plant Design," by R. W. Stovel; this considers briefly the location and arrangement of the proper setting of the various apparatus and the efficiencies obtainable and gives some details of the equipment of the modern construction of moderate size.

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The Utilization of Electric Motors by a Terminal Company.

The Bush Terminal Company is one of the latest developments of the transportation problems in and around New York Harbor, and its development and profitable operation is the result of the congested terminals on Manhattan Island and in New Jersey.

The corporation has acquired a large acreage and an extensive water front extending from Thirty-ninth to Fifty-second street, South Brooklyn. .

It has completed four docks, each one of which is larger than any other dock in New York Harbor, and has built warehouses and laid down nearly thirty miles of railroad. It handles freight in freight cars directly from the railroads and on to the docks, thereby saving not only the increased dock charges of New York city but the cost of rehandling. It connects its railroad lines with the various railroads terminating in and around New York city by means of barges on as regular a schedule as the schedule of any railroad. It is equipped with tugs, barges, lighters, railroad cars, steam locomotives and electric motors.

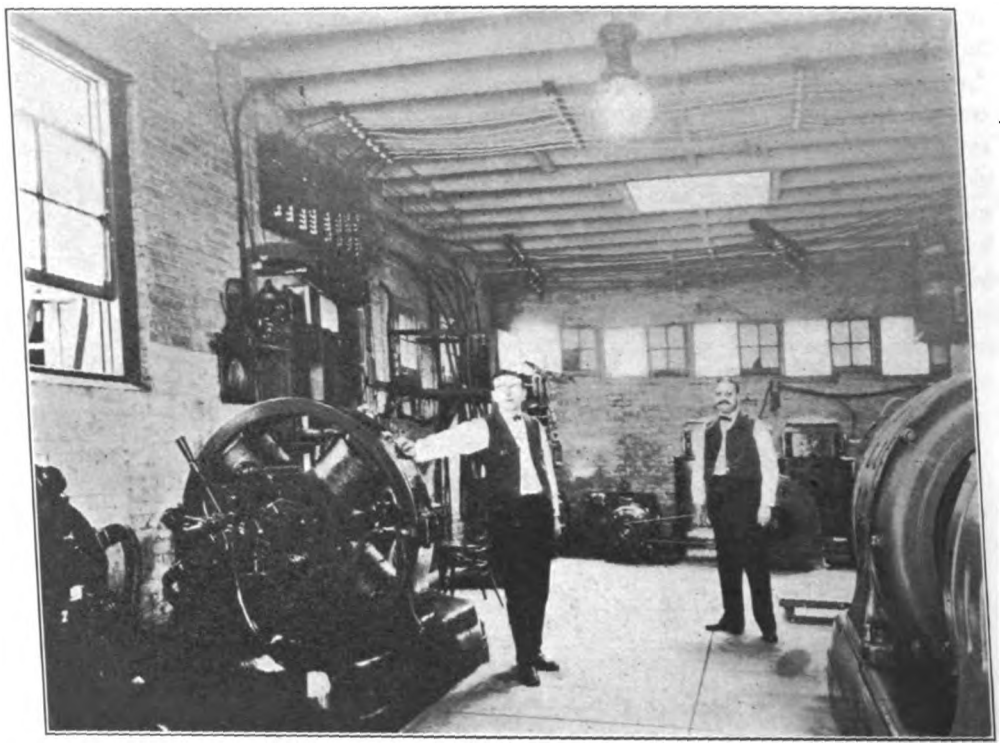

FIG. 1.—VIEW IN TRANSFORMERS SUBSTATION, BUSH TERMINAL COMPANY.

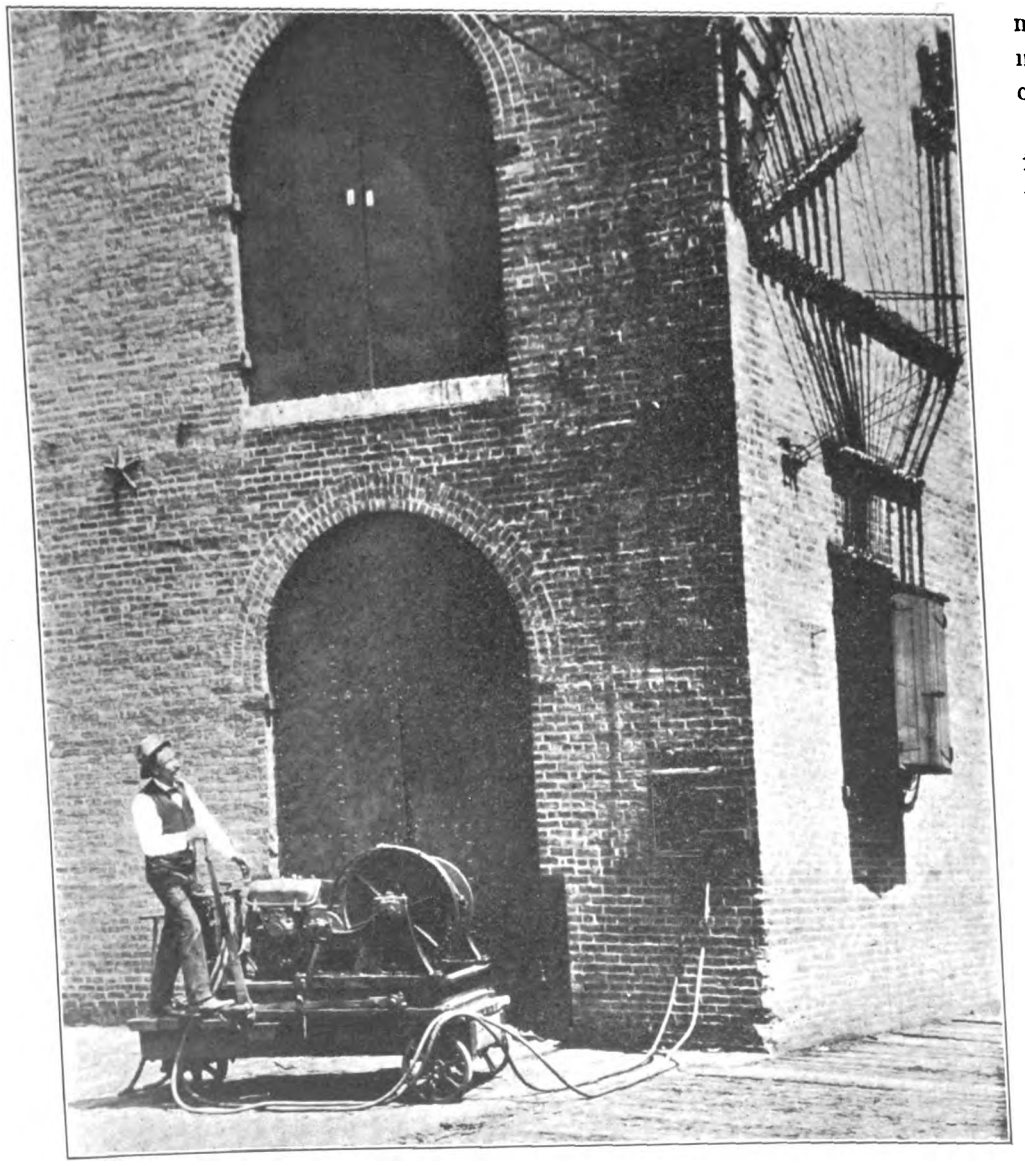

FIG. 2.—PORTABLE MOTOR AND TERMINAL BOXES, BUSH TERMINAL COMPANY.

The property is under the direction of Mr. Bush, the president, and Mr. Goodrich, general engineer, both of whom are technically educated engineers, and, as may be expected from this situation, modern facilities and economic methods of handling have been introduced.

The utilization of the electric current for the rapid and economic handling of freight and packages has been developed to its fullest extent. At the present time the company obtains its power from the high-tension main of the Brooklyn Edison Company. Alternating current at 8,000 volts is converted into 300 volts direct current and distributed around the plant. (The substation is shown in Fig. 1.) The wiring is on the four-wire system and located at convenient intervals both inside and outside of the piers and warehouses, as is shown in Fig. 2. Portable electric motors and hoists are used almost exclusively for handling the packages. The specifications call for an electric motor, which at eighty amperes and 220 volts will raise one ton 250 feet per minute, and the service test of the motors is dropping one ton 100 feet and catching it before it reaches the ground in the last ten feet of fall. It is extremely interesting to watch the various uses made of these portable electric motors. Two will be brought together and operated by one man, the two ropes going through different pulleys in such a manner that packages can be hoisted, swung and deposited without the necessity of rehandling. This hoisting will be done by one motor, then a second motor will tighten on its rope and release the first motor which will cause the package to be deposited on the pile, or on or in the

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freight car. Two electric motors and two stevedores will handle across the dock, and into or out of the warehouses more tons or more packages than a crew of from twenty to thirty men, varying according to the articles being moved. The saving in time and labor by using the electric motors, in some instances, is something over seventy-five per cent. Fig. 3 represents two motors used in taking cotton out of the freight cars and handling it up five stories and into the warehouses.

Municipal Steam Turbine Plant, Anderson, Ind.

An interesting municipal electric lighting plant enterprise is under way at Anderson, Ind., and marks the second introduction of the steam turbine in American municipal power plant service. The city of Anderson has for some years operated an electric light plant in connection with the city waterworks, located near White River. The electric installation is housed in a separate building, approximately 50 by 100 feet, adjacent to the waterworks plant whose boilers furnish the steam power necessary for the operation of the electric light plant.

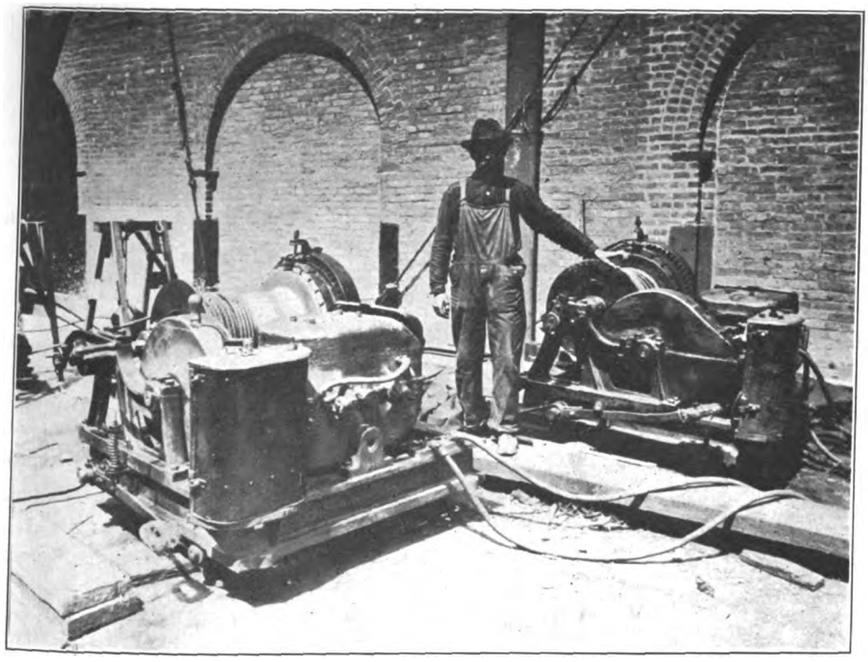

FIG. 3.—TWO MOTORS HANDLING COTTON BALES FROM FREIGHT CARS.

The present lighting equipment comprises two belted generating units, but the increasing demand for light and power renders the available capacity inadequate to carry even the present load, at times resulting in a severe overloading of the entire equipment. In order to secure immediate relief from these conditions and avoid the necessity of erecting additions to the power-house, Westinghouse steam turbine generating units have been selected for power extensions. At the present time two 400-kilowatt units will be installed, together with one twenty-kilowatt exciter, direct-connected to a Westinghouse standard engine, and a complete switchboard equipment.

As the result of the employment of turbines in this plant it has been found possible to install a complete boiler plant in the electric light building, thus rendering the operation of the lighting system entirely independent of the waterworks system. The new boiler plant consists of three 310-horse-power Stirling water-tube boilers equipped with Roney mechanical stokers. The boilers will not be arranged for superheat, but will supply saturated steam to the turbines at 150 pounds pressure, all condensation being returned to the boilers by a steam loop and Holly gravity return system. The turbo-generators will furnish three-phase current to the lighting power and distributing system at a frequency of 7,200 alternations and at 2,200 volts pressure, no step-down transformers being used. The turbine equipment will operate condensing as the plant is located near the river bank where condensing water is available. Surface condensers will be used and the condensation from the turbines will be returned directly to the boilers, as the exhaust is entirely free from oil.

An interesting feature of the turbine installation is brought out by the fact that by replacing the belted units with turbine-driven units, sufficient space is made available for the installation of the complete boiler plant, together with an additional turbine unit and the necessary boilers at such times as the future demands upon the plant require this extension.

E. R. Vincent, M. E., of Indianapolis, Ind., has been retained by the city of Anderson as consulting engineer, and the installation is under his general supervision.

Sprague Flexible Metallic Conduit for the Interborough Subway Cars.

A recent testimony to the value of flexible metallic conduit was made by Vice-President and General Manager Bryan, of the Interborough Rapid Transit Company, New York city, in an interview published in the New York *Sun*, August 12. Speaking of the fireproof construction of the new cars for the subway, and the impossibility of the Paris accident being repeated in New York, he says: "The wiring for lighting the cars is on the roof away from the passengers. Two small wires are insulated with asbestos and carried in conduits of flexible metal." The flexible metallic conduit which he refers to is that manufactured by the Sprague Electric Company, which received the order for this type of conduit for the Interborough car wiring for lights. This type of conduit is excellent for car wiring as well as the wiring of buildings where thorough protection to wires and insulation is essential. Its flexibility is such that it can be bent around corners and over obstructions with ease, the energy required to bend it being no more than is required to bend a manilla rope of the same diameter. No elbows, therefore, are required and the installation is reduced to absolute simplicity.

The International Association of Municipal Electricians.

The eighth annual meeting of the International Association of Municipal Electricians will be held at Atlantic City, N. J., September 2, 3 and 4. The papers for discussion have been announced, and in some cases these have been distributed for perusal by the members, in order that an intelligent discussion might be brought about. The following papers have been distributed: "Records and Reports," by Austin S. Hatch, Detroit, Mich.; "The Importance of the Fire Alarm and Police Telegraph," by W. H. Thompson, Richmond, Va. There has also been established a question box, and a number of questions have already been filed.

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CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

MEXICAN ELECTRIC TRACTION—An electric traction system is to be built between Allende and Zarazoza, both places being located in the state of Coahulia, Mexico. The distance is about twenty miles. It is intended to eventually extend the line to Ciudad Porfirio Diaz, on the Mexican frontier. The line would then be about sixty miles long.

A HEAVILY CAPITALIZED HOLDING COMPANY SAID TO BE ORGANIZED IN CALIFORNIA—A holding company with a capital of $50,000,000 for the Huntington electric lines in southern California has been organized. Senator W. A. Clark, of Montana, and E. H. Harriman have a minority of the stock in the company, Hellman and Huntington keeping the control. The interested persons have decided not to disturb the existing four companies which represent the Hellman and Huntington lines.

NEW POWER-HOUSE—Within the next two weeks the Louisville Railway Company will begin the erection of a power-house at Meadow Brook station on the Third avenue Jacob Park car line. It will be a brick structure, two stories in height, and will cost about $26,000. The house will connect with the new power station at Logan and Lampton streets, and the voltage, coming from the latter station, will be reduced at the Third street station to the voltage necessary for operating the two Jacob Park street car lines.

BROOKLYN RAPID TRANSIT NOT TO EXPERIMENT WITH POULSON PLAN—The plans for relieving the congestion during rush hours at the loops at the Manhattan end of the New York & Brooklyn Bridge during rush hours will not be along the lines suggested by Mr. Niels Poulson. His plan was to construct a moving walk-way. President Edward W. Winter, of the Brooklyn Rapid Transit Company, has announced that the Poulson plan would practically receive no recognition at the hands of the Brooklyn Rapid Transit Company, inasmuch as the company is now carrying out the plan for four additional loops. The latter plan is now in course of construction and the passengers are using the local bridge cars at night while the work is going on.

THE CONNECTICUT POWER SCHEME—The New Boston & Springfield Electrical Power Company, with a capital of $4,000,000, has just been organized by New York promoters and capitalists and has secured the principal water privileges along the branch of the Farmington River from Otis, Mass., to New Hartford, a distance of about twenty miles, taking over the Greenwoods property in New Hartford and the rights recently secured in Otis and New Boston by the Boston and New York parties, Messrs. Flint, Gile and others. The purpose is to convert the water power along the river into electrical power and transmit it to Springfield, Mass., where it is said contracts have already been made to furnish 10,000 horse-power. It is estimated that 7,500 horse-power can be obtained at New Boston and upward of 6,000 horse-power at New Hartford and Otis. At least $3,000,000 will be expended along the Farmington River to develop this power.

INTERURBAN CORPORATION—A corporation, representing millions of dollars, has been organized at Beaumont, Tex., to build, operate and manage a great system of interurban lines. For some time there have been meetings between several capitalists from Ohio and many of the most prominent and influential of the capitalists of Beaumont. Their plans and objects have not been given publicity, but it develops that the secret sessions have had to do with a system of electric lines that will connect the oil and rice industries that have been flourishing in this section of the state, and handle their products to the gulf. The men interested in the project are: Messrs. E. R. Norvell, Captain William Wiess, Turner & Nabers, McFadden, Wiess & Kyle, T. S. Reed, W. C. Averill, G. W. Carroll, Captain George W. O'Brien, Colonel George A. Mill and John N. Gilbert, of Beaumont, and George M. Craig, of Port Arthur, John R. Lynn, of Springfield, Ohio, William Abbott Smith, Hugh Smith and Theodore Weyant, of Columbus, Ohio. The company is capitalized at $300,000, and application for the charter has been made. The corporation will be styled the Beaumont, Sour Lake & Port Arthur Traction Company. It has taken over the rights and holdings of the construction company now building between this city and Sour Lake, and, following the policy of that company, will lose no time, but complete the line in the same manner that it has begun. The company does not take over the Beaumont, Port Neches and Port Arthur lines, but will build a line between these points entirely separate and distinct. R. C. Welles, who has been the superintendent of construction for the old company, will act in the same capacity. George White has been engaged as chief engineer of the corporation. J. N. Lynn will act as consulting engineer and have personal charge of the electrical affairs. It is stated that the stockholders represent not only the best element of the city, but have over $10,000,000 behind the project.

PERSONAL MENTION.

MR. J. J. WELCH has been transferred from the position of manager of the Paterson district of the New York & New Jersey Telephone Company to take charge of the Jersey City office of the company.

MR. THOMAS A. EDISON, it is said, has perfected a commercial phonograph and made it practical for taking court testimony and other dictation. The record used is nine inches long, and capable of taking several letters.

MR. J. F. BLAUVELT, of the New England Butt Company, of Providence, R. I., was a New York visitor this week. Mr. Blauvelt's company is probably the largest manufacturer of insulated wire braiding machinery in the world.

MR. A. E. RODGERS, general manager of the Perth & Kalgoorlie Electric Traction system, is drawing up plans for an electric traction system to be constructed in West Australia, to operate in and around Essendon, Flemington and Kensington.

MR. A. W. DOUGLAS has tendered his resignation as secretary of the Shawinigan Water and Power Company, of Montreal, and is to leave for the Pacific coast. Mr. Douglas will be succeeded by Mr. Howard Murray, who has been connected with the company for a number of years.

MR. J. K. ROBINSON, of Iquique, Chili, who represents the Westinghouse Electric and Manufacturing Company, the Standard Underground Cable Company, and other prominent American manufacturing interests in Chili, Peru, Bolivia and Ecuador, is visiting the United States, where he will place contracts for the electrical equipments of two extensive Chilian nitrate plants.

MR. H. E. HUNTINGTON, of Austin, Tex., it is announced, has purchased all the independent telephone toll lines in Texas, aggregating 1,000 miles, and for which he has paid $400,000. It is stated that Mr. Huntington has now closed negotiations for the purchase of the independent telephone exchanges located in Austin, San Antonio, Houston, Corsicana, Waco, Beaumont, and nearly a score of other towns in Texas, Louisiana and Indian Territory.

DR. J. A. McGOWAN'S paper on "First Aids and Appliances," which was read at the Chicago convention of the National Electric Light Association, has been reprinted and is being distributed to members of the association. This is in line with the suggestion that was made at the convention at the time the paper was read. The information contained in this paper is regarded as most valuable, and should be in the possession of every electric station manager.

MR. CHARLES L. EDGAR, Boston, Mass., president of the National Electric Light Association, was a visitor to New York last week, in connection with association matters. President Edgar has appointed a number of committees and editors of different departments to report to the twenty-seventh convention of the National Electric Light Association, which will be held in Boston Mass., next May. These appointments will be announced later. By taking up active work at so early a period in the year Mr. Edgar hopes to furnish a convention programme that shall exceed in interest, if possible, the very attractive ones of the past years.

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ELECTRICAL SECURITIES.

There was a very evident disposition manifested by large financial interests to bring about a cessation of forced liquidation and to support a decided raise in prices. The temper of the stock market throughout the country showed a decided change, in that the bull movement might almost be termed enthusiastic in its nature. All along the line prices advanced sharply, and these advances were held firmly all through the week, the markets closing strong on the last day. This condition of affairs has been prophesied for some time, and the question that is raised now is one which looks for an answer which will convey the reasons for the disastrous period which has just been gone through. There has been, even in the periods of greatest decline during the past eight or nine months, no internal complication which would justify the aggravated decline which set in early in the year and which has continued so steadily. Notwithstanding the pessimistic viewpoint of some speculators, following the protracted period of depression, an examination of statistics shows that there is little basis for an argument that industry in general is in any way radically wrong. Railroad earnings are breaking all past records for corresponding times, and while the cereal crop in one direction was more or less of a disappointment, this is more than compensated by record-breaking conditions in the surplus-producing territory. This condition of affairs will create a prosperous community among the agricultural interests of the country. It is also noticed that the iron and steel trades are enjoying a solid business, with no indications of any serious reversal. Railroad operatives are looking forward to a remarkable business during the coming harvesting season, and although railroad car shops are surfeited with orders, it is probable that there will be more or less of a car famine shortly to handle the moving interior commerce.

ELECTRICAL SECURITIES FOR THE WEEK ENDING AUGUST 15.

New York:	*Closing.*
Brooklyn Rapid Transit	45⅝
Consolidated Gas	179⅜
General Electric	164
Kings County Electric	165
Manhattan Elevated	135½
Metropolitan Street Railway	115
New York & New Jersey Telephone	145
Westinghouse Manufacturing Company	165

The Westinghouse Electric and Manufacturing Company has made application to the New York Stock Exchange for permission to list $9,135,200 of assenting stock. The money raised from the sale of this stock will be used for making extensions to plants to meet the growing business of the company and for working capital. A portion of this stock was issued in 1901, and the amount includes the $4,500,000 issued in May. This makes the amount of assenting stock outstanding $18,516,551, leaving nearly $2,500,000 of this class of stock still in the treasury.

The Kings County Electric Light and Power Company has declared a regular quarterly dividend of 2 per cent, payable to stockholders of record August 21.

The list of electrical securities shows a considerable advance since the closing prices for last week. Brooklyn Rapid Transit gained 6⅝ points; Consolidated Gas, 11⅜ points; General Electric, 14 points; Kings County Electric, 10 points; Manhattan Elevated, 6½ points; Metropolitan Street Railway, 6⅛ points, and Westinghouse Manufacturing Company, 5 points.

Boston:	*Closing.*
American Telephone and Telegraph	134
Edison Electric Illuminating	239
Massachusetts Electric	81
New England Telephone	123
Western Telephone & Telegraph preferred	82

The feature of the market during the week was the strong buying of American Telephone and Telegraph shares. During this buying the price held firm and was bid up 2½ points to 134. Edison Electric Illuminating gained 14 points. Massachusetts Electric was dealt in considerably. New England Telephone gained 3 points, and Western Telephone and Telegraph preferred held steady at 82.

Philadelphia:	*Closing.*
Electric Company of America	8 1/16
Electric Storage Battery common	55
Electric Storage Battery preferred	54
Philadelphia Electric	5¾
Union Traction	43¾
United Gas Improvement	84⅜

Chicago:	*Closing.*
Chicago Telephone	120
Chicago Edison Light	140
Metropolitan Elevated preferred	65
National Carbon common	21
National Carbon preferred	88
Union Traction common	4¾
Union Traction preferred	18½

It has been announced that the operating expenses of the Union Traction Company have been considerably increased since the universal transfer system was imposed on it by the city of Chicago a year ago next October. Before this period the company used about 1,000,000 transfers monthly, whereas at present 2,000,000 or thereabouts are necessary to meet the large traffic over the company's lines. It is stated that the Metropolitan Elevated traffic has been cut into three or four thousand a day on account of this transfer system.

NEW INCORPORATIONS.

BEATRICE, NEB.—The Virginia Telephone Company. $4,000.

WILMINGTON, DEL.—American District Telegraph Company. $20,000.

COUNCIL BLUFFS, IOWA—Summit Rural Telephone Company. J. C. Geister and others, incorporators.

AUGUSTA, ME.—Swain Island Telephone and Telegraph Company. $5,000. President, W. B. Snidsay; A. C. Smith, treasurer.

CINCINNATI, OHIO—The Interstate Telephone Company. Incorporators: S. P. Kineon, O. L. Perin, E. Zimmerman, R. H. Ellis-ton and F. K. Ludlow.

TRENTON, N. J.—The Saginaw Bay City Railway and Lake Company. $3,000,000. Incorporators: Joseph F. Cotter, William Eidell and I. C. Clow.

WAPAKONETA, OHIO—United Farmers' Telephone Company. President, R. A. Kerr; vice-president, M. Lavison; secretary, J. N. Graham; treasurer, C. C. Creps.

ADRIAN, MICH.—The Citizens' Electric Light, Power and Heat Company. $100,000. The new concern takes in the old electric light and power company.

WINONA, IND.—The Winona Electric Light and Water Company. $100,000. Its purpose is to furnish light and power to Winona, Warsaw and surrounding territory.

JAMESTOWN, N. Y.—Ashville & Panoma Telephone and Telegraph Company. $15,000. Incorporators: C. W. Appleby, A. H. Appleby, E. E. Berry, A. J. Peterson and B. D. Phillips.

OMAHA, NEB.—Monona Telephone Company; $100,000; incorporators: J. B. Huff, S. B. Martin and others. Goldfield Telephone Company; $10,000; incorporators: Howard Crill and others.

WAPOKONETA, OHIO—The Buckland Telephone Company. H. D. Bowsher, T. B. Bowsher, Dr. R. W. Sharp, B. Graham, J. Edman, G. W. Romshe, S. A. Brookhart, C. Lathrop and C. F. Bowsher.

TRENTON, N. J.—Southern Kentucky Interurban Traction and Power Company. $125,000. Incorporators: C. W. Courts, J. M. McCutchen, J. C. Browder, S. R. Crewdson, R. P. Manley, R. R. Clark, J. W. Clark, H. S. McCutchen, W. P. Bainbridge.

JERSEY CITY, N. J.—Southern Telephone and Telegraph Company; $25,000; incorporators: Arthur Johns, E. P. Hervey, G. W. I. Dwinnell. Atlantic & Pacific Telephone and Telegraph Company; $2,500; same incorporators. Sauttum Telephone and Telegraph Company; $2,500; same incorporators.

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TELEPHONE AND TELEGRAPH.

DALLAS, TEX.—A new automatic telephone system will be installed at Chelburne.

PHILADELPHIA, PA.—The Factoryville Telephone has been incorporated with a capital of $5,000.

BALLSTON SPA, N. Y.—A telephone line will be built to connect Galway and Ballston and points east.

NEWARK, OHIO—The Newark Independent Telephone Company is erecting an exchange at Granville.

DELPHI, IND.—The Cass County Security Company has bought out the Logansport Home Telephone Company.

MAYSVILLE, KY.—The Mutual Telephone Company has decided to build a new line from Dover to Fernleaf.

ENNIS, TEX.—The Independent Telephone Company is erecting a line to Corsicana, to connect with southern Texas.

DANVILLE, ILL.—An underground telephone service is being installed by the Vermillion County Telephone Company.

SYRACUSE, N. Y.—The Syracuse Telephone Company plans the expenditure of about $300,000 for the betterment of its service.

BOSTON, MASS.—At a meeting of the Whitman selectmen it was voted to grant a franchise to the Automatic Telephone Company.

PITTSBURG, PA.—The Federal Telephone Company is building a line from Washington, Pa., to Wheeling, about thirty-five miles.

SKOWHEGAN, ME.—The Hartland & St. Albans Telegraph and Telephone Company has been organized with a capital of $10,000.

JANESVILLE, WIS.—A new farmers' telephone line has been constructed to Willowdale by the Rock County Farmers' Telephone Company.

FLORENCE, COL.—About twenty new telephone lines are being built south to Silver Creek and adjoining towns by the Colorado Telephone Company.

KANSAS CITY, MO.—The Haley Telephone Company, which has a franchise to install a telephone system at Independence, is hastening the work.

ALBERT LEA, MINN.—The American Telephone and Telegraph Company will build a line into this county, having already secured the right of way.

FALL RIVER, MASS.—The Fall River Automatic Telephone Company has completed its copper toll line connecting with the New Bedford automatic exchange.

JEFFERSON CITY, MO.—The Liberty Telephone Company, of Liberty, has filed articles showing that it has made an increase in its capital stock from $15,000 to $25,000.

LOCKHART, TEX.—The Commercial Telephone Company has been granted permission to erect a telephone line from the county line on the San Marcos & Lockhart to Lockhart.

NORTHAMPTON, MASS.—The Southern Berkshire Telephone Company has been organized, and will connect Great Barrington with Alford, Egremont, Suffield, New Marlboro and Monterey.

WILMINGTON, N. C.—The Southern Bell Telephone Company will erect a $16,000 building in Charlotte, and spend about $35,000 in equipping a new exchange and placing its wires underground.

LINCOLN, NEB.—The Golden-Rod Telephone Company, of Wahoo, has filed amended articles of incorporation with the Secretary of State, increasing the capital stock from $50,000 to $150,000.

PETERSBURG, VA.—The Petersburg Telephone Company has secured the right of way to Chesterfield Courthouse, and will at once establish communication between Petersburg and that place

SPRINGFIELD, MO.—At the annual meeting of the Home Telephone Company the following directors were elected: H. B. McDaniel, F. J. Curran, A. J. Eisenmayer, W. D. Tatlow, E. B. Bentley, B. E. Meyer and C. O. Trask.

BROCKPORT, N. Y.—The Brockport Telephone Company has been incorporated with $10,000 capital, the directors being Frank A., A. P. and G. L. Winne, James Brenman, Thomas H. Dobson, Mary E. Talman and James Conley.

HAGERSTOWN, MD.—The Chesapeake & Potomac Telephone Company has completed its new line to Harper's Ferry, Weverton and Sandy Hook, connecting with Hagerstown. All iron wires in Hagerstown have been replaced by copper wires.

BIRMINGHAM, ALA.—At the annual meeting of the stockholders of the People's Home Telephone Company, the following directors were elected: H. H. Stambaugh, A. E. Adams, J. Vautrot, Jr., D. M. Forker, W. H. Hassinger, H. L. Badham and H. B. Gray.

REYNOLDSVILLE, PA.—A farmers' telephone line will be built from Knoxdale to Reynoldsville, *via* Emerickville. A line is being constructed from Knoxdale to Brookville, *via* Cool Spring, and another is now in operation from Knoxdale to Punxsutawney.

SHELBYVILLE, ILL.—The Queen City & Shelby County Mutual Telephone Company has been incorporated with a capital of $10,000 to construct and maintain a telephone system. J. F. Ulmer, S. A. Richardson, J. H. Thomas, G. Griffith and W. O. Bennett are the incorporators.

PHILADELPHIA, PA.—By a unanimous vote, the stockholders of the Bell Telephone Company have voted to increase the capital stock of the company from $12,000,000 to $16,000,000. The additional money will be employed in making improvements in this city and surrounding territory, and extending the lines.

BANGOR, ME.—The Cumberland Telephone Company has been organized at Portland for the purpose of doing a general telephone and telegraph business in Cumberland County, with $50,000 capital stock. The officers of the company are: President, Milville E. Kelley, of Saco, Me.; treasurer, Alexander Speirs, Westbrook, Me.

AUGUSTA, ME.—The Central Maine Telephone Company has been organized at East Fairfield, Me., for the purpose of operating telephone lines in Kennebec, Somerset, Waldo and Penobscot counties, with $10,000 capital stock. The officers are: President, M. D. Holt, of East Fairfield; treasurer, C. M. Holt, of East Fairfield.

PATERSON, N. J.—The stockholders of the Paterson, Passaic & Suburban Telephone Company have elected the following directors for the ensuing year: C. W. Kline, E. C. Stokes, W. Dumont, B. Gummere, J. W. Lindsay, H. H. Hamil, G. A. Post, W. S. Hancock, W. Bamford, F. A. Demarest, J. D. Patton, S. Sheldon and W. D. Blauvelt.

ALBANY, N. Y.—The State Line Telephone Company has been incorporated to operate a telephone line, connecting Albany, New York city, Syracuse, Rochester, Buffalo and other places in this state and in Canada. The capital is $1,000,000, and the directors are William Engert, George Engert, C. W. Andress, R. P. Lyon, D. A. Nesbitt and E. A. Reynolds, of New York city, and H. N. McKay, of Brooklyn.

HAMMONTON, N. J.—It is stated that it is the intention of the Interstate Telephone Company to erect its trunk lines to Atlantic City, to connect with the Eastern Telephone Company, which will build from Camden to this point. The former company has secured a franchise to build lines throughout Atlantic County, while the Eastern company has similar privileges through Camden County. This combination will give an independent long-distance telephone service between Atlantic City and Philadelphia.

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ELECTRIC RAILWAYS.

WARREN, OHIO—Work has been commenced on the new Middlefield-Sharon electric line. The first section to be opened will be between Middlefield and Bloomfield.

ELKTON, MD.—At a recent meeting of the Chesapeake City Electric Railway Company the contract for the building of the road was let. The work is to be completed by October 31.

SUNBURY, PA.—The Edgewood trolley line will be extended through Coal Township to Zerbe Township and Trevorton, and then on into Lower Augusta and to Sunbury, connecting with the line there.

COLUMBUS, OHIO—The Marion & Findlay Electric Railway Company, with a capital of $10,000, has been incorporated by J. W. Scott, R. M. Shutt, Charles E. Watson, W. K. Stanley and R. B. Oliver. The line will connect Marion and Findlay, touching Marseilles and Forest.

ATHENS, GA.—It is stated that the proposed electric road from this city to Carnesville, in Franklin County, will be built. The new road will be the longest electric line in the state, the distance from Athens to Carnesville being about thirty-five miles by the route to be followed.

KANSAS CITY, MO.—The Oklahoma Traction Company has been organized to build an electric line between Oklahoma City and Guthrie, a distance of thirty miles, and work will be commenced shortly. In addition, the company will operate street railway systems in the two cities. Power-houses will be erected at both towns.

VINCENNES, IND.—The preliminary contracts for the construction of the Southern Indiana Traction Company's line have been let, and it is expected that work will begin some time during the summer or early fall. The line will be forty-three miles in length, and will start at Vincennes, passing through the towns of Monroe City, Petersburg, Algiers, Otwell, Ireland and Jasper. The road will be used to carry freight as well as passengers.

HOUSTON, TEX.—It is said that the Electric Interurban Railway Company will build two lines between Galveston and Houston, and in all probability purchase the Galveston Street Railway Company's property. One of the lines between Houston and Galveston has been surveyed. This will be an air line running between the lines of the Galveston, Houston & Henderson and the Gulf, Colorado & Santa Fe railways.

FORT WAYNE, IND.—The Fort Wayne & Springfield Railway Company, another interurban line which proposes to operate between Fort Wayne, Middletown, Decatur, Monroe, Berne, Geneva, Portland and Pleasant Mills, has incorporated. The company has a capital of $300,000, and the directors are: William H. Fledderjohann, John H. Koenig, Benjamin A. Fledderjohann, Edwin J. Hoppel, Willis Armstrong, Edward Fledderjohann and Christian Vogt.

FREELAND, PA.—A number of Freeland citizens have organized a new company to be known as the Freeland Electric Coach Company, which is virtually a branch of the Trackless Trolley Company, of Scranton. A charter has been granted and an organization effected with the following officers: President, Hugh Malloy; vice-president, Albert Goeppert; secretary, S. J. Neuberger; treasurer, M. Schwabe. A line will be run to Upper Lehigh, St. Johns, Eckley, Sandy Run and other towns.

ALLENTOWN, PA.—The Easton & Belvidere Street Railway Company has awarded the contract for the building of its road, and work has been commenced. The road will be built from Siegfried, Pa., across the country to Belvidere, N. J., tapping several boroughs and villages. It will be forty-three miles in length. The directors of the company are: W. S. Read, Leominster, Mass.; Charles A. Shipper, Milford, Mass.; Michael J. McGawley, Boston; John McGawley, Lowell, Mass.; E. B. Fullen, Haverhill, Mass.; Charles A. Richardson, Boston; Howard Mutchler, of Easton.

DECATUR, ILL.—The sale of the Decatur street car system has been effected, a syndicate of eastern capitalists represented by W. B. McKinley, of Champaign, purchasing the entire issue of $250,000 in capital stock for $200,000. The system has been bonded for $212,000. The syndicate already owns street car and interurban systems, gas and electric lighting plants in several cities in Illinois and Indiana. It is now building interurban systems that will eventually be joined and make an electric railroad from Danville through Champaign and Decatur to Springfield, thence to St. Louis.

ELECTRIC LIGHTING.

FLORENCE, NEB.—At a meeting of the city council a proposition was submitted by the Omaha Electric Light and Power Company to install arc lights in the city for street lighting and a price made for lighting business places and dwellings—the city to enter into a ten-year contract with the company—the lights to be in operation within sixty days after the contract is signed.

LOGAN, UTAH—Members of the electric light plant committee have visited Logan cañon for the purpose of selecting a location for the city's power-house. They state that work will begin on the structure in the near future. Lumber is being rapidly received from Oregon and the work of manufacturing the pipe is in progress. It will be placed in position as rapidly as completed.

ALPENA, MICH.—The Alpena Light, Heat and Power Company has been organized under the laws of Maine, with a capital stock of $500,000. The company is to develop the water power of the Thunder Bay River and generate power for manufacturing institutions of the city. The new corporation will also take over the waterworks system, the electric lighting plant and the gas plant, all separate companies.

COLUMBUS, OHIO—Announcement has been made that the fund derived from the sale of bonds to provide for the construction of a municipal electric lighting plant, $232,000, was about exhausted and that a deficit of considerable proportions was inevitable. To complete the plant the pole line must yet be provided for, there will be needed a crane, steam pipe-fitting and some small pumps. The outside construction will be a heavy item unless poles should be rented. That question is undecided.

OMAHA, NEB.—The Omaha Electric Light and Power Company, a recently organized corporation, has taken over the property of the Omaha Thomson-Houston Electric Light Company, together with the two lighting companies of Council Bluffs. Floating indebtedness of $40,000 and bonded indebtedness of $298,000 will be taken up and new bonds to the extent of $1,500,000 will be issued. The new company is organized under the laws of Maine and some of its heavy stockholders are residents of Boston. There will be no change in the management of the concern.

JACKSONVILLE, FLA.—The power-house of the West Palm Beach Electric Light and Power Company has been completed, and turned over to the company. Those who have charge of the work of installing the plant have promised to turn on the lights by the first of December, and it now looks possible to keep this promise. Two carloads of poles have arrived, and these will be placed in position immediately. The machinery for the power-house will not be shipped until the end of the month, but in the meantime a great deal of the outside wiring is to be done, and the work of completing the system carried forward with all possible haste.

SEATTLE, WASH.—City Engineer Thomson has asked the city council to appropriate $26,200 for work on the municipal light plant during August. Now that the money for full construction of the system is assured, the city officers feel no hesitancy in appropriating money from the general fund, to be returned when the money from the sale of the bond issue is in the vaults. Mr. Thomson wants to get the timber crib down in position during extreme low water in Cedar River this fall, and he intends to rush things to do this. The city has now 150 men at work on Cedar River and more men will be added during the low water season. In segregating his items of expense for August, Mr. Thomson fixes the sums as follows: Field party complete, $1,000; labor on flume, supplies, etc., $3,200; labor and material for timber-crib dam, $8,000; power-house station, $3,000; right-of-way clearing, $3,000; total, $26,200. The clearing of right-of-way, building of flume station, etc., will be done by the city. The contracts to be let cover mainly the electrical equipment.

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INDUSTRIAL ITEMS.

THE PNEUMATIC ENGINEERING COMPANY, 128 Broadway, New York city, has issued a new catalogue describing apparatus for pumping by compressed air. The book contains a great deal of information and the illustrations are well executed.

THE CUTLER-HAMMER MANUFACTURING COMPANY, Milwaukee, Wis., is distributing an attractive souvenir in the form of a dice-box and dice. A celluloid strap which encircles the box bears the legend "Winners—Cutler-Hammer Field Rheostats."

F. B. BADT & COMPANY, Monadnock Block, Chicago, Ill., has taken the agency at Chicago for Field clay conduits, manufactured by C. J. Field, New York city. W. G. Nagel Electric Company, Toledo, Ohio, has taken the Field agency for Ohio, Indiana and Michigan.

THE UNION SWITCH AND SIGNAL COMPANY, Swissvale, Pa., is distributing its catalogue of interlocking and signal devices. Section 3 shows the assembly and presents half-tone reproductions and diagram illustrations of all the parts of mechanical locking and operating devices.

THE JANDUS ELECTRIC COMPANY, Cleveland, Ohio, announces that owing to the rapid increase in its eastern business, it has been found necessary to move into larger quarters, and the company is now located in the Engineering Building, 114 Liberty street, New York city.

THE STANDARD ELECTRICAL MANUFACTURING COMPANY, Niles, Ohio, manufacturer of "Star" incandescent lamps, is meeting with large sales of its products. F. W. Stillwagon is president, W. H. Pritchard, vice-president, and J. P. Gilbert, secretary and treasurer of the company.

THE J. H. WHITE MANUFACTURING COMPANY, Brooklyn, N. Y., is distributing its new catalogue descriptive of electric gas and combination fittings, shells and trimmings, and lighting specialties. This covers an extensive line of brass goods, a careful alphabetical index makes reference to any particular apparatus easy.

THE H. W. JOHNS-MANVILLE COMPANY, 100 William street, New York city, calls attention to its "Anti-Sweat" pipe covering. This prevents condensation on the surface of the pipes and stops all dripping from "sweat." It also protects the pipes from rust and decay. Full information, samples and prices will be forwarded on request to the company.

THE McGUIRE MANUFACTURING COMPANY, Chicago, Ill., has issued a handsome calendar for the six months beginning July, 1903. On each leaf is a fine half-tone reproduction of a piece of apparatus made by the company. These are, respectively, a pneumatic sprinkling car, a rotary snow sweeper, when not in use as a sweeper this can be used as an electric locomotive or freight car; a motor-car truck, a solid steel Columbian truck, a 39-A double truck for interurban and high-speed city service, and a Maximum traction truck No. 3.

THE STANDARD PAINT COMPANY, 100 William street, New York city, is distributing a "Ruberoid album" as a souvenir of the twelfth year of success of "Ruberoid" roofing. This is a weatherproof elastic and odorless material. The outer covers of the album are intended to show the appearance of "Ruberoid" roofing, which is a dark gray in color, presenting a smooth finish surface when laid. The illustrations show the great variety of structures to which this material has been applied with unvarying success.

THE ALLIS-CHALMERS COMPANY, Chicago, Ill., has issued an elaborate souvenir catalogue, descriptive and illustrative of Reynolds-Corliss engines, built exclusively by the Allis-Chalmers Company, at the Edward P. Allis Works, Milwaukee, Wis. Following views of a number of the Allis-Chalmers works, are views in the several departments of the Edward P. Allis Works. These are followed by views of typical machines and installations of street railway engines, electric light engines, pumping engines, blowing engines, rolling mill engines, hoisting engines and air compressors.

THE KELLOGG SWITCHBOARD AND SUPPLY COMPANY, Chicago, Ill., has recently been awarded a contract by the Pittsburg & Allegheny Telephone Company for a 3,000-line common battery, multiple switchboard for McKeesport, Pa. Present equipment, 1,000 lines. The company has also received an order from the National Telephone Company, of London, England, for an 800-line common battery board for Lavender Hill, London. A contract has also been awarded it for the entire exchange equipment at Pasadena, Cal. This is a 7,200-line switchboard, with 1,500 lines equipped. The contract includes the telephone instruments.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, Pa., is distributing a new catalogue entitled "Instructions for the Care of the Exide Battery in Electric Vehicles." This describes and illustrates in detail all battery parts; gives directions for installing and assembling battery in a vehicle; describes switchboard and charging connections, the charging of batteries in vehicles, the charging of batteries when removed from vehicles, excessive and injurious overcharging, the treatment of batteries used but occasionally, and the putting of batteries out of commission. This is supplemented by the general rules for the proper care of a battery.

THE EDISON ELECTRIC ILLUMINATING COMPANY, Boston, Mass., has been publishing some very attractive literature, beginning with the May issue of *Edison Light*. This little publication illustrates the untiring efforts which the Edison company is making to give the population of Boston the very best quality of service, both for illumination and power. The company has recently issued a bulletin giving advance information regarding points where electric automobile batteries may be charged. This gives the charging stations on the line of the Edison company in Greater Boston, and also the places in Massachusetts not on the Edison lines, as well as places in Connecticut, Maine, New Hampshire and Rhode Island.

THE LAGONDA MANUFACTURING COMPANY, Springfield, Ohio, has every reason to be satisfied with the rapid success made by its boiler-tube cleaners. So great has been the demand that the Lagonda company was recently forced to build a new and greatly enlarged factory, which has been thoroughly equipped with special tools and machinery. Even in the new quarters, however, the company is forced to run overtime to keep up with orders. This prosperous condition has been arrived at by the efficient and careful management of Mr. Bradley and the practical engineering equipment of Mr. Weinland which has enabled him to produce a boiler cleaner which removes scale and which not only works rapidly but is strong and lasting.

MESSRS. E. P. ROBERTS & COMPANY, Cleveland, Ohio, consulting engineers, have opened a department of cement engineering and are now prepared to take entire charge of the designing and supervision of the construction and operation of cement plants. This firm has been in business for ten years and has large experience in electrical, mechanical and civil engineering, having had the consulting and supervising work for a great number of electric railways, electric lighting and power plants, manufacturing plants, etc. The cement department opens up a new field and the services of George S. Perkins, M. E., have been secured to look after the work. Mr. Perkins is a graduate of Stevens Institute of Technology, class of 1891, in the course of mechanical engineering and has had an extensive experience in the designing and constructing of cement plants.

THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, Rochester, N. Y., and Chicago, Ill., has recently sold a two-position toll line board equipped with selective lock-out and toll line apparatus to the Citizens' Telephone Company, of Mankato, Minn. A switchboard and entire exchange equipment have been sold to the Lewiston Telephone Exchange Company, of Lewiston, Minn. The Minot Light and Telephone Company, of Minot, N. D., has purchased recently additional switchboard apparatus. The Madelia Telephone Company, of Madelia, Minn., has also bought an entire switchboard equipment. The Stromberg-Carlson company has also sold twenty selective lock-out equipments to the Independent Telephone Company, of Winthrop, Minn., and a quantity of telephones to the Farmers' Mutual Telephone Company, of Volga, S. D. Bulletin No. 5, which has just been issued, describes and illustrates a fine line of central energy telephones. This bulletin is handsomely printed, and will be sent on application to the company.

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CHARLES W. PRICE . . . . PRESIDENT and EDITOR
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WM. HAND BROWNE, JR. . . . TECHNICAL EDITOR
AINSLIE A. GRAY . . . . . ASSISTANT EDITOR

WESTERN OFFICE—40 Dearborn Street, Chicago, Ill.
CHARLES FRENCH, Manager.

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TO ADVERTISERS

CHANGES for advertisements should be in this office by Friday noon for the following week's issue.

NEW ADVERTISEMENTS should be in the office not later than Monday noon to assure publication in that week's issue.

WHAT AN EMPLOYER MAY EXPECT OF THE YOUNG ENGINEER.

When an employer is looking for a young engineer just out of college, one of two things must be expected—either the employer must be satisfied with a young man who has a broad preparation, but who has not made a thorough study of any branch of engineering, or he must be satisfied with a specialist who has had but a narrow preparation. This preparation, as time passes, will become narrower and narrower if the graduating student is to keep pace with the art. In each case active practice tends to correct the deficiencies of the school training; and although it would seem that in the end the first method would give the best results, it must not be forgotten that, as it is frequently stated, this is a day of specialists, and it seems but natural that this should be recognized in the technical schools.

ELECTRICITY IN COAST FORTIFICATIONS.

An interesting instance of the rapid extension of the use of electricity is furnished by the fortifications distributed along our coast. A few years ago the electric light was introduced to add to the comfort of the garrisons and to provide better illumination of the works. Once a generating plant had been installed, there was at hand a supply of power in a convenient and easily controllable form, and this led to its use for purposes which were not contemplated at the time the plant was installed.

Various Uses of Electricity in a Fortress.

Electric fans have been put in to make the living quarters more comfortable in hot weather, and electric motors have been adopted for training the guns, a class of work for which they are particularly well adapted. Motors are used to drive the ammunition hoists and to do other work which before had either been done by hand or some less satisfactory power. Searchlights have been installed, enabling a fortification to sweep the sea at night. The various posts of the fortress are connected together by telephone, so that the commandant is in touch at all times with the entire garrison, and can instantly transmit orders to any point. The various fortifications along the coast are tied together by telephone and telegraph, so that on the appearance of the enemy at any point all the fortifications would be informed of it. Submarine mines are controlled electrically, and even the guns may be fired by this means, by an officer at some distant point. By means of wireless telegraphy, a fortification can be kept in touch with the scouting vessels, and would be informed of the approach of the enemy long before he is visible from the coast. The telautograph may be brought into service for transmitting orders, and electric signaling lights are replacing the older types. Electric lights are used for range-finder crosshairs, for lighting the range-finder stations; and electric clock circuits furnish accurate time to all parts of the fortification. To ensure the continuity of these manifold service, accumulators are now installed, so that there will at all times be a constant and reliable supply of power.

Importance of the Electrical Equipment of a Fortress.

Thus, from being at first a small auxiliary, the electrical equipment has extended until it is now probably the most important part of the entire equipment of the fortress. While, of course, the intention of the fortress is primarily to provide a suitable place for the coast guns, the guns themselves would be useless unless means were provided for handling and operating them. The electrical equipment has become the controlling factor, for it not only trains the guns and fires them, but transmits the order to fire. It is found in the fortress in nearly all of its applications, and for its proper management men are required who are skilled in all branches of electrical application. It furnishes an instructive example of how quickly a new agent may be employed for an old work, and how its success in one application leads to its further use, until it drives from the field all rivals.

THE TRACKLESS TROLLEY

Although there have been but few instances where the trackless trolley, or the electrically operated omnibus, has been introduced, it would seem that the advantages of this method of transportation will be recognized before long. This system has been tried, with reported success, abroad, and we believe it will soon be in operation in several places in this country.

Trackless Trolley Might Be Used where Traffic Is Light.

There has been a remarkable growth of the trolley roads of late—a growth which hardly seems to have been justified by the needs of the country. Wherever there is

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a demand for transportation facilities, a trolley road is projected and, in many cases, constructed, although the traffic conditions do not always warrant the necessarily heavy investment. Would it not be well, in many of these cases, to try first the trackless trolley? The expense would be far less—probably not more than one-tenth that necessary for the trolley road. If it were found not to pay, the loss would not be great; and if the development was such as to make a railroad necessary, there would have been practically no loss.

Of course, for the best conditions, there should be good roads, but the introduction of the trackless trolley brings into the field a new ally for the good roads movement, while the trolley roads, however well laid, can not but be some obstruction on the highway. It would seem to be a wise thing for automobilists and horse owners who are interested in road improvement to favor the trackless trolley, rather than a trolley road, wherever such a system would satisfy the requirements of the district where the road is contemplated.

THE SCHENECTADY RAILWAY COMPANY'S SYSTEM.

On other pages of this issue is described the city and interurban system of the Schenectady Railway Company, Schenectady, N. Y. Situated as Schenectady is, as the natural hub from which radiate several lines traversing a territory famous for its picturesque environment, and tapping several cities of considerable commercial importance, the system is worthy of study. The excellent condition of the various divisions, and the splendid community of interest which exists between the employés and the executive and operating departments, merit investigation—that similar conditions might exist throughout the country. The convention of the American Street Railway Association, holding forth at Saratoga, September 2, 3 and 4, will bring to this part of the country a host of men who are familiar with every detail of railway operation, and this system will no doubt do its part in presenting an opportunity for entertainment and investigation.

WHY HAS NOT THE TELAUTOGRAPH COME INTO GENERAL USE?

It is often true that great inventions, involving in their development a vast amount of ingenuity, expense and persistent effort, are practically sidetracked upon the eve of complete reduction to practice by some change in the commercial conditions that originally called them forth from the brains of their inventors, or by some unforeseen adaptation of another device for filling the same public need in a different way. The application of this to that exceedingly ingenious invention, the writing telegraph or "telautograph," is being witnessed to-day; the usurping factor that inhibits or delays the use of this wonderful instrument being the speaking telephone. Even the day of its extensive use in combination with the telephone seems to be indefinitely delayed. The telephone alone has so far completely filled the public need for quick and informal intercommunication. One is reminded, by an interested contrast, of the back pages of some old numbers of *Harper's* along about 1877 or 1878, in which were shown some pictures of the then new "Bell telephone," illustrating a form of the old "double crown" magneto telephone arranged upon a subscriber's desk, with a telegraph set, on a shelf at one side, as a reserve or auxiliary apparatus. A few numbers later the same magazine describes the Hughes microphone in its earliest stages. The influence of this latter invention in converting the telephone from a merely scientific apparatus into a commercial agent of vast utility, put a quietus upon any need of the telegraph as an attachment to the telephone.

Ingenuity of Invention no Assurance of Commercial Success.

On the other hand, also, the ingenuity displayed in a developed invention, or the pains and labor involved, are in themselves no assurance that the invention is going to fill an extensive need. An instance of this is the proposed use of the phonograph as a labor-saving intermediary in business correspondence. We have in mind also some almost superhumanly ingenious machines designed to take the place of telephone operators, in examining which we were forced to the conclusion that the inventor's time had been simply wasted on devices which were a monument of investment of brains and labor and were a success, mechanically speaking, but which were underbid from the start, so to speak, by better methods of accomplishing the same object, in ways that recognized more closely all of the practical conditions of the problem. Thus it happens that the work of Gray, of Messrs. Pollak & Virag and of Gruhn, in attacking this problem in various interesting ways, is delayed in consummation by the agency of intercommunication mentioned actually in possession. Moreover, the use of the telephone, during its quarter century of life, has impressed itself upon the business world by effecting a decline in the amount of written communication, which it replaces so handily. The convenience of quick delivery of messages, of comparison of information between individuals widely separated, and the possibility of getting through a vast deal of business by modifying its conduct so as to make it, so to speak, "telephonable," have had such an effect that today business men would not submit to making use either of the army of messengers or the multiplicity of written messages that the elimination of the telephone would involve.

Writing Telegraph Valuable in Combination with the Telephone.

The proposition of the consolidation of the writing telegraph with the telephone, that has been brought up from time to time, to fill a supposed need, seems to us to have value that will prevail sooner or later, the question of its adoption being dependent probably upon the history of telephone management within the next few years. To our view, a writing telegraph attachment to the telephone, reduced to as practical a form as the present telephone substation, would have a marked and beneficial effect upon the telephone service itself, as well as proving to be a great addition to the public convenience. There are a large number of operating delays and "bad calls," representing a vast aggregate of friction and delay in the handling of the telephone service, that would be eliminated, or at any rate much reduced, by such a consolidation of these two inventions.

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THE RELATION OF SCIENCE TO COMMON LIFE.[1]

BY J. M. MACFARLANE.

My theme is "The Relation of Science to Common Life," the life of the mass of individuals, of the nation, if you will. A very unacademic subject, you will say, as measured by the older standards. I chose it on that account. In not a few university centres, the time has not long gone when such a subject would have been curtly dismissed with the remark, "We have nothing to do with common life; we follow our own high educational aims." Too often the universities have stood aside in cold and unsympathetic isolation—shall I not also say in helpless disfavor—while the busy thinking world outside has carried forward the beacon lights of truth and progress. Listen to Whewell when, as master of Trinity College (Cambridge), he went up to London fifty years ago to deliver his notable address before the Royal Institution. Speaking on "The Influence of the History of Science upon Intellectual Education," he said: "I venture to address you, relying upon an indulgence which I have more than once experienced. Of such indulgence I strongly feel the need, on various accounts, but especially that, being so unfrequently in this metropolis, I do not know what trains of thought are passing in the minds of the greater part of my audience who live in the midst of a stimulation produced by the lively interchange of opinion and discussion on the prominent questions of the day." Uttered soon after the exhibition of 1851, and when the scientific world was entering on new conquests, such an apology may seem unaccountable. Happily, our university presidents of to-day are more in touch with the throbbing, vibrating life of humanity, even though they may not claim the profundity of thought that lived in the master of "Trinity."

If there be one characteristic more than another of our age and day, it is the steady welding and cooperative development proceeding among the leading races of the world. Nowhere is this seen on so phenomenal a scale as in our country, where with the Anglo-Celt, Jew and Greek, Frank and German, Italian and Norseman together ply the arts of peace. And why such a commingling of human lives? The answer may be given, and so far well, that here liberty is assured to all, that equal rights and equal opportunities come to all. Back of this, however, is the basic fact that in this country scientific progress has been comparatively unhampered by costly patent laws, by hereditary vested rights, by lands being held in the hands of a few. But perhaps above all, and permeating all, though often silently working, there exists a keen and rapid method of inductive reasoning that carries forward the individual and the community on progressive and yet safe lines. It is this method, applied to all branches of science with increasing exactness, as human freedom increasingly asserted itself during the bygone century, which has culminated in the marvelous scientific position occupied by the country to-day.

What relation then has science, and should it have, to our universities on the one hand, and to common life—to the mass of free earnest thinking people, on the other? In attempting to answer we must constantly keep in view tradition and history—our relation to our ancestors, real or imaginary. We all, like the Chinese, worship these ancestors—at least in their relations—and they worship them most powerfully who are furthest removed from the land that gave them birth. So it is that we fear to break with the past, and inherit incongruous combinations. Says Whewell: "You will not be surprised to be told that our modern education has derived something from the ancient Greek education, because you know that our modern science has derived much from the ancient Greek science. You know that our science—in the ordinary sense of the term—has derived little from the ancient Romans. . . . But if we take the term science in a somewhat 'wide' acceptation, we shall derive from the Roman history not a negative but a positive exemplification of our proposition. For in that wider sense there is a science of which Rome was the mother, as Greece was of geometry and mathematics. The term science may be extended so widely as to allow us to speak of the science of law—meaning the doctrine of rights and obligations, in its most definite and yet most comprehensive form; in short the science of jurisprudence. . . . And thus two of the great elements of a thorough intellectual culture —mathematics and jurisprudence—are an inheritance which we derive from ages long gone by; from the two great nations of antiquity."

So far Whewell, who in attempting to elevate Roman law to the dignity of a science forgot that much of it was unscientific to the last degree, and tended to produce, not organic national equilibrium, but to set the patricians against the plebeians, and both against the bondmen, who often showed finer qualities than either. Little wonder is it that Rome fell, unsaved by her laws.

Let us see whether a different viewpoint and source of origin for the science of law and equally for all scientific relations might not be obtained. Huxley thus puts it: "It is a very plain and elementary truth that the life, the fortune and the happiness of every one of us and, more or less, of those who are connected with us, do depend upon our knowing something of the rules of a game infinitely more difficult and complicated than chess. It is a game which has been played for untold ages, every man and woman of us being one of the two players in a game of his or her own. The chess board is the world, the pieces are the phenomena of the universe, the rules of the game are what we call the laws of nature. . . . Education is learning the rules of this mighty game. In other words, education is the instruction of the intellect in the laws of nature, under which name I include not merely things and their forces, but men and their ways; and the fashioning of the affections and of the will into an earnest and loving desire to move in harmony with those laws. . . . The object of what we commonly call education —that education in which man intervenes and which I shall distinguish as artificial education—is to make good defects in nature's methods, to prepare the child to receive nature's education. . . . In short all artificial education ought to be an anticipation of natural education. And a liberal education is an artificial education which has not only prepared a man to escape the great evils of disobedience to natural laws, but has trained him to appreciate and to seize upon the rewards which nature scatters with as free a hand as her penalties." To pursue Huxley's reasoning to its ultimate limit, advanced teaching of all the laws of nature is the highest function of the university in relation to our common life. In other words, to make each man who leaves its portals most highly qualified for useful, intellectual, manly life. But, as I hope to show later, this qualification is to enable him to use wisely—not meanly—the forces around him, so as to build society into an organism.

Therefore, every upright pursuit in life which man enters on should have the highest principles and practice governing it represented and taught in our universities, by the best men in the most perfectly equipped manner. This may be an ideal at present. Granted, it is nevertheless one toward which, I am persuaded,

[1] Abstract of Sigma Xi Society address, June 18, 1903, before the chapter of the University of Pennsylvania.

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every university must move. In this manner science will confer the dignity that is deserved on the physician's scalpel, the bricklayer's trowel, the chemist's test-tube, the engineer's lathe, the biologist's microscope, the agriculturist's spade or ploughshare.

It is a property of most scientific questions that they project themselves into the future. Whether we accept the teachings of Kidd's suggestive couple of volumes or not, his prophetic outlook into the future is inspiring, and despite destructive criticisms his principle of "projected efficiency" is one that every true scientist tacitly believes in and works up to.

While it will gladly be conceded that few if any countries foster scientific advance more than America, it will as readily be conceded that this has been mainly on the applied side, and that much remains for accomplishment in non-remunerative educational equipment. Here I place in front rank the need for spacious and splendidly furnished museums for all the sciences. Those of us who have walked, time and again, through the mechanical, the chemical, the zoological, the mineralogical and other sections of the South Kensington Museum, or corresponding ones of the Continent—not to speak of many local museums of lesser repute—know that we have nothing to compare with them. Suppose we make observation for a time in the mechanical section, where accurate models may be even seen at work. There the schoolboy lingers enquiringly before them, and he thus forms great conceptions of man's inventive relation to the world forces around him. The factory worker learns how his machines have grown, have been evolved, and how he may possibly perfect them further. For the college and university teacher these collections furnish comparative and concrete illustrations by which a lasting picture is fixed in the mind. Such institutions are costly to erect, to furnish, to man, and to support annually. Their high educational worth must be gauged not by the fruits of years, but of decades and centuries, for the mental stimulus they afford is often hidden away and silent. The question of cost should be a minor consideration in planning such undertakings, amid the corporate and individual wealth that characterizes such centres as our own. Civic pride and loyalty, material pride and loyalty, pride in and loyalty to our highest human development should be sufficient impelling force. Here let me say, with all caution and reserve, but yet with perfect conviction of purpose, that when we read or learn of lavish individual expenditures, for individual gratification alone, it should arouse in every one of us the desire to so mould public opinion that such superfluous ostentations shall cease. If the owner of the wealth thus diverted can be shown that his wealth can most patriotically be expended in building up the country's institutions, then we have successfully done battle for the right.

A note of warning is sounded against the dangers of specialization. I trust that every one directly or indirectly connected with our institutions realizes its dangers. Though Darwin pathetically confessed as to its effects, no one has put it more forcefully than Stuart Mill, who says: "The increasing specialization of all employments; the division of mankind into innumerable small fractions, each engrossed by an extremely minute fragment of the business of society, is not without inconveniences, as well moral as intellectual, which if they could not be remedied, would be a serious abatement from the benefits of advanced civilization. The interests of the whole—the bearings of things on the ends of the social union—are less and less present to the minds of men who have so contracted a sphere of activity. . . . This lowering effect of the extreme division of labor tells most of all on those who are set up as the lights and teachers of the rest. A man's mind is as fatally narrowed and his feelings toward the great ends of humanity as miserably stunted, by giving all his thoughts to the classification of a few insects, or the resolution of a few equations, as to sharpening the points or putting on the heads of pins. The 'dispersive specialty' of the present race of scientific men, who, unlike their predecessors, have a positive aversion to enlarged views, and seldom either know or care for any of the interests of mankind beyond the narrow limits of their pursuits, is dwelt on by M. Comte as one of the great and growing evils of the time, and the one which most retards moral and intellectual regeneration. . . . He demands a moral and intellectual authority charged with the duty of guiding men's opinions and enlightening and warning their consciences; a spiritual power whose judgments on all matters of high moment should deserve and receive the same universal respect and deference which is paid to the united judgment of astronomers in matters astronomical." We must acknowledge to a large degree, the saneness of Mill's position, but if we all cease specializing one day in the seven at least, the spiritual power desiderated will have opportunity to dwell in our midst. The Jewish Sabbath is by no means the worn-out institution that some would have us believe.

Another rock ahead in the channel of progress demands most careful consideration and steady action. Our present-day political and economic systems often foster methods by which science and scientific discovery are degraded or robbed of their true value, while the scientific worker is often defrauded of that reward that should come from sturdy effort of mind and hand. It has truly been said that "crafty men contemn studies, simple men admire them, wise men use them." The founding by Besant of what might be called "the authors' mutual protection society" marked an epoch in the history of English literature. No such organization has yet been evolved to foster and protect scientific discovery. But to put the whole question on a much higher plane than that of mere financial well-being, I venture to say that since science stands for accuracy, probity, clear statement of fact, unveiling of error of every kind—whether intentional or unintentional—it can have no sympathy with the deceit and chicanery that are so rampant around us, and that threaten at times even to swamp the high ideals of our universities.

Are the laws of science then, as we ordinarily understand these, to be our sole guide and rule in life? This enquiry causes me to recur to Huxley's picture of life already quoted. Are all the moves on the human chess board to be dictated only by thoughts of self-interest and self-preservation, or even by thoughts on behalf of our friends and offsprings, as Huxley, in his later days, attempted to prove. Some of the "moves" operated repeatedly in the world's past have given us an environmental human outcome, products that we call "strong lives," "strenuous lives," "unscrupulous lives," "useful lives," "instructive lives." But the greatest type, and the one that we almost unconsciously worship is "the beautiful life."

Every organism from amœba to man lives by a process that we may call "organic molecular equilibrium." When the supplies of life energy and food integration exceed the dissipations and disintegration, growth and development proceed. When both are balanced maturity has been attained. When the converse to the first holds true, decay sets in. Applying this fundamental principle to our common

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human life, the highest human scientific aspiration might be expressed in the aphorism "society an organism." Such a condition society is far from having attained to. But like all organic bodies, if it is rightly to perform its functions, and to perpetuate its like, such it should become. At present, even in its hightest expression, it consists of human molecules that often exhibit abundant energy, that undergo permutations and combinations, that show affinities and repulsions, but that lack some form of energy necessary to link them into an organic whole, to give them social equilibrium and stability. Society has been struggling through millennia to become an organism, has been searching for that energy and that source of energy that will give it life equilibrium. At times and in places the result seemed to have been achieved, only again to be impaired, or lost amid a chaos of discords, by the disrupting agency of one or of a few unscrupulous souls, who have acted like a disorganizing ferment on the organizing mass.

Though unfashionable with many to-day, and not least with the followers of science, the only motive form of human energy that has stood the test, and that is stronger to-day than ever before, is the power, the force of love, of compassion, of sympathy, as communicated by the greatest social lawgiver the world has seen. The early founders of Christianity were charged with it, and for three centuries they shook and finally subdued the Roman empire. We have it in our midst and it lives through all the upheavals consequent on human competition, on commercial war. In our hospitals, in our college settlements, in our church and public beneficences, in our increased regard for human life, we feel the effects of this energy, though we see it not. The social settlements of Owen and others were truly preliminary nineteenth century scientific experiments to test the strength of the law of love, and the amount of this energy needed to vivify and unify the social organism. Like thousands of scientific experiments before and since they partially failed, but their failures and successes have been recorded, so that succeeding experimenters might carry the enquiry to a successful issue.

The fetish of unbridled commercial competition which has too long lorded over us, is in many ways inimical to our highest interests. It can be a helpful servant if kept in subjection, it becomes a harsh tyrant if worshipped as a god. It can not retain supremacy alongside the gospel of peace and love. If so, the latter suffers or becomes effaced, and mankind becomes the loser.

Tangential Water-Wheel Efficiencies.

At a recent meeting of the Pacific Coast Electric Transmission Association, George J. Henry, Jr., read a paper on "Tangential Water-Wheel Efficiencies." The conclusions which he has reached are the result of an elaborate series of experiments carried out in a special laboratory since 1899, with a view to determining scientifically and practically the relative advantages of different bucket shapes. To obtain the best efficiencies, it is necessary to have the proper pipe line, gate valves, nozzles, water-wheels and buckets, wheel gates, wheel pit and trail-race, and all of these must be properly designed for the particular conditions under which they are to operate; and all will vary with the head or pressure, the quantity of water, and the revolutions which the wheel is to make. Many a water-wheel bucket has been overworked for years and then charged with losses that occur because of its being improperly worn, due to this overwork. Again, buckets are frequently charged up with all kinds of losses, which are really due to something for which the bucket is not responsible. Pressure or wheel diameter, or speed on a given wheel can not be varied radically without materially altering the efficiency. The various losses occurring at the bucket are due to the discharge velocity with which the water leaves the bucket, air and surface friction inside the bucket, imprisoned water in the bucket, variation in the stream form, producing erratic conditions of impact, the loss occasioned by the stream being displaced by the entering bucket, and eddy currents in the buckets.

To correct these losses, the following methods are suggested: The water should move in a curved path on the bucket surface and turn through an angle of as nearly 180 degrees as possible. If the water moves in a smooth curved path and the stream form is retained, spreading out gradually with a fine fan-like discharge, and the least number of buckets used, then the air and surface friction will be a minimum. The imprisoned water will cause little loss if the bucket surfaces are smooth and so shaped that the water will leave the wheel freely. Displacement of the stream can be avoided by a proper shape of the cutting edge and dividing knife.

The above losses and considerations for their prevention are all of such a nature —so entirely interdependent—that their quantitative value can not be predetermined, except in a general way. In designing a water-wheel, it is certain that the exercise of the most careful judgment is necessary in laying out the surfaces.

The author then describes results of tests on a large number of different shapes and styles of buckets, and photographs were shown, illustrating the behavior of the stream of water when it impinged upon the buckets.

The First Standard-Gauge Electric Railway in Prussia.

A consular report states that Berlin has entered upon the employment of electrical traction for suburban service on the state railways of standard gauge. Since the middle of May, experiments have been in progress on the lines of the Potsdamer Station in Berlin—the focal point of suburban traffic within the city limits—to Gross Lichterfelde, a distance of five and one-half miles. These experiments have been entirely successful, and the regular traffic was begun on July 15, with trains of three cars each, with a ten-minute schedule in each direction. Current is supplied from the southwestern power station of the already existing belt line railway, and is transmitted over an insulated third rail laid beside the track. Each train is made up of one second-class and two third-class cars, each sixty-three feet long by nine feet wide. The weight of the total train is 128 tons, and the capacity is 200 passengers seated. The third-class cars are placed one at each end of the train, each being equipped with one motor. The second-class car is in the middle of the train, and carries no motor.

The opening of this line may mark the beginning of a general change from steam to electricity for the important and rapidly growing suburban service of Berlin. A second line, which leads to Cöpenick, several miles distant up the Spree, is already being converted to electricity and will be put in service during the summer.

The Manufacture of Brick.

The current volume of the transactions of the American Ceramic Society contains a paper by Samuel B. Peppel, entitled "Further Contributions to the Manufacture of Artificial Sand Stone or Sand Brick." This is a new building material, formed by mixing sand and lime, which is then hardened by treating it, while under pressure, with live steam. The author describes the raw material, its preparation and the behavior of the mixture in the press, methods of hardening, testing and the mechanical equipment of the works. He then discusses the merits of the various systems of manufacture.

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TWO SIMPLE METHODS FOR LOCATING FAULTS IN CABLES.

BY EDWIN F. NORTHRUP.

The most common fault occurring on telephone lines consists of a cross between two lines or a ground on one or more lines.

If the fault occurs in a lead-covered cable and one or more wires can be found in the cable, which are not defective, or if there are outside wires, with terminals at the two ends of the cable, a cross or a ground can be located in a very simple manner and without any calculations more than a simple multiplication and division. The essential apparatus will consist of a straight piece of bare resistance wire, a scale, such as a meter stick and a millivoltmeter, or a detector galvanometer, which will indicate a fraction of a milliampere; and a number of cells of battery. We will describe two methods.

I—TO LOCATE A CROSS WHEN AT LEAST ONE GOOD WIRE CAN BE FOUND IN THE CABLE.

This first method to be described may be applied when there is at least one good wire in the cable having substantially the same length as the defective wires.

In Fig. 1, the wires 1, 2, 3, 4 in the cable are assumed to be of the same length (this is not always true, but will be considered later) and the wires 1, 2 and 3 are crossed, the wire 4 being free from a cross. The length 1 of the cable, in feet or miles, is assumed to be known. It is required to determine in the simplest possible way the distance from the station A to the cross C. Call this distance r_1. Let the tester at station A have the good wire joined to any of the crossed wires at station B, as indicated at S, Fig. 1. Now choose on a straight rule 1,000 arbitrary divisions, say millimetres, and fasten a binding-post at the beginning and end of this distance. Stretch a piece of about No. 24 German silver or iron wire between the posts so as to lie over the scale and continue the wire beyond the right-hand post for a length exactly equal to that between the posts, and fasten the end to another binding-post placed at any convenient place. Calling the posts, counting from the zero of the scale, *f*, *g*, *h*, join the end of the good wire to *h* and the end of one of the crossed wires to *f*. Connect one end of the battery to one of the other crossed wires and the millivoltmeter or detector galvanometer to the posts *f* and *h*. If the end of an insulated wire joined to the free pole of the battery be now touched upon the wire stretched over the scale, a point may be found where the galvanometer will show no deflection. The distance to the fault will then be simply the scale reading from *f* multiplied by the length of the line and this product divided by 1,000. Thus suppose a balance is obtained when the scale wire is touched 342 divisions from the left-hand end of the scale and the line is 3.4 miles long. Then

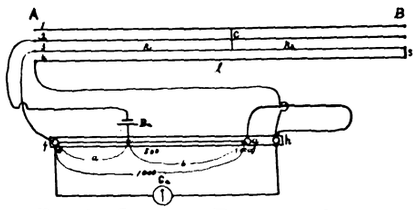

FIG. 1.—LOCATING FAULTS IN CABLES.

r_1 or the distance to the cross is $342 \times 3.4 \div 1{,}000 = 1.1628$ miles.

If the cross has a very high resistance the battery current will be small and several cells or even 110 volts may be needed to make the galvanometer sufficiently sensitive. If a high voltage is used, it is advisable to insert some resistance in series with the battery or source of current to avoid burning out the touch wire *f* to *h*, by accident in case the resistance of the fault suddenly drops when the high voltage is applied. The algebraic theory of the above method is as follows:

Referring to Fig. 1 for the meaning of the letters, $\frac{r_1}{r_2 + l} = \frac{a}{b}$, but $r_2 = l - r_1$ if the wires in the cable have the same length.

Hence $\frac{r_1}{2l - r_1} = \frac{a}{b}$ and solving for r_1, $r_1 = \frac{2al}{b + a}$.

Since $b + a$ has been made equal in length to 2,000 scale divisions $r_1 = \frac{2al}{2{,}000} = \frac{al}{1{,}000}$.

If the wires 1, 2, 3 are grounded at C

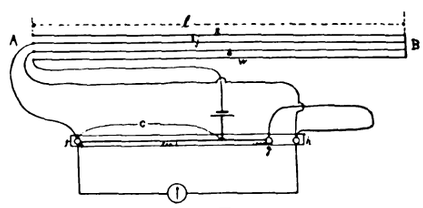

FIG. 2.—LOCATING FAULTS IN CABLES.

instead of crossed, then the side of the battery which was before joined to the crossed wire would now be connected to earth and the same subsequent procedure followed.

II—TO LOCATE A CROSS WHEN TWO GOOD WIRES ARE AVAILABLE.

Method I assumes that the several wires in the lead-covered cable are all of the same length and that at least one good wire exists in the cable. Now it may often happen that one wire, as the good one, is a central wire in the cable, and that the crossed wires are outside wires which on account of twisting around the inside wires are of a greater length. In this case r_2 does not equal $l - r_1$ (Fig. 1), and an error would be introduced. By the method to be described the distance to the fault (which may be a cross or a ground) can be determined as a certain fraction of the length of the lead pipe, and this distance will be independent of the length of the faulty wire in the pipe or of whatever twist it may have. The only assumption which has to be made when extreme accuracy is sought is that the faulty wire shall twist in the same uniform manner throughout the entire length of the lead-covered cable. If it starts as an inside wire or an outside wire, it must continue as such. The location of the fault is determined by taking two readings with the arrangement as described for using method I, but with the connections made first as shown in Fig. 2 and second as shown in Fig. 3.

In Figs. 2 and 3, W and *b* are two good wires, and these wires may be in the cable or outside the cable and have any resistance, and 1 is crossed with *n*, or 1 may be grounded. The wires are joined together at station B, and at station A connections are made to the slide wire apparatus, first as shown in Fig. 2. It is required to find the distance *x* from station A to the cross or ground at *j*, this distance being measured along the lead-covered cable and having no reference to the actual length of the wire. Let the reading taken for a balance with the connections of Fig. 2 be called C. Now disconnect wire *w* from the battery and connect the battery to one of the crossed wires or to ground, according as a cross or ground is to be located. The connections will now be as shown in Fig. 3. Let a second reading be taken for a balance and call this reading S. Then if 1 is the total length of the lead-covered cable, the distance *x* to the fault from station A, measured along the cable is

$$x = l \frac{S}{C}.$$

In order that a balance may be obtained in the first instance, the wire *b* must have a greater resistance than the wire 1, or part or all of the wire between the posts *g* and *h* must be short-circuited. If it is found that to obtain a balance in the first instance the toucher *t* would have to touch the wire *f*, *g*, *h* to the right of the post *g*, then any arbitrary resistance may be added to the wire *b* until the

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reading c comes on the scale between f and g. This resistance, if used, must be left in during both readings. It is better to add resistance to b than to short-circuit the wire g to h as the scale readings will be longer and hence more accurate. As an illustration of the formula above, suppose the first reading c is 400 scale divisions and the second reading 200 scale divisions, and suppose the lead cable is 3,200 feet long, then the distance from station A to the fault is simply $x = 3{,}200 \times \frac{200}{400} = 1{,}600$ feet.

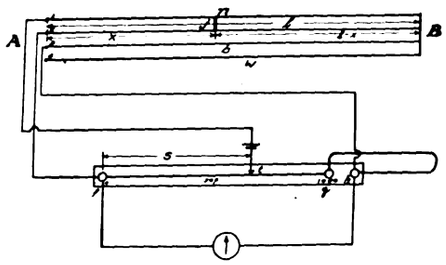

FIG. 3.—LOCATING FAULTS IN CABLES.

As the above two methods require no knowledge of resistance formula, or in fact any electrical knowledge whatever, they may be readily applied by unskilled linemen and faults located, especially where the second method can be applied, with considerable accuracy. A special advantage of the second method is that it is only necessary to know the length of the cable and not the length or resistance of the two extra wires used. The algebraic theory of the second method is as follows: Figs. 4 and 5 are diagrammatic representations of Figs. 2 and 3, corresponding letters having like meanings. With the conditions as shown in Fig. 4, $\frac{l}{b} = \frac{c}{a}$ or $b = \frac{a}{c} l$.

Since $f\,g = g\,h$ in resistance, if 1 is greater than b in resistance, the balance can not be found on the scale. In this case, short-circuit $g\,h$ or, preferably, add an arbitrary resistance to wire b. Changing the connections to be as shown in Fig. 5. $\frac{x}{l - x + b} = \frac{s}{r}$ and substituting the value of b from the first equation.

$$\frac{x}{l - x + \frac{a\,l}{c}} = \frac{s}{r}, \quad \frac{c\,x}{c\,l - c\,x + a\,l} = \frac{s}{r} \text{ or } x = \frac{l\,s\,(a + c)}{c\,(r + s)}$$

but as $a + c = r + s$, a constant $x = l\,\frac{s}{c}$.

As b eliminates and w does not enter the equation, their resistance need not be known.

It has been shown how the two methods described may be applied with simple apparatus which any lineman can rig up in a short time and still obtain accurate results.

An apparatus called the lineman's fault finder has, however, been recently placed upon the market for locating faults by the above methods with ease and accuracy. By going into certain refinements such as selecting a long wire of great uniformity for the slide or touch wire, and by substituting for the extra length of wire, g, h, a resistance coil having accurately the same resistance as a length of 1,000 scale divisions of the slide wire, and by using a sensitive galvanometer, etc., an apparatus may be made which, by method II at least, will locate faults with the highest possible accuracy, and with the greatest simplicity and despatch.

The writer is indebted to C. L. Goodrum, of the United Telephone and Telegraph Company, of Philadelphia, for the first suggestions of the usefulness of the above methods of fault locating.

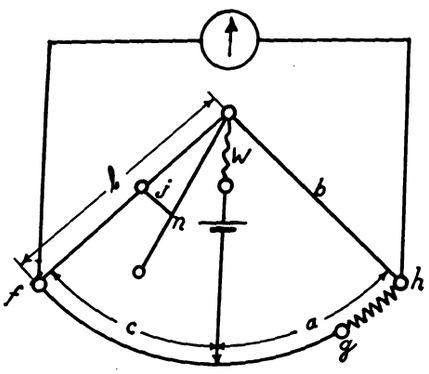

FIG. 4.—LOCATING FAULTS IN CABLES.

New Oil Engine.

In a type of oil engine which has attracted much favorable notice the oil is vaporized and ignited without the use of any external source of heat. The main drawback has been that the engine would not run indefinitely with light loads, owing to the explosions not occurring with sufficient frequency to keep the igniting portion at a sufficiently high temperature. A modification of this type of motor just brought out by the Britannia Company, of Colchester, England, is claimed to be free from this drawback. The vaporizer is arranged, as usual, at the back of the cylinder. On the suction stroke a vapor valve is opened by the cam shaft, and through this valve air is drawn into the cylinder through the vaporizer, into which at the same time a little oil is sucked through an automatic valve. This mixture of air and oil is in itself too rich to be explosive and the main supply of air is drawn through a separate air valve into the cylinder. Two passages connect the vapor valve with the cylinder. One of these is large and straight, while the other is narrow and U-shaped. The lower portion of the U contains the igniter—a piece of metal having ribs, which enable it to absorb heat readily when the explosion takes place. This piece therefore becomes and remains red hot, while the rest of the vaporizer is only at a black heat. The vapor which is drawn through this igniter on the suction stroke is far too rich to burn, but on the compression stroke air is forced back into the igniting piece and provides the necessary oxygen for the vapor already there to ignite. None of the exhaust passes through the igniter, which is consequently not cooled down in the case of a missed explosion. The proportion of oil and gas used is regulated by throttling the air supply. As already stated, part of this air is drawn through the vaporizer and the rest through the air valve. If the admission to the latter is throttled a greater proportion of the air used will be taken through the vaporizer and will carry with it a proportionately greater amount of oil. The maker claims that, once started, the engine will run absolutely without attention for several hours.

German Telegraph and Telephone Statistics.

Telegraphic and telephonic statistics for 1900 have just been printed in the Statistical Yearbook for the German Empire.

Telegraphs—In 1900 Germany had 24,471 telegraph offices, with 36,000 instruments in operation; Great Britain, 11,512 offices and 38,000 instruments; and the United States, 22,954 offices and 81,000 instruments.

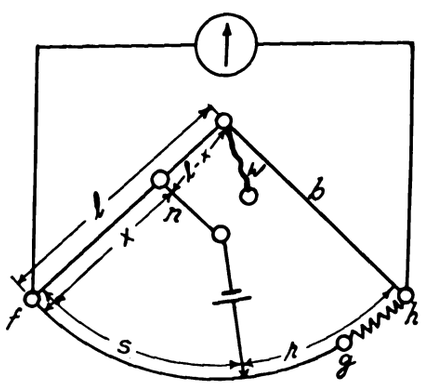

FIG. 5. LOCATING FAULTS IN CABLES.

The number of telegraphic despatches transmitted in 1900 was:

Great Britain	92,000,000
United States	63,000,000
France	50,000,000
Germany	46,000,000

Telephones—In Germany there were 2,411 cities or towns having public municipal telephone systems, with 305,795 connections. France had 1,199 public telephone plants, with 72,480 connections.

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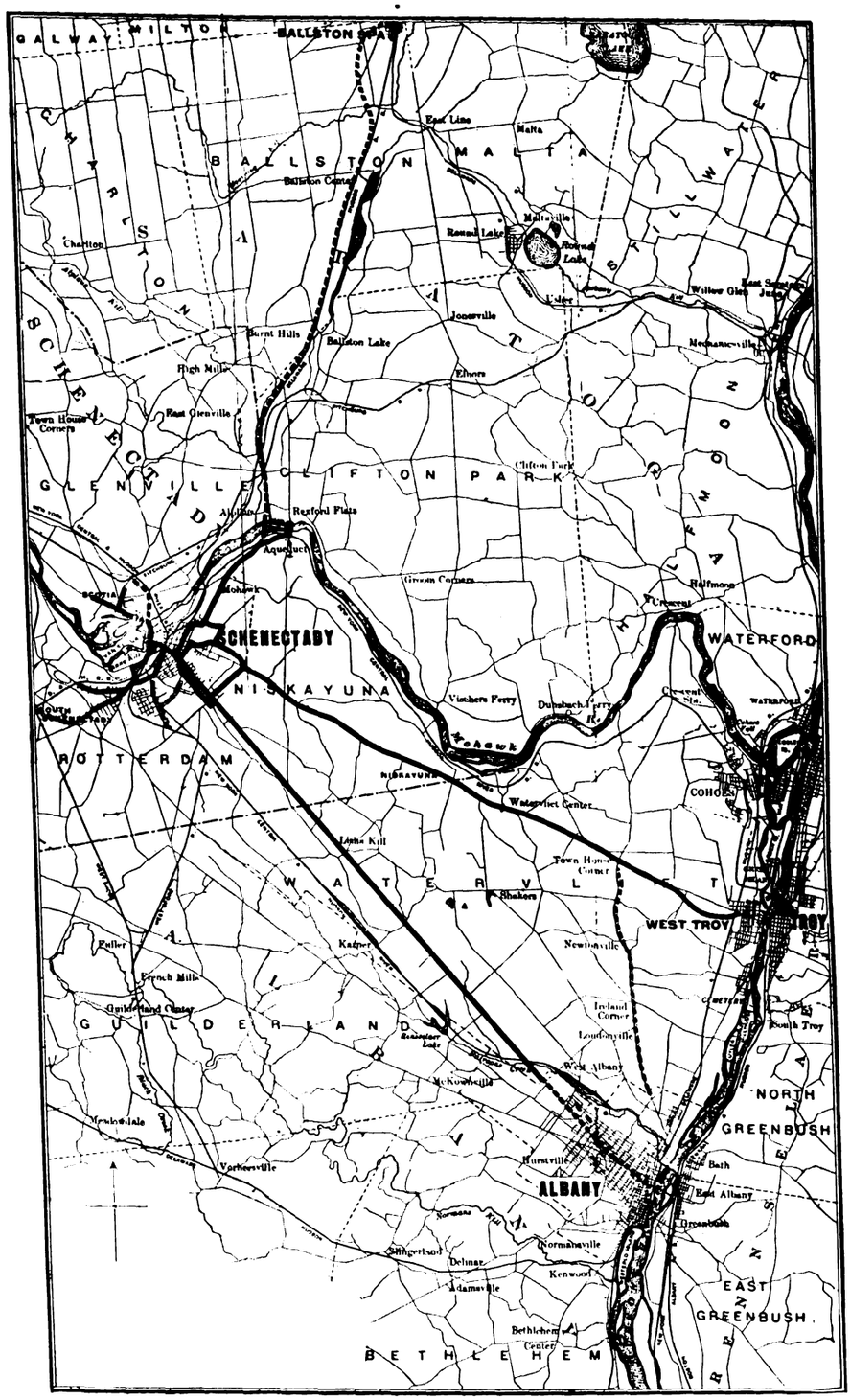
The City and Interurban System of the Schenectady Railway Company.

THE city and interurban system of the Schenectady, N. Y., Railway Company offers an attractive proposition for study from many points of view. A number of features of more than ordinary interest contribute to make the operation, maintenance and utility of this system of electric traction remarkable. The convention of the American Street Railway Association, meeting at Saratoga, N. Y., September 2, 3 and 4, will centre interest to a greater or less extent in this section of the country, and at this time a survey of the Schenectady railway system is appropriate and highly interesting.

The city of Schenectady is located about 160 miles north of New York city, on the line of the New York Central & Hudson River Railroad. Its topographical position makes it the natural centre of a system of interurban roads radiating in several directions to a number of feature cities in New York state. Albany, the capital of New York state, is fifteen and one-half miles southeast of Schenectady, and a magnificent double-track road, stretching in an almost perfectly straight line, has been in operation for over two years. To the north, to Ballston Spa and Saratoga, whose numerous mineral springs make this latter city one of the most popular resorts in the country, a double-track road about twenty-two miles in length is about completed. Troy, a manufacturing city of large proportions and of great commercial importance, is sixteen miles to the east, and a double-track road was completed between Schenectady and this city in March of the present year. To the south, a road is contemplated to South Schenectady and Altamont, a distance of eleven miles; while to the west, a connection has been made with the Fonda, Johnstown & Gloversville Railroad, making it possible to ride from Albany to Gloversville, a distance of fifty miles, without change of cars.

In addition to this intercity service, which affords the pleasure-seeker the greatest variety of entertainment with regard to picturesque scenery and safe high-speed riding, the company has a city proposition to handle which approximates very closely to metropolitan conditions, in handling the rush-hour traffic which is imposed upon the system, due to the assembly and retirement of the employés of two of the largest manufacturing interests of the country, namely, the works of the General Electric Company and those of the American Locomotive Company.

To sum up, the Schenectady Railway Company is operating at present over seventy-five miles of track, and has in course of construction about thirty-six additional miles; while its equipment has increased since 1894 to over 100 cars, handling during the year ended July 30, 1903, over 7,000,000 passengers. It seems remarkable that in 1894 the system consisted of two miles of single track, with an equipment of four closed cars, and at this period the company seriously considered the proposition of cutting down the service to three closed cars because of the lack of patronage. The extraordinary growth of the system may be attributed to the rapid increase in the population of the city of Schenectady, due to the development of the two large industries noted above—the General Electric Com-



THE SCHENECTADY RAILWAY COMPANY'S SYSTEM.

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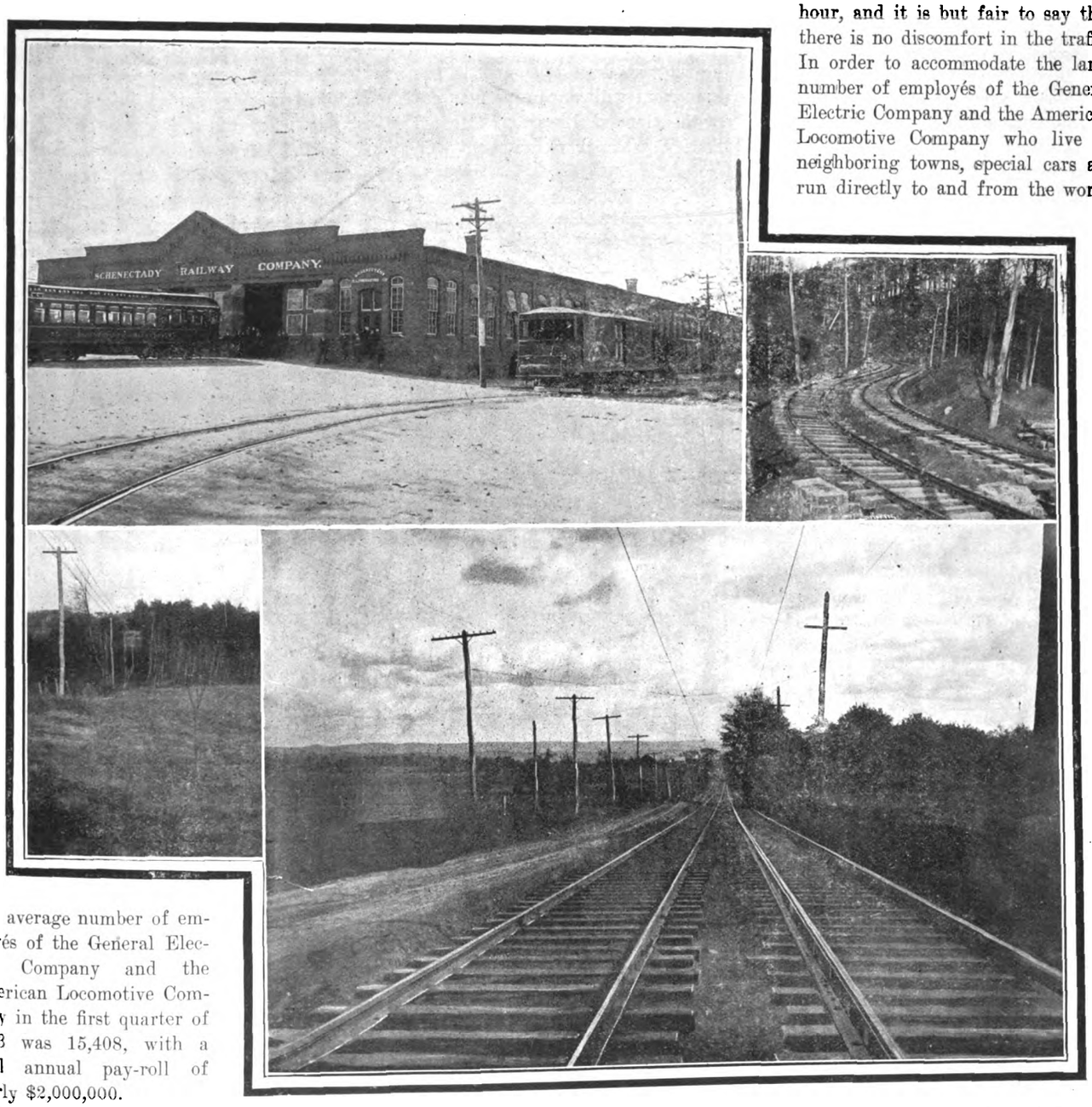
pany and the American Locomotive Company.

A fair idea of the increase in the population of the city may be gained from the following figures which have been taken from authoritative statistics: In 1880 there was a population of 13,655. In 1882 this was increased to 22,730; in 1890, to 31,682; and in 1902, to 53,000.



The average number of employés of the General Electric Company and the American Locomotive Company in the first quarter of 1903 was 15,408, with a total annual pay-roll of nearly $2,000,000.

Union College, one of the oldest institutions of learning in the country, is situated at Schenectady.

THE FULLER STREET CAR BARNS—A TURN ON THE TROY DIVISION, PRIVATE RIGHT OF WAY—A BIT OF THE HIGH-TENSION LINE—WHERE HIGH SPEED IS EASY.

Improvements in street construction are going on continually, and the city of Schenectady, while having passed through a boom which was in many ways similar to those witnessed in our western states, is still spreading, and a fine system of streets is being laid out and rapidly made up into first-class residential districts. The Schenectady Railway Company operates six lines in the city, under the following headway: State Street-Scotia Line, ten minutes; Bellevue-Aqueduct, seven and one-half minutes; Union Avenue Line, seven and one-half minutes; "A" Belt Line, five minutes; "B" Belt Line, five minutes; State Street Stub, fifteen minutes. These lines cover 22.66 miles within the city limits.

The handling of the large number of employés of the General Electric Company in the short space of time allowed before shop hours, and the inevitable haste with which the workers desire transportation home after business ceases, brought up a problem which presented many serious phases. By building a loop at the entrance of the works, with necessary storage tracks from which extra cars could be fed into the main line without interrupting the regular traffic, the company solved this problem successfully. In this manner 3,000 people are loaded and unloaded from the cars in less than half an hour, and it is but fair to say that there is no discomfort in the traffic. In order to accommodate the large number of employés of the General Electric Company and the American Locomotive Company who live in neighboring towns, special cars are run directly to and from the works over all interurban lines, both morning and evening.

The accompanying map of the Schenectady Railway Company's system will show the ramifications of the road and give a good idea of the city and interurban divisions.

Both the Troy and Albany divisions are

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operated on a fifteen-minute headway from 9 A. M. to 8 P. M., and on a thirty-minute headway at other hours of the day. On the hour a special service has been established between Schenectady and Albany, called the Schenectady-Albany Limited. The trip is made in forty-five minutes, without stops outside of the city limits. For this special accommodation no extra fare is charged. A similar service will soon be put into effect on the Troy division. Round-trip tickets to Troy and Albany are sold at forty cents, and are interchangeable. A single fare is twenty-five cents. Commutation books containing fifty-two tickets, and limited to one month, are sold for $7.50.

As may be seen from the map, the line from Schenectady to Albany is practically a straight line. The track construction on this line approximates very closely to heavy steam railroad practice, and the riding is of the most satisfactory nature. The elimination of curves and the easy roll of the country allow a very high speed to be maintained on this division.

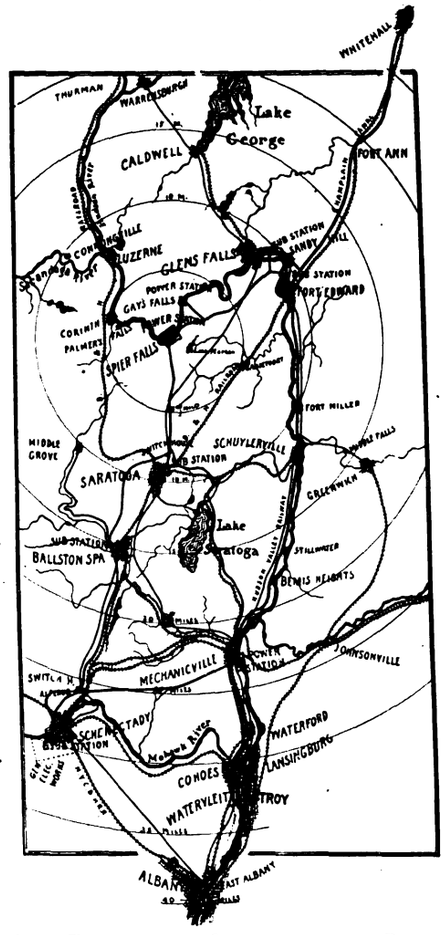
The road from Schenectady to Troy abounds in picturesque views of the surrounding country and passes through the celebrated Mohawk Valley, bringing into view the Helderberg Range, the Catskill Mountains, the Adirondack and Green Mountains, and the famous Mount McGregor, N. Y. For some distance the cars on the Troy division parallel the Mohawk River, while the division running from Schenectady to Aqueduct parallels the Mohawk River and the Erie Canal for the greater part of its length.

When the Ballston-Saratoga division has been completed, passengers will be taken from Albany and Troy, by means of a cutoff around the city of Schenectady, directly to Saratoga in about one hour.

The company is erecting near the Aqueduct, and just outside of the northerly limits of Schenectady, a double-track steel bridge having a total length of 1,769.53 feet. This is being built by the American Bridge Company, and is of the riveted lattice truss type, pin connected, resting upon ten concrete and masonry piers. This bridge will be forty-five feet above low water.

Plans have been made for a large terminal station in the centre of the city of Schenectady. The various executive offices of the company will be located in this station, and also the offices of the entire operating departments. Suites of offices will be rented in this building, and a commodious waiting-room will be established. The interurban cars, as well as some of the city local cars, will loop around this office building, enabling the Albany, Troy, Saratoga, Amsterdam, Johnstown and Gloversville passengers to be conveniently transferred to any car desired. This terminal station will be on lines of such magnitude as will make it not only a model, but the first of its kind erected in any of the eastern cities.

The rolling stock of the company is of the most modern type and is equipped throughout with apparatus manufactured by the General Electric Company. On the city system there are twenty-nine sin-



THE TRANSMISSION LINE FROM THE POWER PLANT AT SPIER'S FALLS, N. Y.

gle-truck closed cars, equipped with two G. E.-67 motors; eight single-truck closed cars, equipped with two G. E.-57 motors; four double-truck closed duplex cars, equipped with G. E.-52 motors; six eight-bench and twelve nine-bench single-truck open cars, equipped with G. E.-67 motors; twelve thirteen-bench double-truck open cars, equipped with G. E.-67 motors. On the interurban lines there are twelve forty-foot double-truck closed cars, equipped with G. E.-57 motors; ten forty-seven-foot double-truck closed cars with smoking compartments, equipped with G. E.-57 motors and G. E.-73 motors; six fifty-one-foot double-truck semi-convertible cars, equipped with G. E.-73 motors. In addition to this, there is a miscellaneous equipment of six motor flat cars, twenty-five dump cars, six express cars, three rotary snow plows, three small snow plows, one sprinkling car and one sand car. These cars were furnished by the St. Louis, Brill, Stephenson, Laconia and Jones car companies. The Brill semi-convertible cars are the most notable of the recent equipments. The interior of these cars is divided into two compartments separated by hardwood partitions having single sliding doors. The smoking compartment is eleven feet ten inches long, and the passenger compartment is twenty-seven feet ten inches long. Both compartments are finished in dull mahogany, handsomely carved, and with a ceiling of bird's-eye maple with gold strippings. The seats are upholstered in leather. The windows slide into the roof when not in use, and the cars are airy and well suited for summer service. The platforms have enclosed round-end vestibules sheathed with steel. The trucks are equipped with four G. E.-73 motors, and the G. E. type M system of train control is used. The interurban cars are all equipped with the Magann system of air brakes. A storage tank capable of holding 250 pounds of air is suspended below the car, and at all car houses and substations compressor outfits are arranged to supply a full charge of air in less than one minute. The Albany cars are fitted with the Flood system of emergency track shoe brakes, as this is considered necessary for extra precaution, because of the ten-per-cent grade on State street, Albany, just below the Capitol. The shoe is pick-shaped, and the wheel runs up on it and becomes locked, traction going on to the lower side of the pick.

A feature of the service on the Troy division is the placing of mail boxes on the front end of every car, so that any one along the route may stop the car to mail a letter.

On the city lines seven-inch and nine-inch girder rails of the Lorain Steel Company's section are used. The ties are firmly bedded in rock and concrete, with a concrete filling up to the tie; and from the curb line to about eighteen inches from the outside of the tracks, asphalt paving is laid. Between the asphalt and the track, and between the tracks, vitrified brick filling is used. This affords a construction which it is easy to keep clean, which facilitates drainage, and provides comfortable riding throughout the city limits.

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The interurban tracks are laid with seventy-five-pound T-rails, thoroughly ballasted with either gravel or broken stone one foot under the ties, and filled up even with the rail. The tracks are well trenched, and careful attention has been paid to the drainage, several miles of six-inch tile having been laid alongside and between tracks.

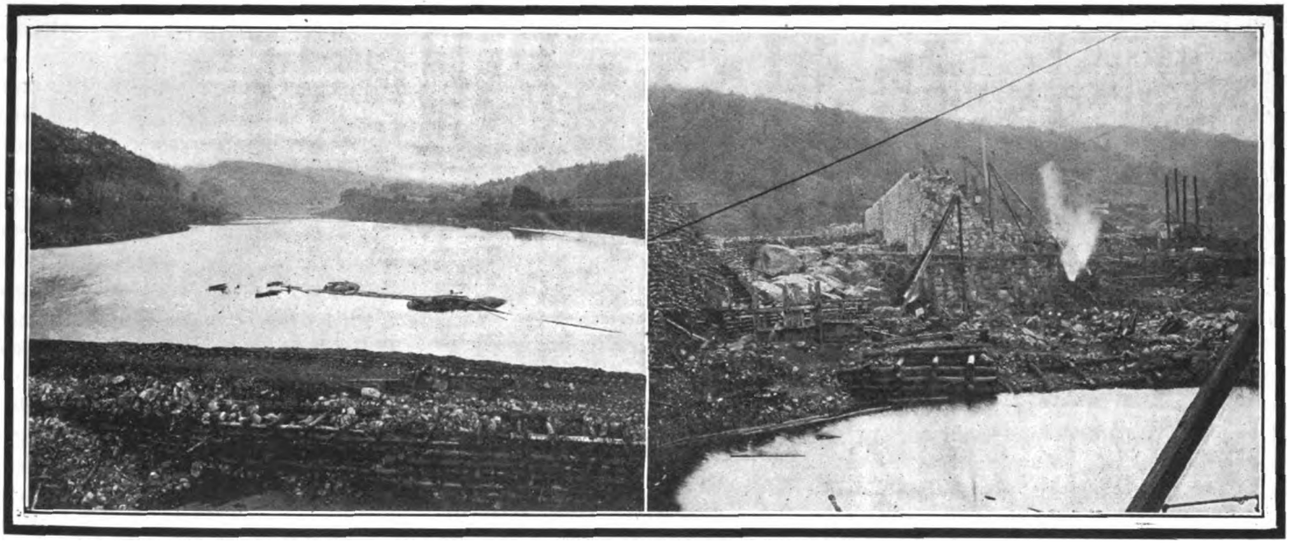
Section houses provided with hand cars and all necessary track tools are maintained at several points on the interurban lines, and the tracks are carefully inspected daily. Warning signals are provided at all danger points, and clusters of lights mark these spots at night.

In order that the passenger may not become confused as to his or her whereabouts either by day or night, all stations or stops along the lines are given numbers in consecutive order, and these are announced by the conductor.

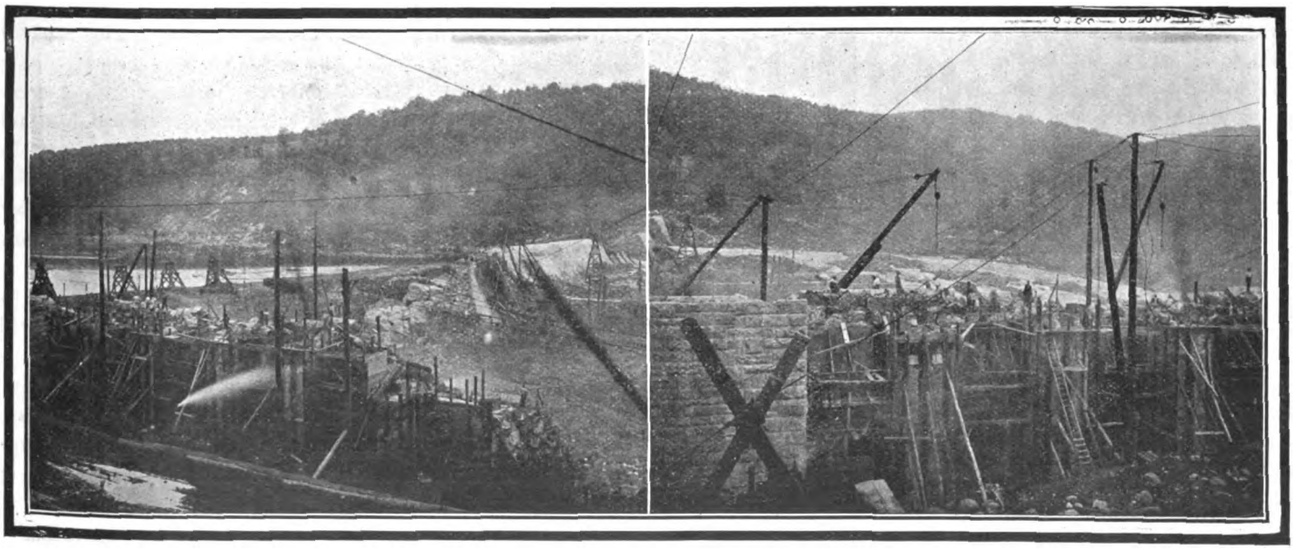
Span construction is used in the overhead work throughout the entire system, except on the Ballston division. For the city and interurban service thirty-five-foot and forty-foot chestnut poles, set 100 feet apart, are used. On the Ballston division thirty-five-foot octagonal yellow pine poles, embedded in concrete, are used in connection with the centre-pole double-bracket construction. The tracks on the Ballston division are on thirteen-foot centres, and the roadbed is graded twenty-nine feet. On the interurban lines 0000 grooved trolley wire is used, and on the city lines, 000 grooved wire.

A number of bridges have been necessary on this system. One at the Scotia crossing of the Mohawk River contains eight spans of the pony truss type, the total length of the bridge being 773 feet, of which 396 feet are laid with single track and 372 feet with double track, there being a siding on the bridge. On the Troy division there is a steel trestle 203 feet long, with an average height of six-teen and one-half feet. On the Aqueduct line there is a pony lattice bridge 103 feet long, with an average height of twenty-six and one-half feet.

The car houses have been erected on Fuller street and on McClellan street, Schenectady, the latter having been but recently built. This building is 300 feet long by 116 feet wide, and is of brick with steel truss roof. Eight tracks are provided, and each entrance is closed with a Kinnear rolling door. In the centre, four tracks have pits seventy-five feet long, and



SPIER'S FALLS, N. Y.—RESERVOIR FROM TOP OF INCOMPLETED DAM. SECTION OF COMPLETED DAM FROM RACE WALL, HUDSON RIVER WATER POWER COMPANY.



SPIER'S FALLS, N. Y.—DAM AND RACE LOOKING OVER SIDE OF POWER STATION. HEAD RACE AND FLUMES, HUDSON RIVER WATER POWER COMPANY.

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at one side there are tracks having pits seventy-five feet long. One section of the building is partitioned off for a blacksmith and machine shop seventeen feet wide by forty-two feet long, and one of the tracks extends through this shop. Included in the equipment of this shop is a twenty-one-inch Barnes drill press, a Buffalo forge, a No. 3 Challenge tool grinder, and a four-ton Harrington hoist, together with all necessary equipment for handling light repairs. The building has a wing twenty-one feet long by sixteen feet wide. The front portion is used for the receiver's room. The centre room is for employés and is provided with individual lockers extending entirely around the sides of the room, and opening from this is a large toilet room. In the rear is a stockroom and office for the storekeeper, with a separate room for the shop employés. One entire side of the Fuller street building is utilized for freight and express business. This is equipped with double doors and has a track at the side of the house. The other side of the house is utilized for the main repair shop. The equipment includes a 100-ton forty-inch by nine-inch Niles wheel press, a thirty-six-inch by sixteen-inch Fitchburg wheel lathe, a thirty-six-inch Niles boring mill, an eighteen-inch by eight-inch Reed lathe, a twenty-one-inch Barnes drill press, a Yankee drill grinder, a four-foot by four-foot Buffalo forge, a No. 4 Challenge tool grinder, two Patten motor lifts, and a five-ton seventeen-foot-span Morris crane.

Plans have been completed and work will shortly start on a very complete repair shop, and when this is completed the Fuller street shop will be used exclusively for a car house. The building will be in three sections, the outside measurements being 201 feet by 210 feet 4 inches. First section will include armature room, machine and blacksmith shops. Adjoining it will be an erecting room which will have 300 feet of pits. The centre section will have two floors. The front is to be utilized for offices for the various departments, and the balance of the section will be utilized for storerooms. The first floor has a steam road track running through it. In front there is a team entrance provided with a platform scale. In the rear will be a large storeyard for rails, ties, special work and other large material. The third portion of the building will have three tracks and will be divided in the centre, the front being for the paint shop and the rear for carpenter shop. In addition to the machinery already owned, which will be centralized here, the company will purchase two fifteen-ton hand-operated cranes, a power rail bender, a motor flat car equipped with an electrically driven crane of five tons capacity, shapers, planers, boring mills and other machine shop equipment. The pits will be open, provided with concrete piers, and will have tracks provided with hydraulic jacks.

A well-equipped emergency house is established in Schenectady, near the centre of distribution of the system. This emergency department is equipped with tower wagons provided with hose crossings, tools and wire. The house is arranged similar to a fire engine house, and is connected with the automatic fire-alarm system. The wagons respond to calls in all districts covered by the electric light-

NIGHT SCENE ON THE TROY DIVISION, SCHENECTADY (N. Y.) RAILWAY.

ing and railway system, and a number of men are kept in constant attendance.

An extensive freight and express business has been developed, and carries on practically all the through business between Albany and Schenectady. Arrangements will soon be made for a similar service on the Troy and other divisions. The freight and express business is conducted by the Electric Express Company, which maintains a distinct organization. Freight stations have been established in both Schenectady and Albany, the latter being in connection with the station of the United Traction Company. The business is divided into three classes. Class A provides wagon service at both ends, handled at thirty cents per hundredweight; Class B, goods which are not handled at either end, ten cents; and Class C, goods which require wagon service at one end only, at fifteen cents. The company maintains three single and three double teams in Schenectady, and one double team and two single teams in Albany. The express cars make four round trips per day, and have a running time between cities of one hour and fifteen minutes. These cars are equipped so that they may be run two or more together, with multiple unit control. The road handles no free baggage. The express company calls for trunks in either of the cities and delivers them in the other at forty cents each. A large amount of trucking was formerly done between the two cities, but the electric line has eliminated this entirely. About four-fifths of the business is made up of incoming goods purchased by the Schenectady merchants. The following figures show the average carrying service done by the company: In May there were 1,272,173 pounds incoming and 366,587 pounds outgoing. In June there were 1,431,444 pounds incoming, with 315,901 pounds outgoing.

All the car-card advertising on the system is handled by the company, a charge of $7.50 per month being made.

A large tract of land at the east end of Ballston Lake, on the new branch, has been purchased, and plans are under way for an elaborate summer park. There will be a large casino, dance hall, pavilion, toboggan slide, carousel, baseball park, trotting track and a number of other features. Brandwine Park, Schenectady, is operated by the company, and is let out for picnics. This park contains a pavilion, refreshment stands and other buildings.

A feature of the trafficking department is the advertising of "Twilight Trolley Tours." Special cars leave the city station each evening and run for twelve miles, returning over one of the interurban divisions. The cars are decorated with colored incandescent lights, and have a shield, star or crescent on the front dash. These ornaments are wired with a single terminal, and the cars are used in the regular service during the day. A charge of twenty-five cents is made for the ride, and the load is limited to the seating capacity of the thirteen-bench open cars.

The power used for operating the Schenectady railway is furnished mainly by the Hudson River Water Power Company from its large water power plant at Mechanicsville, augmented at times by the steam plant of the General Electric Company. The power is transmitted from Mechanicsville at a voltage of 10,000 and a frequency of forty cycles over two entirely different routes. One

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The second transmission line starting from Mechanicsville passes along the Erie Canal through Watervliet, where it turns and following the line of the Schenectady Railway Company's Troy division tracks enters the Troy substation, located at Lathams Corners. From here three No. 2 B. & S. wires follow across country to the Albany substation, located at Karner on the line of the company's Albany division. Duplicate lines then follow the tracks located on the Albany-Schenectady turnpike into Schenectady to the General Electric works, thus making almost a circle of these transmission lines crosses the country about in a straight line from Mechanicsville to the General Electric works at Schenectady, touching Alplaus and crossing the Mohawk River at the Scotia bridge. This is the main line and consists of three No. 000 B. & S. bare copper wires mounted on double petticoat porcelain insulators. The power transmitted over this line is used to supply the wants of both the General Electric Company and the Schenectady Railway Company. The power used by the railway company in its Dock street substation is conducted by two No. 1 B. & S. three-conductor cables, one being used exclusively for the railway load and the other for lighting the city, being transformed to 2,300 volts for the lighting circuits.

THE INTERIOR AND EXTERIOR OF THE TROY SUBSTATION, AND ONE OF THE CARS, TROY DIVISION, SCHENECTADY RAILWAY.

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from Mechanicsville around through the substations and the General Electric works back to Mechanicsville. When the new Dock street substation is completed these transmission lines will be changed somewhat. The lines from the Albany substation will be rebuilt to consist of duplicate aerial lines of No. 1 B. & S. bare copper from the Albany substation to the city limits. The current will then pass underground through duplicate paper-insulated cables, each consisting of three No. 1 B. & S. stranded wires made into a cable, to the new Dock street station, instead of going direct to the General Electric works. The connection between the new Dock street station and the General Electric power-house will be by three three-conductor No. 000 B. & S. cables placed in duct in the street. The line from the General Electric works to Mechanicsville will remain unchanged.

The Hudson River Water Power Company will furnish power from another source, *i. e.*, Spier's Falls, situated approximately forty miles from Schenectady, over a transmission line direct to the power-house of the General Electric Company. The voltage of this line will eventually be 30,000.

Another steam source for supplying power to the railway company besides the present power-house of the General Electric Company will be the large steam turbine station now being built by the General Electric Company. This station will contain at present three 1,500-kilowatt Curtis steam turbine sets and will use Stirling boilers and electric auxiliaries. The station is designed, however, for a much larger capacity.

The old steam power-house of the Schenectady Railway Company, on Dock street, is a one-story building, having a frontage on Dock street of seventy-four feet and extending 119 feet toward the tracks of the New York Central & Hudson River Railroad Company. The station is divided longitudinally by a party-wall into a boiler room on the south side and an engine and dynamo room on the north side. The use of steam has been discontinued, although the machinery has not been dismantled. The boiler room contains one Stirling and three Babcock & Wilcox boilers aggregating about 1,030 horse-power, while the engine equipment consists of one Erie simple and two vertical Westinghouse compound engines; one Ball & Wood engine having been sold recently. The railway machinery at present operating in the station consists of three rotary converters made by the General Electric Company, each of 300-kilowatt capacity at 760 revolutions per minute. There is also one 200-kilowatt, 800 revolutions per minute, compound-wound, General Electric rotary converter. The 10,000-volt, forty-cycle, three-phase current from Mechanicsville is fed into the three 300-kilowatt rotary converters through nine static transformers of the air-blast type, each of 110-kilowatt capacity and which transforms the voltage from 10,000 to 372.

The 200-kilowatt rotary converter is fed through a 225-kilowatt, three-phase, air-blast transformer. All of these transformers are provided with additional leads connected to the middle points of the secondary windings, in order that the rotary converters may be started from the alternating-current side at half voltage, thus cutting down the starting current.

The railway switchboards are of the standard General Electric type for such installations, and are of black enameled slate, provided with the usual circuit-breakers, ammeters, knife blade switches, etc. One of the panels is provided with a total Thomson recording wattmeter. The 10,000-volt operating switchboard is placed in a gallery above the low-tension boards, and is equipped with oil switches, ammeters, etc.

The Troy substation of the railway company is located at the intersection of the Loudonville road and the Troy-Schenectady turnpike. The lot covers an area of 3.22 acres. The building is one story and cellar, twenty-six feet by seventy feet. The station is built of brick and is thoroughly fireproof in construction. The floor is of concrete with a granolithic top. The apparatus consists of three 300-kilowatt rotary converters operating at 760 revolutions per minute. The transformers are of the three-phase, air-blast type and are two in number, each of 330-kilowatt capacity. Each converter is also provided with a reactive coil in the alternating-current side for the purpose of regulating the voltage. Part of the cellar is made into an air-blast chamber for the transformers, while in the other part of the cellar the cablework and wiring is carried on insulators fastened to the walls and converter foundations. The switchboard is of black enameled slate and is made up of three direct-current feeder panels, two direct-current rotary panels, two alternating-current rotary panels and three 10,000-volt panels. The low-tension panels are all of the General Electric standard pattern, provided with circuit-breakers, ammeters, etc.

The 10,000-volt panels are provided with single-pole, oil-break switches, mounted in separate brick cells, about ten feet back of the panels themselves. The switches are provided with overload relays, and in the panels themselves are mounted horizontal, edgewise, black oxidized ammeters, voltmeters, power-factor indicators, and one round pattern, induction, recording wattmeter. The bus-bars back of the panels are heavily insulated and carried on an insulated iron framework. All of the 10,000-volt feeders enter the station overhead and are connected with a suitable number of lightning arresters of the Wirt type. At this station there is also an air compressor for use in connection with the Magann air storage system. This air compressor is operated by a belted twenty-horse-power induction motor.

The Albany substation is a one-story frame structure with cellar, is forty-five feet square. The lot on which it stands is 75 feet by 100 feet. The description of the Troy substation applies directly to that of the Albany substation.

The Ballston substation is in process of construction and is intended to furnish current for the operation of the Ballston division of the railway company. The following apparatus is in process of manufacture by the General Electric Company: Three 300-kilowatt, forty-cycle, compound-wound rotary converters running at 800 revolutions per minute; three air-blast, 220-kilowatt transformers provided with double secondary windings; one blower set, consisting of a two-horse-power three-phase, induction motor, direct coupled to a thirty-five-inch Buffalo forg fan; two forty-five-kilovolt-ampere, air blast, reactive coils; one twenty-horse power, three-phase induction motor wit two pulleys for operating a Magann com pressor and the necessary switchboar panels for the above apparatus.

The property on which the new Doc street substation is built has a frontag on Dock street of 180 feet, while the di tance on the rear next to the New Yo Central & Hudson River Railroad Co pany's tracks is 368 feet. The depth the lot is 165 feet. The new substati is 165 feet eight inches front by forty-f feet two inches deep, and is of brick a steel construction, thoroughly firepr throughout. The station is without a c lar for the reason that at times freshets water from the Mohawk Ri and Erie Canal overflows and would in likelihood flood the cellar. The outs walls of the basement are faced w brownstone and the basement itself is vided off by means of brick partition w

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into air-blast chambers, bus-bar compartments and oil-switch cells.

On the first floor will be located all of the transforming apparatus, and this floor is of steel and concrete construction.

The railway apparatus to be placed in this substation consists of two 600-kilowatt, 600-volt, six-phase, forty-cycle rotary converters, together with two ninety-kilovolt-ampere air-blast, static transformers. Two 300-kilowatt, 600-volt, three-phase, forty-cycle rotary converters, and two forty-five-kilovolt-ampere, air-blast, reactive coils, and six 110-kilowatt, 10,000-volt, primary, forty-cycle, air-blast transformers, space being left for a future 600-kilowatt rotary converter.

All of the 10,000-volt bus-bars, etc., are placed in the basement between brick and concrete barriers, and each phase is thoroughly insulated. The transmission and primary lines leading to the various transformers are operated by means of oil switches, electrically operated, these switches being placed in brick cells. The switchboard panels are placed on the opposite side of the station from the switches and the operating voltage is reduced by means of potential and current transformers so that at the switchboard panels it will not be greater than 150 volts. The current for operating the oil switches is furnished by means of a storage battery, built by the Electric Storage Battery Company, of Philadelphia, Pa., and consists of fifty-five cells. The 10,000-volt bus-bars are arranged so that they can be sectionalized by means of knife-disconnecting switches. All of the switchboard panels are of black enameled slate and the instruments have the marine finish. Each of the three-phase incoming line panels has a capacity of 4,000 kilowatts at 10,000 volts, and each panel contains the following apparatus:

One horizontal, edgewise ammeter; one horizontal, edgewise voltmeter; one double-pull, overload relay with lamp for indicating the open and closed position of the oil switches; one controlling switch for oil switches, together with the necessary current and potential transformers and static dischargers.

There are two three-phase, outgoing line panels with a capacity of 1,500 kilowatts at 10,000 volts, and each panel contains one horizontal edgewise ammeter, one polyphase, induction, recording wattmeter (railway pattern), together with relays, controlling switches, indicating lamps and current transformers and static dischargers.

Each of the three-phase, rotary converter panels is equipped with a power-factor indicator and horizontal, edgewise ammeter and a three-phase induction recording wattmeter, together with overload relay, controlling switches for the oil switch, indicating lamps and secondary transformers.

The lighting of the Dock street powerhouse has been worked out with a view of providing against any possible failure of current. The ordinary lighting will consist of twenty-four arc lamps, placed on brackets fastened to the sides of the wall and lighted by means of current from the ordinary lighting circuits of the company. As an emergency lighting a number of incandescent lamps will be mounted on the roof girders and will be fed from the railway circuit. Should both the railway and lighting fail, arrangements have been made for placing a number of lights on the storage battery. The station will be provided with a traveling crane having a capacity of fifteen tons and will be arranged in such a manner that the track for this crane extends outside of the building under an archway so that teams driving under this archway may be unloaded directly by the crane.

The Schenectady Railway Company, in addition to the express company, also operates the lighting and gas companies. The installed load of the lighting company amounts to an equivalent of 84,000 sixteen-candle-power lamps, while the motors for three-phase current number 4,556. A great deal of this lighting is used for stores and signs, but over fifty per cent of the light is used for domestic purposes. This fact, and the great number of meters installed in proportion to the population, is one of the features of the lighting system. The lighting company also furnishes current for lighting the street lamps of the city, the series alternating tub transformer system with enclosed arc lamps being used. Current is obtained from Spier's Falls, Mechanicsville and the General Electric Company, similar to the arrangement for the railway current, and is supplied to the Dock street substation at Schenectady. The apparatus at present consists of motor-generator sets and static transformers. Owing to the lack of capacity, three feeders are run on forty cycles, but the intention is ultimately, when the new Dock street station is completed, to furnish sixty cycles throughout. The new Dock street station will contain three 500 and three 250-kilowatt motor-generator sets, and will be a model in every respect, using the most up-to-date switching and other apparatus. The distribution system in the centre of the city will be mostly underground, ducts being made for this purpose, and the cable now being in process of construction. The system consists of sixty-cycle, single-phase, 2,300-volt primaries with manholes and subway transformers and a system of three-wire secondary mains. The underground cables will be run through the business portions of the city, and the outlying portions will be supplied by overhead feeders. The system of three-wire secondaries and banked transformers is used wherever convenient, individual transformers being used only in isolated cases.

A contract has just been obtained from the city of Schenectady for furnishing apparatus, pumps, motors, etc., and tower for pumping water used for public purposes. This plant will consist of vertical high-head turbine centrifugal pumps, and will have a capacity of 12,000,000 gallons daily. The pumps will be direct-connected to 800-horse-power, forty-cycle induction motors. This will be one of the first installations of its kind in the world, and will be unique in type; and it is proposed to make a model in design and construction. By a recent purchase of the Mohawk Gas Company's plant, the railway company has added another division to its properties. Extensive plans have been laid to rebuild and add to the local plant, and some of the work is already completed. The maximum capacity of the generating plant will be 1,750,000 cubic feet. The company is now serving 3,500 customers, sixty per cent of these using prepayment meters. Both coal and water gas is manufactured.

The company maintains a very complete system of records and accounts. The general manager has before him at all times tabulated statements of the equipment and general condition of the system, and these are brought up to date at frequent intervals. All operating expenses and receipts are figured on a basis of eighteen-hour cars per day, and each item of expense is charged to its proper account. A detailed statement for each month, together with some statements obtained from well-known roads employing the same system, is posted for comparative purposes in the office of the general manager. An examination of the operating expense sheet for the month of May, 1903, gives the receipts per eighteen-hour car as $51.62. This is claimed to be higher than the receipts of any other similar proposition in the country. The operating expenses are given as 60.9 per cent of the gross receipts. These figures do not include the lighting business or the express business, as these are operated as distinct organizations.

The discipline and spirit of the employés are excellent, and the extremely liberal treatment of the employés by the company has brought about a condition of affairs which is a high tribute to the executive and operating departments. Promotion is by order of seniority, the men starting extra on the city cars and moving up to regular cars; then extra on local interurban cars, and

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finally to regular service on a limited interurban car. All employés are allowed ten days' vacation with full pay, after one year's service. The superintendent keeps a card index system, and a record of each man is placed in a filing case, together with application, medical examination and reports relative to his work. There are three ways of action in case of infraction of rules—first, by inspector; second, by letter; third, a call before the superintendent. The latter action is seldom taken. The first failure to report on time calls for a suspension of two days; if repeated again within six months, a suspension of five days. For the third time within six months the employé is called before the inspector for trial.

At the Fuller street car house an entire floor has recently been added and fitted up with a remarkably complete club room for the employés. The four front rooms are utilized for the office of the master mechanic, the company's physician, the express manager, and the office of the benefit association. The club rooms include a billiard and pool room, a locker room, washroom with bathtubs and shower baths, two bowling alleys with platform for spectators, and a reading room, as well as an assembly room with platform and stage. The partitions between the reading room and the assembly room are vertical sliding doors, so that the rooms can be thrown together for large gatherings. The dues of the association are fifty cents a month, which is deducted from the pay of the men each month. The constitution provides that if the fund is not sufficient to meet the obligations, the board of trustees shall have the right to assess each member not to exceed an additional fifty cents per month. Disability by reason of accident or sickness insures a member an income of $1 per day for a period not exceeding ninety days. The death of a member provides an insurance of $150. The management of the association is vested in a chairman and six members. The chairman is always an officer of the Schenectady Railway Company, who appoints three members of the board of trustees, the other three being elected by a majority vote. These club rooms are so arranged that they present at all times a most inviting prospect to the employé with time on his hands, and are well worthy of inspection and study by any one interested in economic conditions.

The officers of the company are: Hinsdill Parsons, president; E. F. Peck, general manager; James O. Carr, secretary-treasurer; J. J. Magilton, auditor and assistant treasurer; C. C. Lewis, chief engineer; F. G. Sykes, electrical engineer; C. F. Coffin, manager gas department; E. J. Ryon, manager express department; Frederic Smith, superintendent; J. H. Aitkin, purchasing agent. Directors: Hinsdill Parsons, E. F. Peck, E. W. Rice, Jr., G. E. Emmons, F. O. Blackwell, H. C. Wirt, J. R. Lovejoy, A. L. Rohrer, W. L. K. Emmett.

Refining Lead Bullion by Electrolysis.

At a recent meeting of the American Institute of Mining Engineers, Anson G. Betts described a new method of refining lead by electrolysis. A solution of lead fluosilicate containing an excess of fluosilicic acid has been found to work satisfactorily as an electrolyte for refining lead. It conducts current well, is easily handled and stirred, is non-volatile and stable under electrolysis. It may be made to contain a considerable amount of dissolved lead, and is easily prepared from inexpensive materials. It possesses, however, in common with other lead electrolytes, the effect of yielding a deposit of lead lacking in solidity which grows in crystalline branches toward the anodes, causing short-circuits. But if a reducing action, practically accomplished by the addition of gelatine or glue, be given to the solution, a perfectly solid and dense deposit is obtained, having very nearly the same structure as electrolytically deposited copper, and a specific gravity of about 11.36 that of cast lead.

A neutral solution of lead fluosilicate is partially decomposed on heating, but this decomposition ends when the solution contains about two per cent of free acid. The solutions desired for refining are not liable to this decomposition, since they contain much more than two per cent of free acid. The electrical conductivity depends mainly on the acidity of the solution. The first experiments were carried out without the addition of gelatine to the solution. The lead deposit consisted of more or less separate crystals. The cathodes, which were sheet-iron plates, lead-plated and paraffined, had to be removed periodically from the tanks and passed through rolls to pack down the lead. When gelatine has been added in small quantities, the density of the lead is greater than can be produced by rolling the crystalline deposits, unless great pressure is used.

As a starting material, hydrofluoric acid of thirty-five per cent is used. This is run by gravity through a series of tanks. In the top tank is a layer of quartz two feet thick, in passing through which the hydrofluoric acid dissolves the silica, forming fluorsilicic acid. White lead in the required quantity is added in the next tank, where it dissolves readily and completely, with effervescence. All sulphuric acid and any hydrofluoric acid that may not have reacted with the silica precipitate out in combination with lead. The lead solution is then filtered and run by gravity into the refining tanks.

The anodes may contain any or all of the elements. Gold, silver, copper, antimony, arsenic and bismuth, being more electro-negative than lead, should remain in the slime in a metallic state, with perhaps tin; while zinc, nickel and cobalt should dissolve. Iron dissolves only slightly. This process completely removes bismuth and antimony, and the small amount of tin—from 0.02 to 0.03 per cent—is easily removed by poling.

The electrolyte takes up no impurities, except possibly a small part of iron and zinc. It may be purified in several ways. For example, the lead may be removed by precipitation with sulphuric acid, and the fluorsilicic acid precipitated with salt. By distillation of the sulphuric acid the fluosilicic acid may be recovered. The only danger of lead poisoning to which the workmen are exposed occurs in melting the lead and casting it.

This process is being used by the Canadian Smelting Works, at Trail, British Columbia. There are twenty-eight refining tanks, each eighty-six inches long, thirty inches wide and forty-two inches deep, each receiving twenty-two anodes of lead bullion, with an area of twenty-six by thirty-two inches exposed to the electrolyte on each side. The total weight of anodes in each tank is three tons, and they dissolve in from eight to ten days. Each tank contains twenty-three cathodes of sheet lead, prepared by depositing lead on paraffined iron cathodes.

Each tank is capable of yielding, with a current of 4,000 amperes, 750 pounds of refined lead per day. In addition to the ohmic resistance, there is a counter-electromotive force of about 0.02 of a volt per tank to be overcome. The tanks are made of two-inch cedar, bolted together and thoroughly painted with rubber paint.

The Journal of the Franklin Institute.

The August issue of the *Journal* of the Franklin Institute contains an article by C. E. Farrington, entitled "Defective Machine Insulation." This discusses the defects of various kinds of insulating materials and their desirable qualities. There are, in addition, the following papers: "Safety Mining Lamps," by Rufus J. Foster; "The Utilization of Blast Furnace Gases for Power Purposes," by Charl Kirchhoff; "On Convergents and Arithmetical Series, the Ratio of Whose Terms Approximates Successively the Value π, and on Their Application to the Construction of Computing Machines," F. L. O. Wadsworth; "Fuel Oil," by John F. Rowland, Jr., and "The Census of Manufactures of 1900," by Charles Munroe (concluded).

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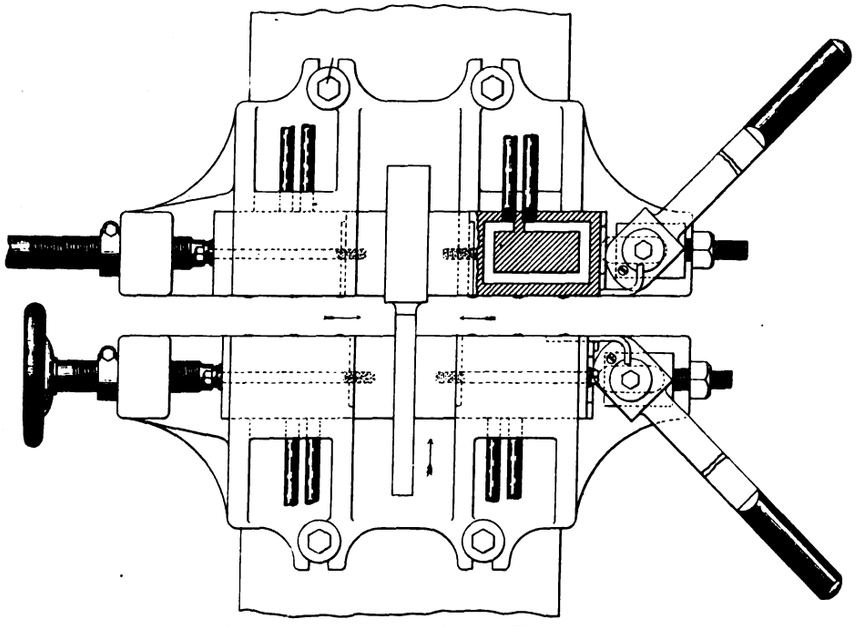
Electrical Patents.

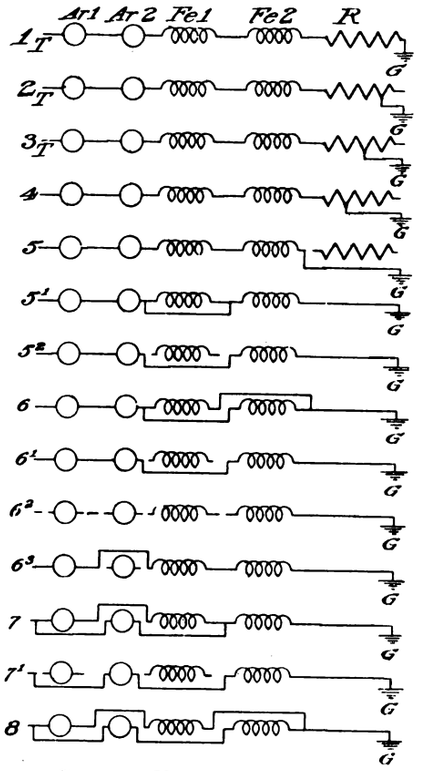
The Thomson Electric Welding Company, of Lynn, Mass., has recently been granted, as assignee, a patent on a clamping device for electric metal-working apparatus, which is the invention of Adolph F. Rietzel, also of Lynn, Mass.



Clamping Device for Electric Metal-Working Apparatus.

The invention is designed more particularly to improve the construction and operation of the clamping devices employed for electric welding machines, although it may be also employed on machines organized or adapted for use in carrying on other kinds of metal-working operations. The successful operation of electric welding machines depends almost wholly upon the construction of the clamping devices which have to be adapted for various kinds of work and which must, moreover, be capable of holding the work tightly and be so constructed that the work may be quickly put in and taken from the clamps. They must also be strong enough to hold the work firmly in the jaws without slipping when the pressure is applied to complete the weld or perform other operations when the metal has been softened by the current to the required degree. One of the principal objects of this invention is to provide clamping devices especially suited for use with heavy work and readily adjustable for different classes or kinds of work. The invention may be employed, for clamping flat stock, straight pieces, angle work, round stock, or other material to be welded or otherwise worked when electrically heated. Another object of the invention is to provide for the application of a clamping pressure to a very considerable portion of the pieces to be welded or worked, so as to provide large areas through which current may be fed to the work, while at the same time giving ready access to the clamping devices and permitting the work to be readily inserted or withdrawn. Another object is to bring the line of clamping pressure upon the work as near as possible to the line of heating or welding. In the preferred manner of carrying out the invention the two clamping jaws which hold the work are mounted at one side of the line of heating in such a manner that the pressure shall be applied in a horizontal line or line substantially parallel to the bed of the machine, thus leaving the opening between the jaws free or clear from above. With one of the jaws is combined a suitable adjustable screw which is set or adjusted for different sizes of work, and with the other jaw is combined a cam lever which is manipulated during the operation of the machine for carrying on a certain class of work or work of a certain size with reference to which the opposite jaw is adjusted by means of a screw, the latter adjustment being practically a slow or fixed adjustment and the former or that which is carried on by means of the cam being the temporary or quick adjustment used in clamping and unclamping the work. Another feature of the invention relates to means for setting or adjusting the jaw for different classes of work and for at the same time providing a means whereby the jaw may be secured to the jaw-carrying slide and may be readily removed to permit the substitution of jaws adapted for different kinds or forms of work.

Frank A. Merrick, of Johnstown, Pa., has devised and patented means for controlling electric motors and the Westinghouse Electric and Manufacturing Company, of Pittsburg, Pa., has obtained control of this patent. The invention is designed to provide an improved method of changing a pair of motors from series to parallel relations without the use of wasteful external resistance and by a series of steps which provides a nearly uniform acceleration in their speed, and which avoids undesirable circuit conditions. The invention more particularly relates to a system of motor control in which motors are changed from series to parallel relation by first connecting their fields only in parallel, then shifting them to a relation in which one of the motors



Electric Motor Controller.

is shunted by the armature of the other motor whose field is in series with the first motor, and then finally connecting the two motors in parallel. In changing from the relation of parallel fields and series armatures to a relation in which one motor is shunted by the armature of the other motor it is of course necessary to change the armatures from series to parallel relation and the fields from parallel to series relation at a time when the motors are carrying considerable current and have attained considerable speed. The simplest and most obvious method of making this change is to open entirely the circuits through the motors and then recircuit them in the desired re-

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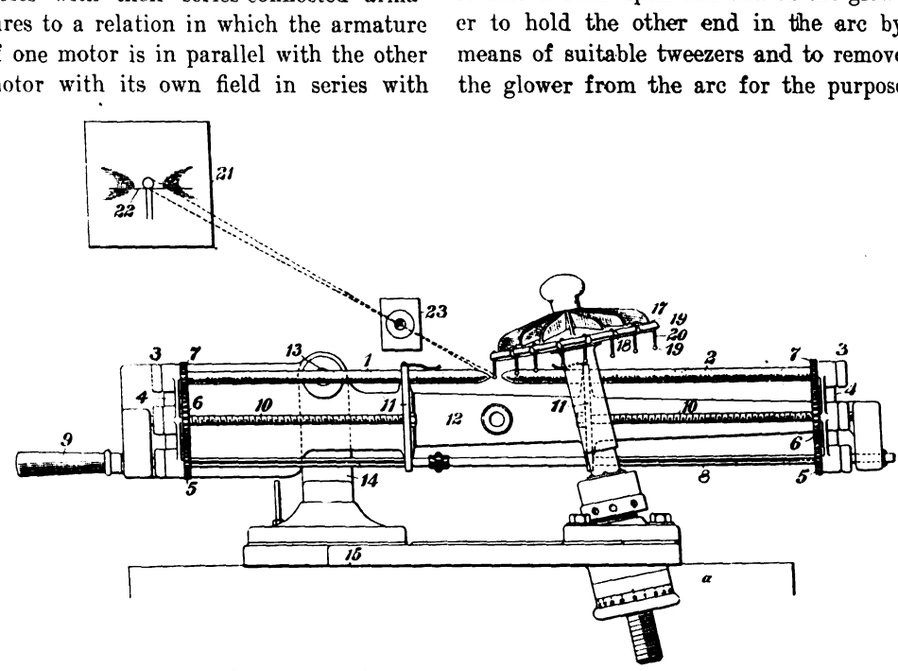
lations. There is no objection to this provided that the period of open circuit is sufficiently brief not to affect the speed or counter-electromotive force of the motors. This, however, has not heretofore been possible in practice for the reason that if the controller be moved rapidly across the open-circuit position the arcs which form between the controller contacts and fingers on leaving the preceding position are apt to be maintained across the open-circuit point until the succeeding position is reached. The effect of this, as will be readily seen, is in a measure to superimpose one circuit condition upon another in a manner likely to result in serious confusion of circuits and very probably give a short-circuit from trolley to ground. This is more apt to occur during the backward movement of the controller from the position of parallel armatures to a position of parallel fields, the arcs in the controller tending to maintain the series position of the fields up to the time that the proper contacts in the controller are engaged to effect a multiple connection of the fields, in which case there can result a direct short-circuit from trolley to ground. Consequently, in order to avoid results of this character it has been necessary to make the points of open circuit sufficiently wide on the controller drum to ensure the extinguishment of all arcs in the controller while moving across this position. This, however, leaves the circuit open for a period sufficiently long to affect the speed and especially under the condition of a heavy load, and the effect upon the car is noticeable. The present invention is more particularly designed to provide a method of control in which the effect of opening the circuit in passing from the position of parallel fields to parallel armatures or the reverse is practically eliminated in so far as any objectionable confusion of circuits or effect upon the car is concerned. With this and the previously stated objects in view, the invention, broadly considered, consists in the method of carrying a pair of motors across an open-circuit position on the controller by making the period of open circuit of brief duration and preceding and following such position in both directions of movement of the controller by circuit relations of the motors or motor elements of such character as to avoid short-circuits and other undesirable circuit conditions which might otherwise result by reason of the fact that arcs formed between the controller fingers and contacts might be maintained across the open-circuit position, and thus tend to superimpose one set of circuit connections maintained through such arcs upon another set established by the controller contacts, such preceding and following circuit relations being, furthermore, such that the conditions which may result from such a superimposition of connections will by their nature and in view of the resistance of the maintained arcs be to a certain extent beneficial. More especially considered the invention consists in the employment of the above described method in changing a pair of motors from a relation in which their fields are in parallel with each other and in series with their series-connected armatures to a relation in which the armature of one motor is in parallel with the other motor with its own field in series with that motor; and in doing this the open-circuit position is preferably preceded by a circuit condition in which both armatures and one field are in series, with the other field open circuited. In the reverse movement of the controller the open-circuit position is preceded by a circuit relation in which one armature and both fields are in series and the other armature is open circuited.



METHOD OF MAKING ELECTRIC LAMP GLOWERS.

A new method of and machine for making electric lamp glowers of the type in which the glowers are non-conductors when cold and become conductors when heated, has been invented by Marshall W. Hanks, of Pittsburg, Pa., the well-known expert in this line, and George Westinghouse has purchased the patent. The object of the invention is to provide an improvement in the art which will cheapen the cost of production of glowers and render it feasible easily and expeditiously to make any number of glowers of any given length in order to adapt them to a given voltage. It has been the usual practice in the manufacture of glowers to form a rod or string of suitable length and of the desired diameter, then cut such rod or string into suitable sections or lengths, then fuse each end of each of the blanks by means of an electric arc to form a bead, and finally attach terminal wires to the beads by embedding the ends of the wires in the beads or otherwise. It is, of course, essential that all glowers intended for use in connection with a given voltage should be of substantially the same diameter and the same length. It has been the practice, therefore, after having formed a bead upon one end of the glower to hold the other end in the arc by means of suitable tweezers and to remove the glower from the arc for the purpose of measuring it. It will be readily understood that several removals of the glower from the arc may occur before the desired length has been reached. In order to avoid the loss of time incident to the operation above specified and at the same time ensure an exact uniformity in the length of the glowers, Mr. Hanks has devised the following machine and method. As illustrated in the accompanying illustration, 1 and 2 are carbon rods or pencils which are included in an electric circuit and between the adjacent ends of which is formed the arc which is utilized in the process. The outer ends of the carbon rods 1 and 2 are seated in socket pieces 3 that are rotatably mounted in heads 4, having gear-wheels 5, 6 and 7 that receive motion from a rod or screw 8, on which the gear-wheel 5 has a screwing non-rotatable fit. The rod or screw 8 is provided at one end with a handle 9, and the hubs of the wheels 6 are mounted upon screw-rods 10, the

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ends of which are supported by stationary heads 11, which also support the inner ends of the carbon rods 1 and 2. All of the parts thus far described are supported by a frame 12, that is pivoted at 13 to a standard 14, so as to permit the operator to raise and lower the arc by means of the handle 9. The standard 14 is so mounted on a base plate 15 as to be turned on a vertical axis by means of the handle 9 to effect any desired lateral adjustment of the arc. Suitably mounted to rotate upon or with a shaft 16 is a table 17, having a suitable number of notches or slots 18, the width of each slot being slightly less than the diameter of the bead 19, on the end of a glower 20, so that a glower may be inserted in each slot and be suspended by means of a previously formed bead on one end from the upper side of the table. The shaft 16 may be inclined to the vertical, as indicated, so that if all of the notches 18 are provided with glowers those on the side opposite the arc will not engage with the carbon as the table is rotated. A suitable device 16*a* may be employed for adjusting the height of the table in accordance with the length of glower that is desired. The table will obviously be located at a definite height for any given length of glower, and so the lower end of the blank will project substantially into the middle of the arc. At a suitable distance from the arc is located a fixed screen 21, on which is placed a horizontal line 22, and at a suitable point between the screen and the arc is placed a magnifying-lens 23, the lens being placed in such position as to project upon the screen a magnified image of the arc and the lower end of the glower. Since the employment of a single lens will serve to project a reversed image upon the screen, the line 22 will be located at the height corresponding to the length of glower desired. Since the projecting image is several times the size of the object, the length may be very accurately measured. In performing the method, glower-blanks, which have been formed in the usual manner, each with a bead at one end, are placed in the slots 18, in the wheel 17, so that the previously formed beads rest upon the upper edges of the slots. The frame 12 will then be so adjusted, both vertically and horizontally, as properly to locate the arc with reference to the lower end of the glower-blank at the inner side of the table. Any desired adjustment of the carbon rods with reference to each other may also be effected by rotating the handle 9. It will be seen, therefore, that the operator has complete control of the position of the arc. Inasmuch as the gauge line 22 and the table slot 18, which is located above the arc, have a definite fixed relation to each other as regards elevation, a given length of glower may always be secured by giving the table a small rotative movement as soon as the inner side of the bead coincides with the gauge line. The glowers may thus be successively moved into position for treatment, and as the table is rotated the completed glowers may be removed and their places filled by blanks, thus making the operation substantially continuous.

The Marconi System and the Yacht Races.

Melville E. Stone, general manager of the Associated Press, contracted with the Marconi Wireless Telegraph Company to report the yacht races and this was carried out with great success. Mr. Stone chartered the fast and commodious steam yacht Chetolah, owned by A. J. Wise, the head of the well-known electrical house of J. H. Bunnell & Company, and from its deck the bulletins were sent every few moments to the Marconi station at Jamaica, L. I., forwarded from there to the headquarters of the Associated Press on Broadway, New York city, and instantly distributed throughout the country. As the first day was foggy at times, the races could not have been reported during these periods with any promptness in any other manner, and the results were of great satisfaction to the Associated Press and its newspapers, and was an undoubted triumph for the Marconi service.

The editor of this journal was a guest of the Associated Press on the occasion on board the Chetolah. The following message was received from him by wireless service at the ELECTRICAL REVIEW office immediately after the first race was declared off.

On board yacht Chetolah,
By Marconi wireless telegraph:

Race declared off at three forty-five, Reliance having sailed one-half course several minutes ahead of Shamrock.

The Associated Press was represented on board by a very able staff of experts, and the Marconi Wireless Telegraph Company of America was represented by William H. Bently and George W. Fishback. The operator for the wireless service was F Newman, and notwithstanding that there were other wireless systems in operation, the thirty odd bulletins sent out were received promptly and correctly.

Index of the Technical Press.

The July issue of the *Index of the Technical Press* contains about 2,900 references to technical articles appearing in the technical press within the last month or so. This index covers practically all the technical journals of the world, making it very valuable to students and engineers.

Street Railways of Leipzig.

Mr. Brainard H. Warner, Jr., consul at Leipzig, Germany, has submitted the following interesting communication:

In the spring of the year 1872, the first street-car line in this city was opened to the public. The cars were, of course, drawn by horses—as they were at that time in almost every other place. It continued in operation until 1895.

CONCESSIONS.

In 1895 the Leipzig city council, the Minister of the Interior concurring, granted concessions to two companies to build electrical street railways upon conditions almost identical, the principal features of which are: The concessions extend forty years from the date the lines were first put into operation (in 1895 and 1896, respectively), at the end of which time all the lines and rolling stock which were then built, or which may thereafter have been built, are to revert to the city, with the exception of the grounds, buildings, machinery, and those motor cars which shall have been built within the last preceding five years.

Rights of City—The city has the right, however, to buy such grounds, buildings, machinery and cars at the price at which they are assessed. In addition thereto, the city has the right to take over the lines after the expiration of twenty years upon the payment of the full assessed value of the grounds, buildings, machinery and those motor cars which shall have been built in the five years immediately preceding, and the full assessed value of the roadbeds and rolling stock; after twenty-five, thirty or thirty-five years, in addition to paying the full price for the grounds, etc., seventy-five, fifty or twenty-five per cent of the assessed value of the roadbeds, etc., respectively. The city must also pay, should it take over the lines, or either of them, at the end of twenty years, thirteen times the amount the net profits have averaged during the five years just preceding; after twenty-five, thirty or thirty-five years, ten and three-fourths, eight or four times the average net profits, respectively. From the receipts, the running expenses, 4.5 per cent for dividends upon the capital stock, and a like sum for interest on the bonds are to be deducted in order to determine the net profits.

Forfeiture of Rights—The right of either company, or both, may be forfeited should one or both of them discontinue running cars along all of the lines or any part or parts thereof without the sanction of the local authorities; if they fail to comply with any ordinance within a

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reasonable time after having been requested to do so in writing; if the funds for running expenses be attached or are otherwise made away with, or if the Royal Ministry should advise that such action be taken.

Stockholders' Rights—If, on account of any of the foregoing reasons, the city should take over the roads or either of them, it must pay to the stockholders of the company or companies an amount which a specially constituted board of experts may determine the plants, equipments, grounds, buildings, etc., to be worth.

Payments for Street Rights—After the first three full years the lines are in operation, they must pay the city for the use of the streets two per cent of the gross receipts, which amount will be increased one per cent after the lapse of every five years, until it reaches five per cent. The lines must pay for paving and repairing the streets where new tracks are put down, in the one instance, and where the running of the cars is responsible for the wear and tear thereof, in the other.

CAPITAL.

The Grosse Leipziger Strassenbahn Gesellschaft, the larger company, known as the "Blue Line," is capitalized at 10,000,000 marks ($2,380,000), which is divided into 10,000 shares of 1,000 marks ($238) each. It has a bonded indebtedness of 10,000,000 marks ($2,380,000), bearing four per cent interest per annum, which is divided into 6,500 bonds of 1,000 marks ($238) each, and 7,000 bonds of 500 marks ($119) each. The company has paid regular dividends to its stockholders since 1896, when it began operations, as follows: For the years 1896, 1897, 1898, 1899, 1900, 1901 and 1902, six, eight, eight, eight, seven, five and one-half and five and one-half per cent, respectively.

The Leipziger Elektrische Strassenbahn Gesellschaft, the other, known as the "Red Line," is capitalized at 6,250,000 marks ($1,487,500), which is divided into 6,500 shares of 1,000 marks ($238) each. It has a bonded indebtedness of 4,000,000 marks ($952,000), bearing four per cent interest per annum, which is divided into 2,000 bonds of 1,000 marks ($238) each and 4,000 bonds of 500 marks ($119) each. Regular dividends have been paid the stockholders since its organization, as follows: 1895 to 1899, four per cent per annum; 1900, three per cent; 1901, two per cent, and 1902, two per cent.

EQUIPMENT AND ROLLING STOCK.

The overhead trolley system is used by both companies. The trolley wires are suspended in the air by wires fastened to the houses on either side of the streets. Where there are no houses, iron posts, located perhaps two feet in from the curbstone, are used as supports. The tracks are laid with such exactness and precision that there is little delay or annoyance caused by the trolley arm becoming displaced.

The lines have 211.57 kilometres (131.17 miles) of tracks, including those in the various car sheds, 124.51 kilometres (77.2 miles) of which belong to the larger company and 87.06 kilometres (53.97 miles) to the smaller. The former has had, for several years past, its own car shops. It has 275 motor cars and 112 closed and thirty open trailers—in all, 417 cars in use. The smaller company has 130 motor cars and twenty closed and thirty open trailers—in all, 180 cars in use. The smaller company's cars are fitted with the ordinary hand brakes, while those of the other (the Blue Line) have the latest Westinghouse air brakes attached, in addition to the hand brakes. All cars are lighted by electricity, oil lamps being sometimes placed in one corner at either end, but, strange to say, none of the cars is heated, even in the coldest days in winter. In winter the car floors are covered with straw, and strips of cheap cotton-plush cloth are hung before the windows to keep at least some of the cold air off the passengers' backs.

AUTOMATIC SIGNAL BOXES.

An automatic signal box was first introduced by the smaller company last year. These boxes are placed at the crossings of electric street railways to warn motormen of the approach of cars in another direction. They have been found to be very satisfactory by both companies, as they are no longer compelled to station flagmen at the crossings or to have the conductors run forward to see if the way is clear.

TRAFFIC AND SERVICE.

Cars are run from 5.17 in the morning until midnight, upon schedules varying from four to fifteen minutes apart. Municipal ordinances prescribe that street cars shall not run at a higher rate of speed than nine miles an hour in the business sections; with trailers, 7.2 miles; and in the suburbs, fifteen miles, or twelve miles with trailers. Cars are not to be stopped at every corner to let passengers on or off, but at places perhaps 250 yards or less apart, marked for the guidance of the public by iron signposts placed a foot or two in from the curbstone.

To each motor car there is a motorman, who is forbidden to talk with passengers, and a conductor, whose duty it is to be on the back platform every time the car stops to help passengers on or off. A municipal ordinance requires that when a trailer is attached another conductor must be carried to look after it. Trailers and motor cars are not connected by a passageway, and passengers are not allowed to go from one to the other without paying an additional fare. There are twenty seats in each car and when all are taken no more passengers are allowed inside, as the aisles must be kept clear.

There are a certain number of standing-room places on the front and rear platforms—perhaps fifteen on an average. When these are taken and the inside is full, the conductor hangs out at the rear end of the car by the entrance a sign "Occupied," and no more stops are made to take on passengers until some are first let off.

FARES.

The fare for a single trip is ten pfennigs (2.38 cents), which entitles one t a free transfer. Passengers carrying large baskets, bundles, etc., must pay a full fare for such.[1]

The Red Line issues six tickets fo fifty pfennigs (11.9 cents). Both lines issue commutation tickets good for three six and twelve months, respectively. Postmen and telegraph and messenger boys are carried by contract, the Imperial Government paying a yearly sum therefor More than seven at a time, however, may not ride on the same car.

All employés of the city, as well those connected with the police department, when in uniform, are entitled ride upon the front platform free charge, but never more than two at time. In addition thereto, a large number of the city officials—at the present time 560—are given "annual passes."

To school children under fifteen years of age are issued special cards, which good only upon the lines running between their respective homes and the schools they attend and between certain hours the day. Under no circumstances these children allowed to get on or the cars while they are in motion.

In the year 1902 the cars of the G Leipziger Strassenbahn Gesellschaft eled 14,399,902 kilometres (8,927,9 miles) and received 4,241,973.83 m ($1,009,589.77) for carrying 45,00 passengers. The company's receipts 9.4 pfennigs (2.24 cents) per pass and 29.5 pfennigs (7.02 cents) pe kilometre (0.621 mile).

The cars of the Leipzig Elekt

[1] A pernicious habit on the part of many, wh be said to have almost become a local custom, is feeing conductors. This is practised by even th are in most moderate circumstances. A passeng ing the regular ten-pfennig fare will, at the t fare is paid, hand the conductor an additio pfennigs (1.19 cents).

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Strassenbahn Gesellschaft during the same period traveled 565,004 kilometres (350,302.48 miles) and received 1,659,407.95 marks ($395,062.86) for carrying 18,160,928 passengers. The receipts of this company were 9.1 pfennigs (2.16 cents) per passenger and 26.02 pfennigs (6.53 cents) per car kilometre.

WAGES.

The wages of a conductor is eighty-four marks ($20) per month for the first year's service; the same amount is paid a motorman for the first six weeks he works. After their respective apprentice terms have expired they are paid from ninety marks ($21.42) to 120 marks ($28.52) per month, the amount being fixed by the length of time they have been employed. The men are given one day off in every six, seven or eight, depending upon the number of hours each one is compelled to work daily. A working-day is usually from ten to twelve hours.

CLEANING AND REPAIRING STREETS.

In the expenses are included the cost of new materials, repairs and cleaning and repairing the streets. As to this last mentioned, it should be said that the streets are cleaned and sprinkled by the city government, for which service the railway companies are charged as follows: For sprinkling and cleaning streets paved with asphaltum, granite blocks, macadam and wood blocks, three pfennigs (0.7 cent), two and one-third pfennigs (0.6 cent), five-sixths of a pfennig, (0.2 cent), and three pfennigs (0.7 cent) per square metre (10.7 square feet) per month, respectively, and, in addition thereto, five per cent for supervising the work. Last year the Blue Line paid 76,416.95 marks ($18,187.25) and the Red Line 48,663.76 marks ($11,581.97) for this purpose. Street paving and repairing is done by contract. The city, however, superintends the work, to see that it is properly done, and for this service charges five per cent of the contract price. Last year the Blue Line paid 239,502.15 marks ($57,001.51) for this purpose, and the Red Line 138,267.21 marks ($32,907.60).

In winter when the snow falls the street-car companies must keep their respective tracks clear, and for this purpose snow plows are used. The Blue Line has fifteen such plows and the Red Line six. The snow is piled on either side of the tracks and carted away by the city, which charges the street-car companies from 1.80 marks (43 cents) to 2.75 marks (65 cents) per wagon load containing about two cubic metres (seventy-one cubic feet), the price depending upon the length of the haul. Last year the Blue Line paid 9,723.85 marks ($2,314.28) for having snowed cleared away.

INSURANCE OF EMPLOYES.

For the benefit of those employés whose wages do not exceed 2,000 marks ($476) per annum, sick, accident, life insurance and assurity funds are established. These are also charged to the expense accounts, as is also the cost of the employés' uniforms, each man being provided with at least one uniform, two caps, an overcoat, etc., per annum, except, however, those who are working for the first year, from whose wages ten pfennigs per day is deducted to pay for the uniforms. Under taxes are included the two per cent of the total receipts, which were mentioned in the paragraphs entitled "Concessions," taxes upon real estate, revenue stamps, etc.

FINANCIAL STATEMENT.

The condition of the two railway companies at the end of the calendar year 1902 is shown in the following statement:

Debit.	Blue Line.	Red Line.
Salaries	$278,335.48	$107,710.44
Expenses	296,370.18	136,566.67
Taxes	35,917 86	14,995.58
Interest account	98,175.54	45,431.82
Gross profits	309,391.05	94.8 4.40
Total debit	$1,018,190.21	$399,538.41
Credit (total income	1 018,190.21	399,538.41

The Production of Copper in 1902.

In his report to the United States Geological Survey on the production of copper in 1902, Mr. Charles Kirchhoff says that the copper-mining industry of the United States suffered during 1902 from the reaction which followed the unsuccessful attempt during 1901 to maintain the value of the metal at an artificial level. The collapse which came toward the close of 1901 left many producers committed to sales covering a long period, at low prices, with the menace of heavy accumulations of metal constantly over the market. Yet production was heavier during 1902 than it had been in 1901, because some of the important mines were worked to full capacity and because some of the enlargements and improvements previously begun became effective during the year. Furthermore, a number of new enterprises first produced important quantities of metal. On the other hand, accidents and labor troubles cut down the outputs of some of the larger undertakings. Unless unforeseen events cause widespread or prolonged stoppage of operations at the mines, Mr. Kirchhoff thinks that the production of copper in the United States will be considerably larger in 1903 than it has ever been. The Lake Superior district will yield considerably more copper; Arizona is expected to return a considerably larger product; Utah may reach a total of 35,000,000 pounds; and Wyoming, Nevada, Colorado, New Mexico, and the southern states will report an increase.

The consumption of copper in the United States was enormous in 1902. It was larger also in other leading industrial countries.

As compared with 268,782 long tons in 1901, the total production of copper in the United States in 1902 was 294,423 long tons of which the Lake Superior district produced 76,165, or 25.9 per cent; Montana, 128,975 long tons, or 43.8 per cent, and Arizona, 53,547 long tons, or 18.2 per cent. This is an increase in the total production of 25,641 long tons, or nearly ten per cent, as compared with 1901.

Utah is forging to the front as one of the most important copper states, and it is notably in the Bingham Camp that development has been most rapid.

Only small quantities of copper ore have been shipped from Alaska to Puget Sound smelters, but it is known that large deposits of copper ore exist, whose development is being taken seriously in hand.

The imports in copper ore in 1902 were valued at $7,921,641, as compared with $14,394,663 in 1901; and the imports of copper in bars, ingots, pigs and in manufactured forms were valued at $12,864,021, as compared with $11,820,459 in 1901. The exports of domestic copper in different forms were valued at $46,811,729 in 1902, as compared with $36,071,448 in 1901. The exports from Baltimore, Md., increased from 54,377,355 pounds in 1901 to 103,607,256 pounds in 1902; and from New York the increase was from 133,540,150 pounds in 1901 to 236,622,515 pounds in 1902.

In the aggregate the reporting mines had a stock of 155,665,652 pounds of copper on January 1, 1903, as compared with 282,014,297 pounds on January 1, 1902, a decline of over 126,000,000 pounds during 1902.

The estimated consumption in 1902 was 551,688,191 pounds, as compared with 382,761,014 pounds in 1901, and with 356,891,121 pounds in 1900. The average selling price of Lake copper during 1902 was 11.86 cents per pound.

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INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Electric Elevators.

The accompanying illustrations show two of the types of electric elevators built

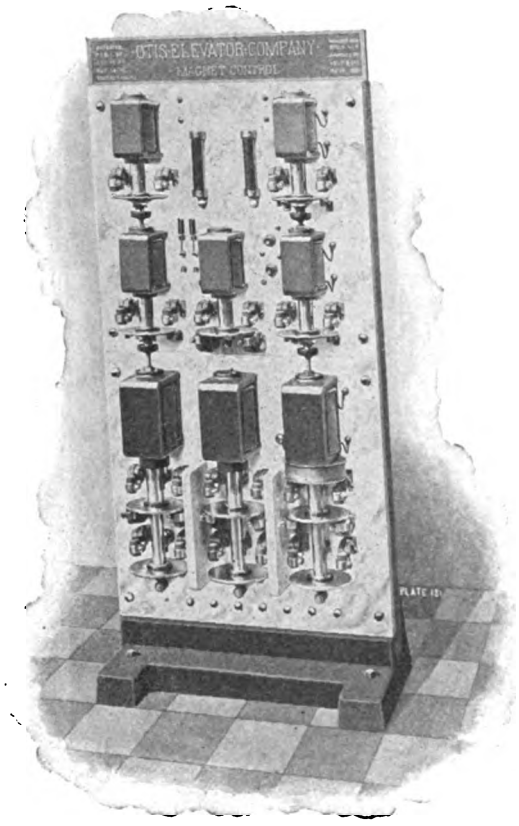

FIG. 1.—MAGNET CONTROLLER FOR ELECTRIC ELEVATORS.

by the Otis Elevator Company, 71 Broadway, New York city. Fig. 1 shows the apparatus used in connection with the electrical system of control. The contacts are of liberal proportions and every part is built in the most substantial manner.

Fig. 2 shows the apparatus for mechanical control. The main line or reversing switch shown in the upper part of the illustration is operated mechanically, and the smaller switches below, which cut out the starting resistance, are operated by magnets, as shown in the large controller in Fig. 1.

There are two systems of control for electric elevators—the electrical and the mechanical. In the former, the elevator is controlled by a small switch within the car, operating pilot circuits which open and close the main line and reversing switches. On starting, there is considerable resistance within the armature circuit, and as the armature accelerates, this resistance is automatically cut out step by step by electrically operated switches. By this means the current is absolutely prevented from increasing above the amount for which the motor is designed, and a gentle start proportionate to load is secured.

The mechanical system of control differs from the electrical in that the line switch is opened, closed and reversed through the medium of a lever or a hand-wheel within the car by purely mechanical means. Closing the switch admits starting current only to the motor, and thereafter the control proceeds in the manner already described, in the respect that the starting resistance is cut out from the armature circuit by automatic switches step by step as the motor accelerates, the same protection of the motor against heavy currents being thereby afforded.

Fig. 3 illustrates the Otis standard drum-type of the direct-connected elevator engine, placed immediately over the hatchway where ordinarily the overhead sheaves would be located. This method of installation has many desirable features, an important one being the entire freedom from elevator machinery in the basement space, which in many buildings is very valuable.

The double-worm electric machine shown in Fig. 3 is recommended for high-speed passenger service, rather than the single-worm type. It is provided with electrical control only, the controlling apparatus being also located overhead adjacent to the engine. The double worm is equally adapted, of course, for installation in the basement, and is so located in thousands of buildings where basement space is particularly valuable or where this method is for other reasons favored by the architects or engineers.

Fig. 4 shows an electric elevator with push-button control. This type of elevator is designed particularly for private residences. No attendant is required, the elevator is always ready for service, and it is equipped with every safeguard which human ingenuity can devise against disability or accident. A passenger desiring to use the elevator presses a button placed near the elevator shaft, and the car, if not in use, immediately travels to that floor and stops automatically. When the car has come to rest at that floor, the door can be opened. The passenger then enters the car and closes the door. The car will not leave that floor unless the door is tightly closed. Inside the car there is a series of push-buttons numbered to correspond with the various floors. The passenger pushes the proper button and the car proceeds to the desired landing and stops automatically. Not until the passenger has left the car and closed the door can the elevator be controlled from any other floor. Should the passenger desire for any reason to stop the car at any point in its travel, he can do so instantaneously by pushing the safety button with which the car is provided.

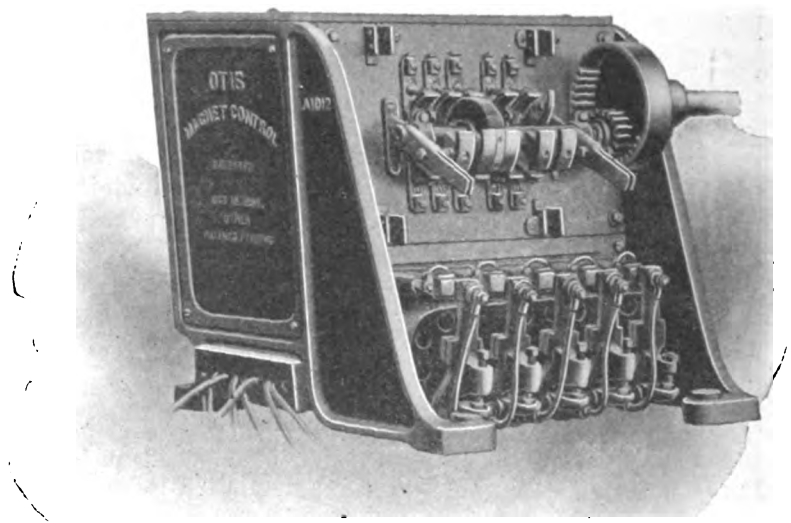

FIG. 2.—SEMI-MAGNET CONTROLLER FOR ELECTRIC ELEVATORS.

This type of elevator, although originally designed for private residences, has been installed with most satisfactory results in apartment houses, hospitals and

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other places where the service is intermittent and it is desired to do away with the expense of an attendant.

The long and varied experience in elevator manufacturing has enabled this company to produce an electric elevator which in operation has been preeminently successful. The company has in actual operation at this time more than 10,000 electric machines in the United States and foreign countries.

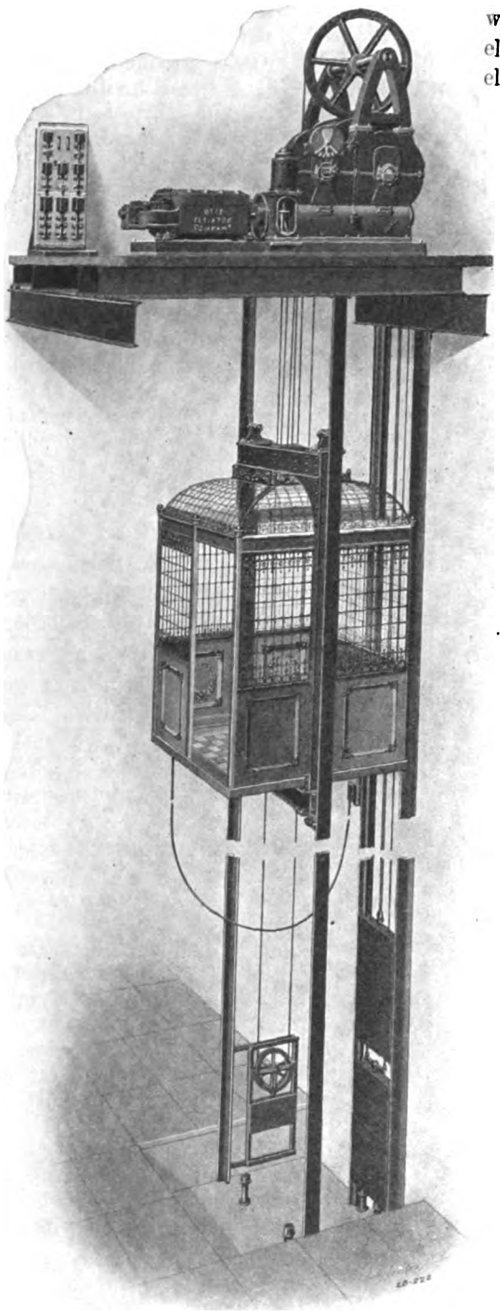

FIG. 3.—DRUM TYPE ELEVATOR ENGINE PLACED OVER HATCHES.

The illustrations herewith only give an idea of the elevator apparatus manufactured by this company. The company also makes electric elevator engines with single and double-worm gear, for both direct and alternating currents; electric dumb-waiter engines; internal geared electric freight engines; single-belt electric freight elevators; combination passenger and freight elevator engines; electric sidewalk hoists; vertical-cylinder hydraulic elevators; horizontal-cylinder hydraulic elevators; high-pressure inverted plunger hydraulic elevators; pulling plunger hydraulic passenger elevators; direct steam passenger elevators; steam belt freight elevators; safety devices, steam hoists for marine work; electric dock hoists; hydraulic ash hoists, and escalators.

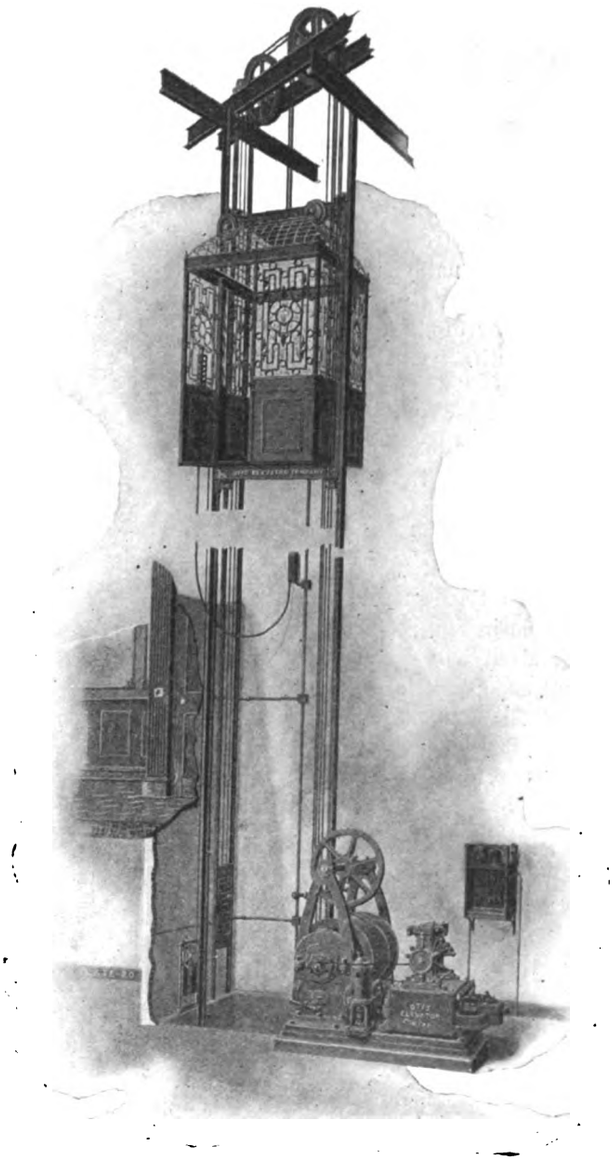

FIG. 4.—ELECTRIC ENGINE WITH PUSH-BUTTON CONTROL.

New Artificial Gutta-Percha.

A new concern has been started in England, with a branch in Germany, to manufacture artificial gutta-percha under the "Gentzsch" patents and rights.

If the material should indeed realize the eminently satisfactory reports which have so far been obtained, there ought to be a very large market for this product, especially in view of the ever-increasing demand and the shrinking supply of the natural product. A well-known European expert is quoted as saying:

"I have recently had an opportunity of seeing some further results obtained by the German post office with submarine and land cables insulated with this new dielectric, and these results fully bear out the claims made by the inventor for the favorable qualities of his products."

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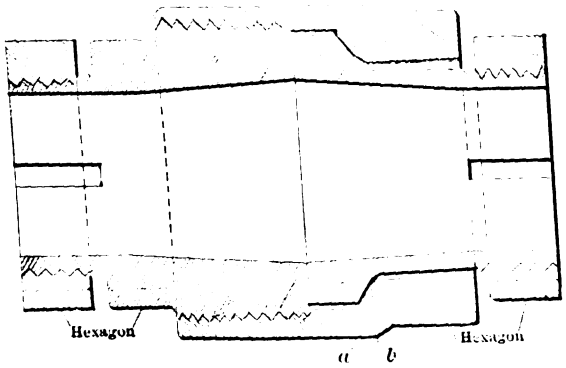
The Double Conical Cable Joint.

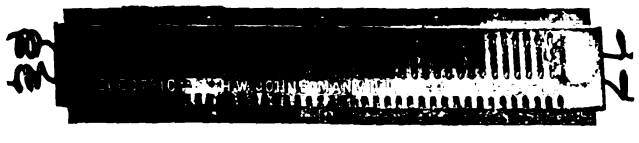
The Electric Cable Joint and Appliance Company, 13-21 Park Row, New York city, has placed on the market a



NEW TYPE CABLE JOINT.

new form of cable joint which is meeting with ready acceptation in both repair and original work. The prominent feature of this cable joint is the great area of contact which is allowed, and another feature of probably equal importance is the great rigidity and strength which is given the joint by the nature of its construction. The drawing herewith presents a sectional view of the cable joint. The joint in its entirety consists of five pieces, and the operation is as follows: The flanged nipple on the right-hand side is so arranged as to carry with it the enlarged sleeve, at the same time allowing the sleeve to have great freedom of movement, which is necessary when the joint is tightened up. The left-hand nipple carries two threads, the extreme left of the nipple having a slot cut diametrically for about half an inch of its length. A nut engages with a thread on the left end of this nipple, and when the cable is inserted the nut is screwed up on the nipple, which causes the nipple to grip the cable very securely. This operation is repeated with the right-hand nipple, and then with a punch or nail a small hole is made in each end of the cable to be joined. A soft commercial copper double conical plug is inserted one end in each end of the cable, and the thread on the outside sleeve is then engaged in the thread of the left-hand nipple, and the whole is brought up to a tight finish.

The following figures have been given,

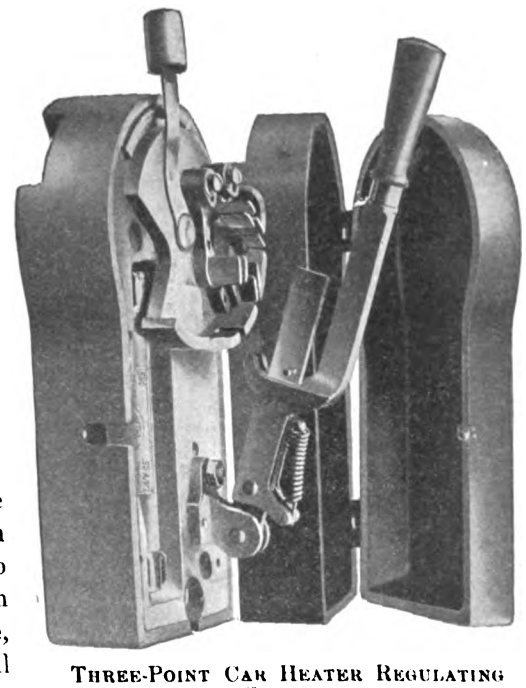


CAR HEATER FOR HEAVY CARS.

showing the large area of contact which this joint affords, and proving that the area is very much in excess of that of the cable itself. At the same time, the tensile strength of the joint, which is made of heavy brass casting, is greater than that of the cable in its best part. In the present instance a cable of 1,000,000 circular mils was measured. This cable had a diameter of 1.152 inches, giving an area of 1.042 square inches. The diameter of the cone is 0.5 inch, giving an area of 0.196 square inch. The area of the shell at *a* is 1.288, plus the cone area, 0.196, making an area of 1.484. The contact area at *b* exceeds 1.031, plus 0.196, giving an area of 1.227 square inches. The outside diameter of the joint is two and three-eighths inches, the total length of the joint being four inches. A number of tests have been made, which show no discrepancy in the drop across the joint with same length of the cable with which the joint is to be used.

Electric Car Heaters.

The H. W. Johns-Manville Company, New York city, is manufacturing a new



THREE-POINT CAR HEATER REGULATING SWITCH.

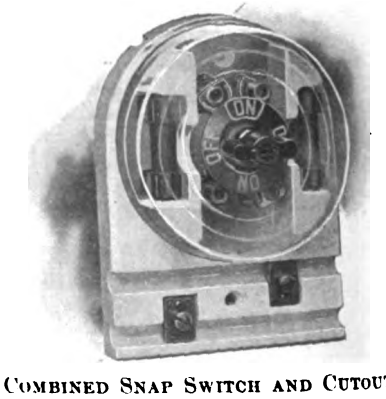
and desirable style of car heater for large interurban electric cars. The construction of this heater is similar to this company's well-known Class K heater, which has been on the market for several years and is used in cars having cross seats. Each heater is thirty inches in length and five inches in height, containing two three-quarter-inch double enameled angle irons held firmly in place by reconstructed granite heads or supports located at each end of the heater. These irons support the resistance coils and furnish superior insulation, thereby preventing short-circuits and the cutting out of resistance, due to contact formed by sagging coils. The casing is very strong and ornamental, and will stand a foot pressure without injury.

In order to meet the increasing demand of large electric cars requiring a greater number of heaters to satisfactorily heat them, the H. W. Johns-Manville Company is enlarging its three-point car heater regulating switch, increasing its capacity to sixty amperes and mounting in the insulating base block a Sachs "Noark" enclosed fuse. This complete controlling and protective device is now combined and enclosed in an iron box, requiring less room than heretofore and being absolutely safe and reliable under all conditions. Closing the quick-break knife blade automatically locks the switch, which is necessary before the cover of the box can be closed, and any movement of the regulator handles is prevented until the knife blade is released.

Combined Snap Switch and Cutout.

The accompanying illustration shows a new specialty which the Hart & Hegeman Manufacturing Company is placing on the market. This is a combined snap switch and cutout and is something entirely new among electrical devices. This device consists of a standard Hart double-pole switch mounted on a suitable procelain base, in connection with two cartridge fuses, all encased under one cover. The terminal clips into which the supply wires are placed are outside of the cover. The switch is furnished either with or without the fuses.

This specialty will be much appreciated by electrical contractors and wiremen. The new device will be found advantageous to control and protect motors, arc lamps and incandescent lamp circuits. It will also be found convenient for use as a service switch in small installations and for panel-board work. In factories and mills, and for general work where switches and cutouts can not be generally centralized, its use will be most economical, effecting a saving in wire and



COMBINED SNAP SWITCH AND CUTOUT.

cabinets. The manufacturer states that it is efficient, durable and safe, and has been approved by the Underwriters' National Electrical Association.

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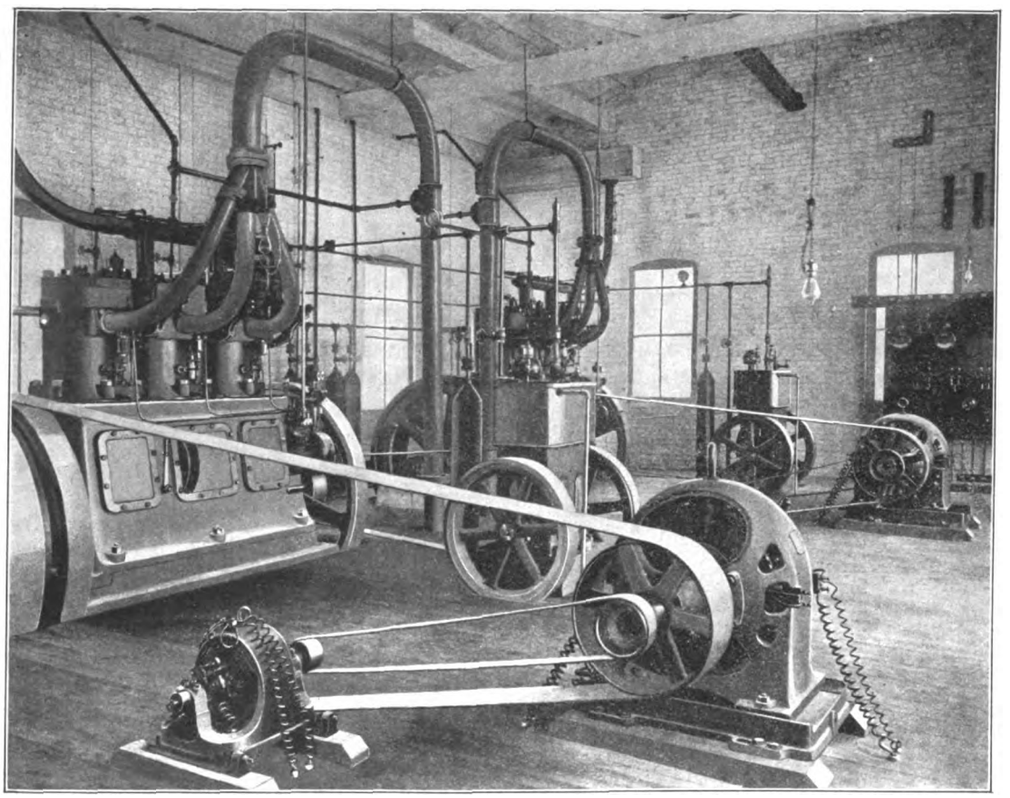
Municipal Electric Lighting Plant at Jewett City, Ct.

The municipal electric lighting plant at Jewett City, Ct., affords an interesting study of the application of a high-power internal-combustion engine for driving an electrical generator, to supply current for the lighting of a small town. Jewett City, Ct., is located on the Worcester division of the New York, New Haven & Hartford Railroad, about ten miles from Norwich. The plant was started about a month ago, and is the first central station in the United States to adopt the Diesel oil-burning engine. The use of this form of prime-mover does away with boilers, coal repositories, stokers, economizers or heaters.



THE MUNICIPAL PLANT AT JEWETT CITY, CT., TWO 75-HORSE-POWER AMERICAN DIESEL ENGINES, BELT DRIVING WESTINGHOUSE ALTERNATORS.

The lighting system at Jewett City, prior to the installation of the new plant, consisted of a sixty-kilowatt, Westinghouse, 2,200-volt, sixty-cycle, single-phase alternator, driven by water power from the Aspenock bleachery. Consideration was given to the claims made by the manufacturers of the Diesel engine, and the town authorities decided to erect a plant on the west bank of the Pachaug River. The plant is located in a brick building, one story high, and the length of the structure is thirty-seven feet eight inches, and its width, thirty feet eight inches. The height, from the top of the foundations to the monitor-capped roof, is about twenty-six feet. A small brick chimney about eight feet high carries away the exhaust which is discharged from the engine cylinders. Before the exhaust enters the chimney, the gases pass through a muffler. The interior of the station is all white, and good ventilation and light are provided by windows on every side.

While, at the present time, the plant consists of a single room, space has been provided for a small office in the northwest corner. A double door, five feet wide, is built in the west wall, to permit of easily transporting machinery either into or out of the building. It is likely that in a short time one corner of the room will be fitted up as a repair room.

Two storage tanks, set under ground near the station, with a combined capacity of 6,500 gallons, supply oil for the engines. The crude oil is brought to the plant in tank wagons holding 640 gallons, and costs 4.6 cents per gallon delivered. The oil is pumped from the main tanks to a vertical tank holding forty gallons, and from this tank it is supplied to the engines.

Two fifty-kilowatt, Westinghouse, single-phase, 2,200-volt, sixty-cycle alternators are belt-driven by two seventy-five brake-horse-power, triple-cylinder, Diesel oil engines of the vertical marine type. The engine cylinders are of fifteen-inch stroke and ten inches in diameter, and the indicated horse-power of each engine is about 100.

These engines are built for the American Diesel Engine Company, 11 Broadway, New York city, by the International Power Company, Providence, R. I. The engines operate on the well-known Otto cycle of admission, compression, combustion and exhaust. They differ radically, however, from the ordinary gas and oil engines in the character of the combustion. This engine has three distinctive characteristics—first, the contents of the cylinder during the compression stroke is air only, and the temperature due to compression is considerably above that which is necessary to ignite the combustible charge; second, the clearance is only about seven per cent of the cylinder volume, and in this space is confined, under great pressure, more than enough air to supply oxygen for the combustion of any amount of fuel the engine is designed to use; third, the combustion of the fuel is not an explosion, but it burns as fast as injected into the cylinder, without increasing the pressure produced by compression.

The temperature due to compression ignites the combustible charge and does away entirely with the need of an electric spark or ignition tube apparatus.

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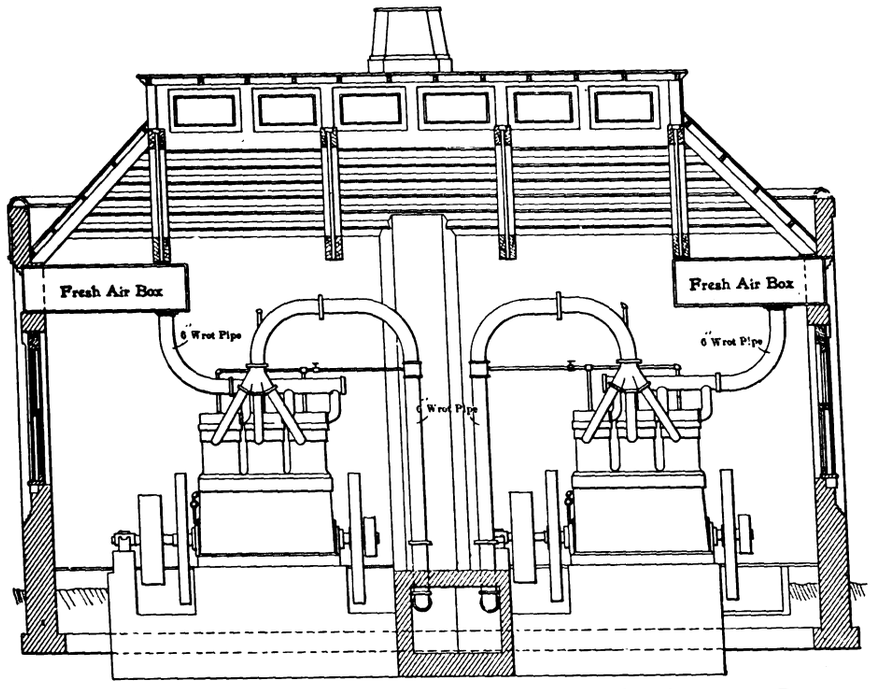
The valve-operating cams are on the usual secondary shaft, driven by the main shaft through an intermediate gear. The admission and exhaust valves are driven by two of these cams. The movement of valve rod and its corresponding arm depends the length of time the valves are open and the consequent duration of oil supply for combustion purposes.

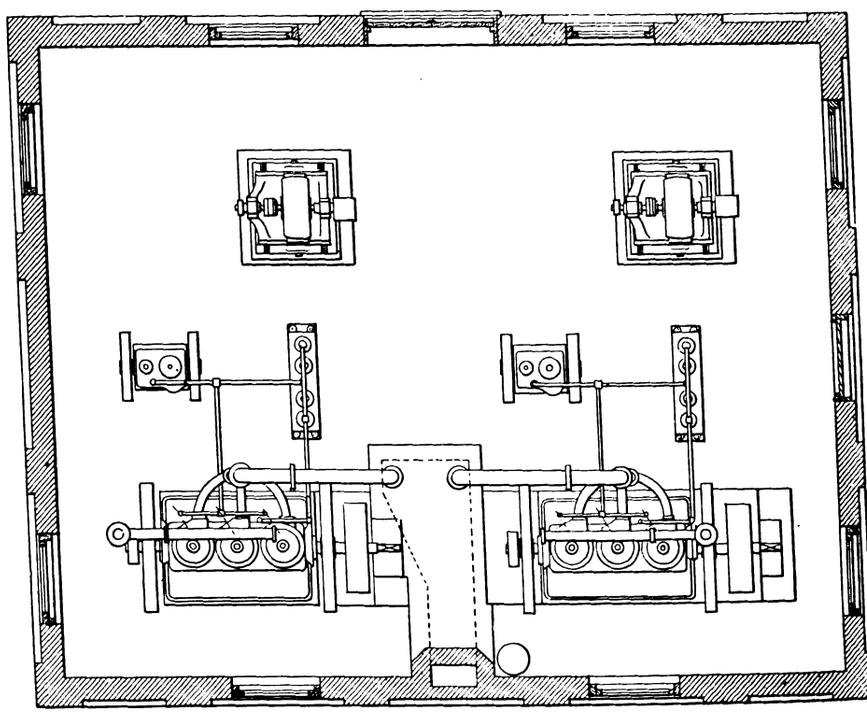
After the fuel valve closes, the gases work expansively, and the atmospheric and terminal pressures differ but little.



ELEVATION AND ARRANGEMENT OF ENGINES, JEWETT CITY, CT., MUNICIPAL PLANT.

the admission valve particularly is very slight. The oil is driven into the cylinders by compressed air through a series of perforated brass washers, and enters the cylinders in the form of a fine spray. An auxiliary air compressor, driven by belt from the engine, supplies the air for this purpose. The air which supports the combustion is drawn into the cylinder through an automatic mushroom valve, and is compressed on the up-stroke to between 450 and 525 pounds pressure per square inch, corresponding to a temperature of about 1,000 degrees Fahrenheit. The fuel valve is open for about one-tenth of the working stroke, and the fuel is let in and consumed during the whole or a part of the period, as determined by the action of the governor. At the termination of the fuel supply, the resulting gases of combustion work expansively during the remainder of the stroke.

The fuel oil is delivered to the fuel admission valve by a pump driven from the cam shaft. One pump cylinder is provided for each of the main cylinders, and back of each is a by-pass valve which, when open, allows the oil to flow again to the suction side of the pump instead of to the valves. The length of time that these by-pass valves are open is controlled by the governor. Upon the relative distance between the top of each



PLAN VIEW OF JEWETT CITY, CT., MUNICIPAL PLANT.

The effect of the compressed air used to inject the fuel is inappreciable. The admission valve is open a constant length of time, but the fuel supply is controlled by the governor, so that only at full load is it injected into the cylinder during the entire period that the valve is opened.

The engine resembles, in outward appearance, the ordinary marine type of steam engine. The connecting rod is carried directly to a pin inside the piston, and the reciprocating parts are all enclosed within an engine housing. Automatic lubrication is used, and a reservoir is provided at the lower part of the housing which serves as a bath into which the connecting rod crank end plunges at each revolution. The machines are provided with double flywheels, in addition to the driving wheel.

The engines are started by compressed air from auxiliary reservoirs which are filled by an engine-driven compressor. A starting valve is opened, which admits compressed air to drive the piston for two or three revolutions, after which the compression in the cylinder is sufficient to ignite the charge. The starting cam is thrown out of action automatically as soon as the admission and exhaust valve mechanisms are thrown in. Enough air is always stored in these reservoirs to enable the plant to start with ease.

The accompanying drawings show the plan and elevation of the station. The auxiliary reservoirs are not shown located exactly as finally installed, but essentially no feature has been changed. On the east side of the building, just outside of the engine room wall, is located a wooden water tank with a capacity of 7,000 gallons. The water from this tank is circulated through the jackets of the engines, and is used over and over again. Each engine drives a small pump beneath the floor, which replenishes the tank when necessary.

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The two alternators are mounted on timbers, and each is compound-wound, driving its exciter by belt. The exciters are each 1.5-kilowatt, 125-volt machines, and run at 1,300 revolutions per minute. These are also mounted on short timbers. The wiring from machines to the switchboard is carried below the floor level, and all 2,200-volt circuits are run in lead-covered cable.

The switchboard is composed of two panels of marbleized slate supported by a steel tubing frame, and is located on the south side of the room. The board is eight feet long and five feet high. Each machine is protected by an Elden circuit-breaker, which is modified so as to short-circuit the compounding winding at the rectifier after the exciter circuit has been opened automatically. Each panel contains a voltmeter and ammeter in addition to the circuit-breaker, and a double-throw, double-pole, interlocking switch for connecting the commercial circuits to either alternator. In addition, one panel carries two double-pole, single-throw exciter main switches and a double-pole, double-throw, horizontal station lighting switch, which throws the twelve and sixteen-candle-power incandescent lamps which illuminate the plant upon either exciter.

One of the panels also contains a double-pole, double-throw, quick-break switch for connecting the series street lighting incandescent circuit with either alternator. To provide against excessive voltage at the lamps in case if any one of the series lamps should burn out, and short-circuit through the base, six lamps have been installed on one of the panels in connection with a radial switch, which throws them in circuit, one by one, as may become necessary to replace burned-out lights. The street lighting circuit is also provided with an indicating ammeter. Rheostats for the alternator fields are to occupy the lower central portion of one panel of the switchboard.

At present there are two single-phase commercial circuits supplying house-to-house transformers, and one street series circuit made up of thirty-candle-power, 5.5-ampere incandescent lamps. The total connected load is equivalent to about 2,000 sixteen-candle-power lamps at present, and there are no direct-current circuits in the town.

Some interesting figures are shown in the economy of operation by the Diesel engine. The machines in this plant are guaranteed to operate on 0.47 pound of oil per brake-horse-power-hour at full load, and on 0.5 pound of oil per brake-horse-power from friction load to full load. With oil at 4.6 cents per gallon, this means about one cent per kilowatt-hour, including wages and supplies, the attendance being very small. The electrical apparatus was installed by H. B. Rust & Company, of Providence, R. I., and the engine and engine appurtenances were erected and furnished by the American Diesel Engine Company.

THE CONVENTION OF THE AMERICAN STREET RAILWAY ASSOCIATION.

THE TWENTY-SECOND ANNUAL MEETING, TO BE HELD AT SARATOGA SPRINGS, N. Y., SEPTEMBER 2, 3 AND 4.

The twenty-second annual meeting of the American Street Railway Association will be held at the Grand Union Hotel, Saratoga Springs, N. Y., Wednesday, Thursday and Friday, September 2, 3 and 4. The secretary has requested the chief executive officers of the different companies to notify all delegates and heads of departments attending the convention that they are expected to be present at all sessions of the meeting and take part in the discussions.

Saratoga is a very popular city for conventions, and the railroad men of this territory are anxious that a great showing may be made, and to this end elaborate preparations have been under way for the proper entertainment and disposition of all those present. A long programme has been arranged, and a number of papers will be presented for reading and discussion. The following subjects have been announced:

"Electric Welded Joints."

"The Evils of Maintenance and Champerty in Personal Injury Cases."

"Train Orders and Train Signals on Interurban Roads."

"Freight and Express on Electric Railways."

"The Manufacture and Distribution of Alternating Currents for City Systems."

"Comparative Merits of Single and Double-Truck Cars for City Service."

"The Right of Way."

An exhibit of street railway supplies will be held at the Grand Union Hotel, which will be the headquarters of the convention. Other first-class hotels are the United States, the American-Adelphi, Congress Hall, Worden and Kensington.

Among those who will occupy space in the exhibit parlors and have already made announcement will be the H. W. Johns-Manville Company, of New York city. This company's exhibit will occupy space No. 67, and its exhibit will consist of the latest developed devices pertaining to the Sachs "Noark" enclosed fuse apparatus, there being a number of large capacity fuse and service boxes, as well as several new designs of fuses. A very complete line of the latest up-to-date overhead line material, ears, clips, trolley wheels, insulated and metallic crossings and section insulators will be on display, as well as a complete line of electric car heaters. The souvenir this year will be a very attractive and useful keepsake. Those in attendance for the company will be J. W. Perry, manager electrical department, New York; J. E. Meek, New York; H. M. Voorhis, of the Philadelphia office, and James Humphreys, of the Boston office. The representatives of the Johns-Pratt Company, manufacturer of overhead line material, special insulating material and Sachs "Noark" enclosed fuse devices, of which the H. W. Johns-Manville Company is the sole selling agent, who will attend the convention are E. B. Hatch, president; Joseph Sachs, electrical engineer; J. C. Howell, purchasing agent, and W. H. White, superintendent.

The officers of the American Street Railway Association are:

President, Jere C. Hutchins, Detroit, Mich.

First vice-president, W. Caryl Ely, Buffalo, N. Y.

Second vice-president, W. Kelsey Schoepf, Cincinnati, Ohio.

Third vice-president, P. S. Arkwright, Atlanta, Ga.

Secretary and treasurer, T. C. Penington, Chicago, Ill.

The executive committee, in addition to the officers named above, is composed of the following:

Herbert H. Vreeland, New York city; Richard T. Laffin, Worcester, Mass.; Andrew Radel, Bridgeport, Ct.; Walter P. Read, Salt Lake City, Utah; Willard J. Hield, Minneapolis, Minn.

The International Association of Municipal Electricians.

The eighth annual convention of the International Association of Municipal Electricians will be held at Atlantic City, N. J., September 2, 3 and 4. The headquarters of the association will be at the Hotel Rudolf. Members and friends who desire to go *via* New York city should communicate with F. C. Mason, chairman of the committee on transportation, 16 Smith street, Brooklyn, N. Y. The train will leave foot of Liberty street, *via* Central Railroad of New Jersey, at 3.40 P. M., Tuesday, September 1. An interesting programme has been outlined. In addition to the social and entertainment features there will be given a lecture on wireless telegraphy by A. Frederick Collins, of New York, illustrated by apparatus and lantern slides. There will also be a demonstration of the Cooper Hewitt mercury vapor lamp and static converter, by Dr. Max von Recklinghausen and Percy H. Thomas. The associate members of the association will make an exhibit of apparatus at the Hotel Rudolf during the convention.

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CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

A $2,000,000 CONSOLIDATION—The Worcester & Southbridge Street Railway Company, the Worcester, Rochdale & Charlton Depot Street Railway Company, the Southbridge & Sturbridge Street Railway Company, and the Worcester & Southbridge Development Company, with the Pinehurst Park and Hotel Overlook properties, are to be consolidated. The capitalization of the new corporation will be over $2,000,000, and it will be known as the Worcester & South bridge Railway Company. The consolidation of these three Massa chusetts street railways with the Worcester & Southbridge Development Company was decided on after a meeting of the directors of the roads last week.

EXTENSIVE MEXICAN ELECTRICAL SYSTEM—Announcement has been made of a project to build a 60,000-horse-power plant in the state of Jalisco, Mexico. The scheme includes the supplying of the city of Guadalajara with light and power and the building of electrical lines within a radius of some 100 miles of that city. The American syndicate, in which it is said W. A. Rogers, vice-president of the West Coast Land and Lumber Company, New York, is the leading spirit, has secured a concession to develop water power along the Santiago River, state of Jalisco, for a distance of about seventeen miles. San Cristobal, a town located about four miles from Guadalajara, will be the site of the principal station. It is expected to have 10,000 horse-power available in about one year.

CAPITAL RAISED FOR THE SUSQUEHANNA POWER DEVELOPMENT—The statement has been made that the Susquehanna Power Company, which was recently incorporated for the purpose of utilizing the water power of the Susquehanna River and conveying electric energy for use in Baltimore, Md., has secured subscriptions to nearly $10,000,000 of its capital. It is now announced that the company is about to sign a contract with a large electrical manufacturer for machinery involving an expenditure of from $2,500,000 to $3,000,000. The engineers and others identified with this project have been busy for the past six months making exhaustive investigations for northern and New England capitalists. Three developments of 50,000 horse-power each are planned, and it is said that the details of construction have been completed. The power company will furnish current to the United Railways and to the United Electric Light and Power Company.

THE PIKE'S PEAK, COL., DEVELOPMENT—Three miles of twenty-one-inch piping have been delivered on the ground of the Pike's Peak power plant being built on the east slope of Pike's Peak at a reported cost of $1,000,000. General Manager Taft is in Manitou overseeing the arrival of the first consignment at that point, and as fast as the piping is received it will be conveyed to the Half-way house and laid in the trenches already prepared for its reception. The pipe will be used to convey the city water from a point above the Half-way house through three miles of steel conduits to the power-house where the water will be dropped 2,240 feet. The water will pass through turbine wheels, generating 3,000 horse-power which will be used to operate the mills and industrial plants in Colorado Springs and adjacent cities. Work on making the excavations for the foundations of the new power-house is progressing rapidly, and by the middle of the month the first course of stonework will be put in.

WALES (ENGLAND) POWER COMPANY ORGANIZED—An important power plant has been projected by the North Wales (England) Power and Traction Company, which has just been organized in London with a capital of $1,350,000. It is proposed to generate electricity by means of water power from the lake in Snowden and in the neighborhood of Conway. The current will be supplied to a short railway and to certain towns in the district of Snowden to local quarry owners, and in bulk to more distant consumers. is the intention of the company to tap Lake Llydaw, which lies the eastern slope of Snowden, at an elevation of 1,416 feet ab sea level. This lake is just over a mile in length, and avera about a sixth of a mile in width. This is equal to an area of al 5,500,000 square feet. It collects rain-fall from an area of al 47,000,000 cubic feet, and the average rain-fall in this territor estimated at 170 inches per annum. A dam 150 feet long is t built across a portion of the lake, raising the water twenty The lake can be tapped thirty feet below its present level or feet below the proposed level, which is estimated to be equiva to a storage of at least 250,000,000 cubic feet of water. The loca of the generating plant will be at a point 1,200 feet below the with which it will be connected by steel pipes. It is estimated 6,000 horse-power will be developed for ninety days, indepen of any rainfall and permanent streams during that time.

THE RESERVOIR AT SPIER'S FALLS, N. Y., FILLED—large reservoir formed by the dam at Spier's Falls, on the Hu River, ten miles north of Glens Falls, has been successfully The flow of the Hudson River was effectually stopped for twenty-four hours. A fortunate coincidence in closing dow this period was the fact that heavy rains had been falling i upper Hudson valley, and the opening of the Indiana River dam. Below Spier's Falls for a considerable distance the b the river ran dry, and at Glen's Falls, Sandy Hill and Fort E all the mills were compelled to shut down. This was take vantage of, however, by the different mill owners to effect a ber of repairs to the masonry and sluiceways. The dam at Falls is of white granite, 157 feet deep, 115 feet broad at the twenty-two feet thick at a point eight feet below the top, and feet in length from shore to shore. The reservoir created dam is some five miles long and a third of a mile wide. T take canal for the power-house is on the east end of the da extends 120 feet to the power-house below the dam and a angles with it. At the entrance it is 130 feet wide in the with a current of water twenty feet deep. The dimensions power-house are 392 feet by seventy feet, with a height of eight feet to the eaves. There will be ten head-gates reg the water, each ten feet wide. Through the wall of the can of the power-house are the openings for the penstocks, each feet in diameter, through which the flow is delivered to bine wheels below. The power-house is divided into th tions—the wheel room, the generator room and the tran room. The wheel room is located on the east side, and ext most the entire length of the building. The ten pairs o wheels are located here, each pair capable of generating 5,0 power under an eighty-foot head. These wheels are contr various types of governors, so that they will run at pr constant speed for all changes of load. The wheels are se feet above the water in the tail-race, and are connected tail-race by means of air-tight draft tubes. The general is directly west of the wheel room and is divided from t room by a brick partition. This will be equipped with eig kilowatt and two 2,000-kilowatt, three-phase, 2,000-volt, f generators, each direct-connected to a pair of water-wh the same room are two 150-kilowatt and one 300-kilowatt exciters, each direct-connected to an individual water-wh transformer room is at the south end of the building an feet by seventy feet. In this room are located thirty 83 and six 770-kilowatt, air-blast, step-up transformers, with sary motors and blowers for furnishing air. Current wi erated at 2,000 volts and carried through cables laid in du the floor of the power-house to the step-up transforme the voltage will be raised to 30,000 volts, and the current be transmitted through feeders to various centres of di located within a radius of forty-five miles from Spier' Troy, Albany, Schenectady and intervening towns and ci

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PERSONAL MENTION.

MR. JOSEPH P. DEVINE, president of the National Battery Company, Buffalo, N. Y., spent a few days last week in New York city.

MR. GEORGE A. McKINLOCK, president of the Central Electric Company, Chicago, Ill., has been visiting New York city during the past week with his family.

MR. W. J. PHELPS, manager of the Phelps Company, Detroit, Mich., manufacturer of the famous "Hylo" incandescent lamp, has been spending some time in Chicago.

SIR WILLIAM PREECE, whose serious illness was mentioned several weeks ago, is understood to be convalescing rapidly, and the latest news is of such a reassuring character that it is expected he will soon be able to resume his practice.

MR. W. F. WEISS, 128 Broadway, New York, who is well known throughout the electrical industry as a public accountant, having acted in this capacity for a good many years with different electrical companies, has recently been appointed receiver for quite a large company. This is almost a precedence as the courts have seldom appointed an accountant as a receiver, and the appointment is considered a tribute to Mr. Weiss's ability and integrity.

MR. C. L. HIBBARD, who for the past few years has been Chicago representative of the Varley Duplex Magnet Company, has tendered his resignation, to take effect September 1. Mr. Hibbard will take charge of a new company which will manufacture and handle several electrical specialties. The name of the company will be announced later. The Chicago office of the Varley company will temporarily be in charge of Mr. William Balke, who for the past five years has been chief inspector at the factory of the Varley company.

MR. WILLIAM J. HAMMER, the well-known consulting engineer of New York city, with Dr. Amon Jenkins, of New York city, has undertaken a series of highly interesting experiments, using a combination of radium rays and Rœntgen rays, to stimulate and bring about a normal action in the paralyzed optic nerve. Several experiments which were performed on an eleven-year-old child in New York city recently have been commented on with great interest. Concerning the latest developments of these experiments, neither Mr. Hammer nor Dr. Jenkins was willing to prophesy any permanent benefit as a result of their work.

NEW INCORPORATIONS.

CAMDEN, N. J.—The General Traction Company. $1,000,000.

AUSTIN, TEX.—Pilot Point Light and Power Company. $30,000.

DES MOINES, IOWA—The Butler County Telephone Company. $10,000.

SARATOGA SPRINGS, N. Y.—Comstock Telephone Company. Increased from $500 to $1,500.

MERIDEN, CT.—The Connecticut Telephone and Electric Company. Increased from $36,000 to $45,000.

RALEIGH, N. C.—Troy Telephone Company. $100,000. Incorporators: J. R. Blair, O. M. Wade, W. A. Cochran.

JOHNSTOWN, OHIO—The Johnstown & Canton Telephone Company. Increased from $30,000 to $50,000.

SPRINGFIELD, ILL.—Alloway Electric Company. $2,500. Incorporators: Wilmore Alloway, Harry Alloway, Edward McMahon.

MILWAUKEE, WIS.—Eau Claire County Telephone Company. $5,000. Incorporators: C. A. Silkworth, J. J. Osborne and M. Cousins.

SCANDINAVIA, WIS.—Scandinavia Telephone Company. $1,500. Incorporators: George C. Willson, A. M. Peterson and O. H. Grenlie.

CLYDE, OHIO—Farmers' Telephone Company. $10,000. Incorporators: F. S. Johnson, F. Hutchinson, S. Decker, F. Royce, D. H. Good, C. C. Wright.

MARION, IND.—The Sims Cooperative Telephone Company. $7,500. Incorporators: Chauncey B. Knowlton, Edward Gillenwater, H. C. Haines and Isaac Rust.

WESTVILLE, N. Y.—Westville Telephone Company. $1,000. Incorporators: F. Green, A. Baldwin, T. Gurney, E. B. Coats, M. A. Stilwell, J. M. Cady and K. H. Baldwin.

TELEPHONE AND TELEGRAPH.

DAVEY, NEB.—The Nebraska Telephone Company will build a new line from Davey to Lincoln.

AUSTIN, TEX.—The Austin Telephone Company has increased its capital stock from $18,000 to $60,000.

WYOMING, ILL.—The Milo & Bradford Telephone Company has increased its capital stock from $5,000 to $20,000.

WILLIAMSON, N. Y.—The Rochester Telephone Company has established a local telephone system in Williamson.

WATERLOO, IOWA—The Iowa Telephone Company has secured permission of the city to place its cables underground.

PORTLAND, ME.—The selectmen of the town of Gorham have granted pole rights in that town to the Northeastern Telephone Company.

BRUNSWICK, MD.—The Chesapeake & Potomac Telephone Company is considering the plan of installing a telephone exchange in this town.

NORFOLK, NEB.—The Nebraska Telephone Company is preparing to rebuild its exchange in this city. Improvements will cost about $15,000.

SPRINGFIELD, ILL.—The Chesterfield Telephone and Telegraph Company, of Chesterfield, has been incorporated with a capital of $15,000.

CANAAN, CT.—The Farmington Valley Telephone Company, of New Britain, has filed a notice of an increase of capital stock from $10,500 to $27,000.

WARWICK, N. Y.—The Warwick Valley Telephone Company's lines are now connected by a metallic copper circuit, *via* Goshen, with the Orange County company at Middletown.

OLD TOWN, ME.—The Riceville Telephone Company has completed a line from Hancock Tannery to Greenfield and Cardville, connecting with the lines of the New England Telephone Company at Costigan.

INDIANAPOLIS, IND.—The Fisher Telephone Company, of Hamilton County, has been incorporated with a capital of $5,000. The directors are T. A. Fisher, T. A. Beaver, J. A. Noury, N. G. Manship and A. C. Harrison.

NEW YORK, N. Y.—Police Commissioner Greene has contracted with the New York Telephone Company for 661 outside telephones in the Borough of Manhattan, and with them a complete system of reporting to precincts will be inaugurated. The cost will be $20,855.20 a year.

CLEVELAND, OHIO—A telephone company has been organized in the eastern part of the county, with the following officers: R. A. Kerr, president; Dr. H. Davison, vice-president; J. N. Fraham, secretary; C. C. Kreps, treasurer. The company will confine its operations to Westminster, West Newton and vicinity.

HIBBING, MINN.—A complete telephone system has been installed by the Great Northern Railway Company on its line between Superior and all range towns. Telephones have been installed at Brookston, Fox, Ellis, Buhl, Chisholm, Hibbing, Mahoning, Kelly Lake and Virginia. The company's object is to relieve the telegraph wires as much as possible.

PATCHOGUE, L. I.—The Suffolk County Telephone Company has been incorporated to extend a telephone line along the south side of Long Island from Amityville to Montauk, and Patchogue has been asked to grant the company permission to erect its poles within the village limits. The directors of the company are H. Clay Losee, County Judge Walter H. Jaycox, Fremont Hammond, Joseph T. Losee, Moses F. Tiger, all of Patchogue, and Ralph C. Greene, of Sayville.

ALBANY, N. Y.—At a recent meeting of the stockholders of the Hudson River Telephone Company, it was voted to increase the capital of the corporation from $4,000,000 to $5,000,000. The increase will be used for extensions and improvements. The Howell Telephone Company, whose lines connect Monroe and Blooming

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Grove, has made arrangements to cooperate with the Hudson River company. This will give the latter company a direct line from Washingtonville to Monroe and an additional circuit from Middletown to Newburgh.

LITTLE ROCK, ARK.—The Little Rock exchange of the Southwestern Telegraph and Telephone Company is installing 500 additional wires to the present switchboard of 2,599 wires, which will give it a total of 3,099 wires. The company is gradually extending its system to all parts of the state and taking over the companies in the smaller towns through which the lines run. Recently it purchased the exchange at Forrest City, and is now putting it in first-class shape. A new line has been opened from Augusta to Bald Knob, from Walnut Ridge to Black Rock and Powhatan, and construction has been begun on a line from Walnut Ridge to Pocahontas.

ELECTRIC RAILWAYS.

LITTLE FALLS, N. Y.—The Blue Ridge Traction Company has filed in the office of the recorder of deeds at Easton thirteen extensions of its route, aggregating about forty-nine miles.

ALBANY, N. Y.—The United Traction Company's line from Albany to Troy has been opened. Cars will run every hour and will go direct to Saratoga, the trip consuming about three hours.

DES MOINES, IOWA—The Council Bluffs, Tabor & Southwestern Electric Railway Company has been incorporated with $200,000 capital stock, to build an electric railway from Council Bluffs to St. Joseph.

PUEBLO, COL.—The Pueblo & Suburban Traction and Lighting Company is making many improvements to its system. Its power line from the mountains is now almost completed, and parts of its lines are now being practically rebuilt.

NEWPORT NEWS, VA.—The Hampton Roads Railway and Electric Company has filed a mortgage on its plant for $300,000, to cover a bond issue of that amount. The bonds are issued for the purpose of making extensive improvements.

SHAMOKIN, PA.—The Shamokin Railway Extension Company has been organized by Shamokin and Philadelphia capitalists. They purpose building an electric railway from Sunbury to Shamokin. It will be an electric express company, chartered to haul passengers, baggage and freight.

CARLISLE, PA.—It is stated to be certain that the trolley road to connect Carlisle with the battlefield of Gettysburg will be built. The line is already completed to Mount Holly, a distance of six miles, from which place the road will go to Zion Church, Bindersville, Biglersville and Gettysburg.

WORCESTER, MASS.—It is stated that a direct trolley line connecting Providence and Worcester is contemplated. Two routes between Worcester and the Rhode Island city are being surveyed, either of which will reduce the distance between the two cities thirty-eight miles. It is understood that the proposed route will be completed within a year.

JACKSON, MISS.—A project is under way to construct an electric railroad between Jackson and Vicksburg in the near future, by a company composed of New York, Chicago and local capitalists. The distance between the two cities is forty-five miles, and the engineers who have surveyed the route estimate that it will cost $15,000 per mile to build the line.

RICHMOND, VA.—Active work has been begun on the rehabilitation of the entire system of the Virginia Passenger and Power Company in this city and Manchester, which, when completed, will cost in the neighborhood of $500,000. The Seven Pines road is to be completely rebuilt, and the Lakeside, Forest Hill and Hull street lines to be thoroughly renovated.

MUNCIE, IND.—It has been announced by an official of the Muncie & Portland electric line, a branch of the Indiana Union Traction Company's system, that work will not be begun on the line before the end of the year. This delay is caused by the fact that the lines between Indianapolis and Logansport, Indianapolis and New Castle, Alexandria and Muncie, and Anderson and Franklin, must all be completed by January 1, 1904, according to their franchises.

GREENSBURG, IND.—It is reported that the capital for the construction of the Madison, Greensburg & Indianapolis traction line has all been subscribed, and that construction work will begin by June, 1904, and be completed within two years. The length of the line is forty-nine miles, and it will run from Madison, through Rexville, Versailles, Osgood, Napoleon and on to this city, where it will connect with the Indianapolis, Shelbyville & Southeastern Company's lines.

BRISTOL, TENN.—The Cumberland Transportation, Light and Power Company has been organized for the purpose of operating a system of trolley car lines in the coal fields of southwest Virginia. The main line proposed is to run from Coeburn to Toms Creek, thence to Wise, Norton, Esserville, Dudlick, Appalachia, Looney Creek and Big Stone Gap. The line will cover a distance of thirty miles of the most thickly settled portion of the mining districts of Wise County, Va.

FRANKFORT, KY.—The Madisonville Traction Company, of Jefferson County, has filed articles of incorporation with the Secretary of State. The capital of the company is $100,000, and Joseph Huffaker, W. H. May, C. C. McCarty, J. O. Duncan and O. B. Bates are the incorporators. The company will construct an electric railway line from Madisonville to Earlington, in Hopkins County, a distance of five miles; from Earlington to Nortonsville, six miles; from Nortonsville to White Plains, eight miles.

EASTON, MD.—The Eastern Shore Transport Company is said to contemplate building a trolley line from Cambridge Ferry to Wye Station on the Queen Anne's Railroad. A ferryboat will run from Cambridge to Cambridge Ferry, connecting with the trolley road. The line, which will be twenty-four miles long, will pass through a thickly settled section of Talbot County. It will connect the towns of Cambridge, Easton, Trappe, Longwood, Skipton and Wye Mills, by way of the Queen Anne's Railroad, with Baltimore and Philadelphia.

MACON, GA.—The Secretary of State has granted a charter for the Atlanta Interurban Railroad Company, with a capital stock of $100,000, with the privilege of increasing the amount at any time to such a sum as may be deemed necessary by the board of directors. The purpose of the company, as set forth by the petition, is to build an electric line from the Chattahoochee River, at a point near Collier's Bridge, to Smyrna, and from there to Marietta. The petitioners named in the application for the charter are officers and employés of the Atlanta Railway and Power Company, and it is believed that the latter company is interested in the project.

AUSTIN, TEX.—The charter of the Beaumont, Sour Lake & Port Arthur Traction Company has been filed by the Secretary of State. The principal offices are to be located at Beaumont, and the capital stock of the company is $300,000. The company will construct an electric line from Port Arthur to Beaumont, and thence to Sour Lake, in the counties of Jefferson and Hardin. The incorporators are C. W. Meeks, Houston; W. A. Smith, H. E. Smith, Theodore Weyant, Columbus, Ohio; John B. Linn, Springfield, Ohio; George A. Hill, Austin; George M. Craig, Port Arthur; B. R. Norvell, William Weiss, George W. Carroll, George W. O'Brien, W. C. Averhill, R. C. Duff, Beaumont.

PITTSBURG, PA.—Charters have been granted to the Coraopolis & Aliquippa Electric Street Railway Company and to the Monaca & Aliquippa Electric Street Railway Company, which propose to build important links in the trolley system connecting Pittsburg with the Beaver Valley. The former company has a capital of $30,000, and will build five miles of road, beginning on the public highway in Shousetown, Crescent Township, Allegheny County, and extending through Shousetown, Stoops Ferry and Coraopolis. The latter company will build ten miles of road, beginning at Monaca, Beaver County, and extending through the townships of Moon and Hopewill to Aliquippa, and has a capital of $60,000. William Redwood Wright, of Philadelphia, is president of both companies. The construction work will begin early in the fall.

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ELECTRICAL SECURITIES.

According to the sentiment of the commission houses, there has been a decided falling off in the attention which the speculative public has given to the stock market during the past week. This, however, is a normal condition, and was looked for to follow the rapid increase in speculative values which set in about a week ago. Several large interests made a determined stand for a lowering of values early in the week, and the success which was met with was all that could be expected. While this pressure materially reduced the standing of some strong securities, still there is a very decided bullish sentiment among professional traders at large.

Railroad stocks have shown more than usual activity, and the trading in one or two strong securities has been remarkable for the extent of manipulation and the strength which developed under considerable pressure. This has been brought about probably by the continued good showing which railroad earnings are making.

Trade reports covering all sections of the country have been uniformly good, and only where statistics show a reaction consequent upon the heavy volume of business which has been evidenced during the last twelve months has there been any failure to witness a healthy condition.

ELECTRICAL SECURITIES FOR THE WEEK ENDING AUGUST 22.

New York:	*Closing.*
Brooklyn Rapid Transit	44¼
Consolidated Gas	177
General Electric	162
Kings County Electric	160
Manhattan Elevated	133¼
Metropolitan Street Railway	113¼
New York & New Jersey Telephone	150
Westinghouse Manufacturing Company	170

Boston:	*Closing.*
American Telephone and Telegraph	134
Edison Electric Illuminating	235
Massachusetts Electric	79
New England Telephone	126
Western Telephone & Telegraph preferred	80

The American Telephone and Telegraph Company's statement of output of instruments for July shows the total number of instruments outstanding to be 3,540,321, an increase of nearly 400,000 since December, the close of the last fiscal year. The expenditures for construction so far this year, at about $60 per instrument, have been something like $25,000,000. This compares with $37,336,000 for the twelve months of the last fiscal year.

Philadelphia:	*Closing.*
Electric Company of America	8⅛
Electric Storage Battery common	55
Electric Storage Battery preferred	55
Philadelphia Electric	6⅜
Union Traction	43⅞
United Gas Improvement	83¾

It is stated that the surplus earnings of the Philadelphia Rapid Transit Company for the fiscal year ended June 30, 1903, after deducting $500,000 for improvements and fixed charges, including Union Traction 3 per cent guarantee, were about $400,000. The gross earnings were nearly $15,400,000, compared with $14,118,158 in 1902 and $10,381,015 in 1896.

Chicago:	*Closing.*
Chicago Telephone	120
Chicago Edison Light	140
Metropolitan Elevated preferred	60
National Carbon common	21½
National Carbon preferred	90
Union Traction common	6
Union Traction preferred	32

The stockholders of the Union Traction, West Chicago and North Chicago Traction companies have approved the receivers' plan for reorganization. Seventy per cent of Chicago Union Traction stock was voted at the meeting.

ELECTRIC LIGHTING.

BROWNSVILLE, TEX.—John W. Maxcy, of Houston, has secured a franchise from this city for electric lights, waterworks and telephones.

PRINCETON, N. J.—The ordinance granting the University Electric Power Company right of way through the borough streets has been passed by the council.

WINONA LAKE, IND.—The city council of Warsaw has voted to the Winona Light, Heat and Power Company a fifty-year franchise for heating, lighting and the furnishing of water to the city.

SENECA, S. C.—A corps of engineers is at work surveying Hatton's Ford, on the Seneca River, where a new power company is to be established for the city of Anderson.

PEORIA, ILL.—The electric light company is installing new lamps throughout the city. These are of the latest type, and it is expected that the service will be greatly improved.

JACKSONVILLE, FLA.—The city electric light plant is making arrangements to handle 8,000 more lights this winter. Two new turbo-generators of 200 kilowatts capacity each are being installed.

BIG TIMBER, MONT.—The Cowles Mining Company will install a 500-horse-power electric plant to operate all the machinery in the camp, as well as to light it thoroughly. Work has been commenced on the power-house.

TACOMA, WASH.—The contract for building the power-house of the Puget Sound Power Company, on the Puyallup River, has been let, and work begun. The contract calls for the completion of the plant by December 1 of this year.

EL RENO, OKLA.—John A. Masters and others have purchased the El Reno Light and Power Company's plant for $60,000. A new company will be organized shortly. The plant was built last fall and began to operate in December. It is thoroughly up to date in every respect.

WASHINGTON, D. C.—Proposals will be received for the construction of the following improvements and until the dates given: Conduit and electric wiring in post office at Aberdeen, S. D., September 14; conduit and electric wiring in post office building at Cumberland, Md., September 15; conduit and electric wiring for post office building at Fergus Falls, Minn., September 10.

ROCK HILL, S. C.—It is announced that work is progressing rapidly on the Catawba Power Company's plant on the Catawba River, and that the company will be ready to furnish power in six months, though the entire work will not be completed for twelve months. When finished, the plant will be able to furnish 6,000 horse-power for the entire year, and for about eight or nine months. 10,000 horse-power. Up to date the work has cost more than $800,000. It is stated that the company has under consideration the project of transmitting 3,000 horse-power to Charlotte for lighting purposes.

LEGAL NOTES.

AUTHORITY TO CONDEMN THE RIGHT TO CONSTRUCT A TELEGRAPH LINE—Authority to condemn the right to construct a telegraph line along a railroad right of way is held in Fort Worth & R. G. R. Company *vs.* the Southwestern Telegraph and Telephone Company (Texas), 60 L. R. A. 145, to be conferred by a statute permitting the condemnation of any land, whether owned by private persons in fee or in any less estate or by any corporation, whether acquired by purchase or by virtue of any provision in the charter of such corporation.

WESTERN UNION SECURES A RESTRAINING ORDER—In the United States Circuit Court, District of Wilmington, Del., on August 21, Judge Bradford issued an order temporarily restraining the Philadelphia, Baltimore & Washington Railroad and the Delaware & Virginia Railroad Company from interfering with the property of the Western Union Telegraph Company on the right of way of these railroad companies. The order of Judge Bradford will remain in force until the question has been finally decided by the United States Supreme Court or until the local court makes a further order.

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INDUSTRIAL ITEMS.

A NEW TELEPHONE CATALOGUE and up-to-date price list have just been issued and are now being sent out by the Electric Appliance Company, Chicago. Any one in the telephone business who has been missed in the distribution will receive a copy of this catalogue by writing to the Electric Appliance Company, 92 West Van Buren street, Chicago, Ill.

THE SAWYER-MAN ELECTRIC COMPANY announces that to further facilitate the prompt handling of orders, it has recently established a distribution depot at the central stores of the company's terminal warehouse in West Twenty-eighth street, New York city. A million lamps are kept in stock, so that any order can be promptly filled. A similar depot is situated at Thirtieth and Market streets, Philadelphia, and others in Boston, Buffalo, Syracuse, Pittsburg, Charlotte, Chicago, Denver, St. Louis, Atlanta, New Orleans, San Francisco, Seattle and other centres of trade.

THE JOHN M. KLEIN ELECTRICAL WORKS, San Francisco, Cal., will remove on October 1 to a four-story building at 107 Battery street, one block from Market street, which is the centre of the wholesale district. The building is 40 feet by 125 feet and is well adapted for this business. The removal of this works to these large quarters is a consequence of its growth. Mr. Klein is a Utica, N. Y., man, and has the largest electrical establishment on the coast. He started twenty-five years ago in a small store, and now is president and general manager of one of the largest business interests west of Chicago.

THE WALLACE BARNES COMPANY, Bristol, Ct., manufacturer of small springs of every description, has ready for distribution its new catalogue and a new stock sheet. This describes and illustrates a line of fine springs of every variety. The company has on hand a large stock of cold-rolled spring wire, from 0.003 to 0.250 in thickness, and carries a large assortment of steel, brass, phosphor-bronze and music spring wire and also a large variety of flattened wire, both tempered and untempered. The catalogue is full of valuable information on motor spring tests, extension spring tests and other formulæ which it will be of advantage for any one interested in this line to secure.

THE BANNER ELECTRIC COMPANY, Youngstown, Ohio, announces that its business is steadily increasing each month of this year, showing a decided expansion over the business of the corresponding months of last year, the business for some months being more than double. The company has experienced no dull season during the summer, and has kept its plant in continuous operation. A new equipment has been added to its lamp department, increasing its facilities so that it is in a position to meet the increasing demand for Banner lamps. A study of the situation shows that the increase in business is due principally to the high quality of the company's goods. Its record shows that it has invariably retained its customers, proving that Banner lamps are giving satisfactory results to consumers. Agencies have been established in all the principal cities, where orders can be filled direct from stock.

THE THOMAS E. CLARK WIRELESS TELEGRAPH AND TELEPHONE COMPANY, Detroit, Mich., is placing on the market the "Clark Coil" for automobiles, gas engines, etc. The vibrators are made so as to remain in constant adjustment, and the contacts are of such low resistance that the sparks from the secondaries are nearer a flame than a spark. The condensers are treated with special prepared paper which the company states it is impossible to puncture. The primaries are separated from the secondaries by high-grade insulating material, and the core of the coil is so constructed as to reduce to a minimum eddy currents and core loss. The condensers are separated from the coil proper at the point where the secondaries leave the coil, and are insulated at this point with hard rubber. The binding-posts and metal parts are of the best mechanical and electrical construction. All exposed parts are nickel-plated and polished, obviating the danger of rust or corrosion.

THE ROBBINS & MYERS COMPANY, Springfield, Ohio, has published a new bulletin entitled "The Standard Motor Book." The machines described in this motor book were the earliest types of what is now generally known as the protected type. The company states that this type is now so commonly used that it has been suggested that a more distinctive name be used, and its machines will hereafter be known as the "Standard" motors and dynamos. A number of illustrations show the assembly and construction of these dynamos and motors, and tables are given showing "Standard" dynamo and motor specifications and telegraphic code. There are diagram illustrations giving the frame sizes, a dimension table of "Standard" motors and dynamos, diagrams showing the various connections for shunt, series and compound dynamos and motors, and a supplementary article on the selection, installation and care of motors. This motor book will be sent to interested parties on request.

THE ALLIS-CHALMERS COMPANY, Chicago, Ill., reports the following partial list of engine sales for July, 1903: Chicago Beach Hotel, Chicago, one 16 by 36 inch, heavy-duty, direct-connected, Reynolds-Corliss engine; Knox Construction Company, Chicago, two 20 and 40 by 48 inch, heavy-duty, cross-compound, direct-connected, Reynolds-Corliss engines; Richmond City Works, Richmond, Va., one 24 and 36 by 48 inch, heavy-duty, cross-compound, Reynolds-Corliss engine; Barrett Manufacturing Company, Beloit, Wis., one 20 and 40 by 48 inch, heavy-duty, cross-compound, Reynolds-Corliss engine; American Aristotype Company, Jamestown, N. Y., one 18 by 36 inch, girder frame, Reynolds-Corliss engine; Stilwell-Bierce & Smith-Vaille Company, Dayton, Ohio, one 16 by 42 inch, girder frame, Reynolds-Corliss engine; Fourche River Lumber Company, Chicago, one 24 by 48 inch, heavy-duty, Reynolds-Corliss engine; one 20 by 42 inch, heavy-duty, Reynolds-Corliss engine; J. I. Case Plow Works, Racine, Wis., one Reynolds air pump and jet condenser; Consumers' Heat and Electric Company, Bloomington, Ill., one 20 and 32 by 36 inch, heavy-duty, cross-compound, Reynolds-Corliss engine; Union Sugar Company, San Francisco, Cal., one 18 by 36 inch, girder frame, Reynolds-Corliss engine; Canton Oil Mill Company, Canton, Miss., one 16 by 42 inch, girder frame, Reynolds-Corliss engine; Henry Du Pont, Wilmington, Del., one 20 by 42 inch, girder frame, Reynolds-Corliss engine; Olds Motor Works, Lansing, Mich., one 16 by 42 inch, girder frame, Reynolds-Corliss engine; The Clayton Oil Mills, Clayton, N. C., one 18 by 42 inch, girder frame, Reynolds-Corliss engine; The Homestake Mining Company, Lead, S. Dak., one 15-32-34 by 42 inch, combined Hor-Vert, triple expansion engine, three 320-horse-power, Sederholm boilers; Lacey-Bukk Iron Company, Birmingham, Ala., one 44 and 84 by 60 inch, vertical, standard furnace, plowing engine; C. A. Macdonald, Chicago, one 16 by 36 inch, girder frame, Reynolds-Corliss engine, without crank, crank-shaft, wheel, etc.; Arkansas City Milling Company, Arkansas City, Kan., one 22 by 42 inch, heavy-duty, Reynolds-Corliss engine; Manhattan Rubber Manufacturing Company, Passaic, N. J., one 24 and 40 by 42 inch, heavy-duty, tandem-compound, Reynolds-Corliss engine; Charles B Pride, Appleton, Wis., one 18 by 36 inch, heavy-duty, Reynolds-Corliss engine, substituted for 14 by 36 inch, sold May 25, 1903; Columbus, Buckeye Lake & Newark Traction Company, Columbus, Ohio, one 34 and 68 by 48 inch, vertical, cross-compound, condensing, heavy-duty, Reynolds-Corliss engine; Lock, Moore & Company, Limited, Westlake, La., one 24 by 48 inch, heavy-duty, Reynolds-Corliss engine; Georgia Cordage Mills, Decatur, Ga., one 16 by 42 inch, heavy-duty, Reynolds-Corliss engine; Marquette Cement Manufacturing Company, La Salle, Ill., one 20 by 42 inch, heavy-duty, Reynolds-Corliss engine; Coe Brass Manufacturing Company, Terrington, Ct., one 22-44 by 42 inch, and one 19-38 by 42 inch, combined Hor and Vert, compound Reynolds-Corliss engines, two air pumps and two jet condensers; Charles Waite, South Dakota, one 12 by 30 inch, girder frame, Reynolds-Corliss engine; two 70-horse-power, 54 by 16 inch, tubular boilers, one No. 5 feed-water heater; The Gauley Company, Camden-on-Gauley, W. Va., one 16 by 36 inch, heavy-duty, Reynolds-Corliss engine; Rock Hill Water, Light and Power Company, Scranton, Pa., one 20 by 42 inch, girder frame, Reynolds-Corliss engine; Memphis Consolidated Gas and Electric Company, Memphis, Tenn., one 27-72 by 48 inch, horizontal, cross-compound, heavy-duty, direct-coupled, Reynolds-Corliss engine.

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Electrical Review

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CHARLES W. PRICE . . . . PRESIDENT and EDITOR
STEPHEN H. GODDARD . SECRETARY and MANAGER
WM. HAND BROWNE, JR. . . . TECHNICAL EDITOR
AINSLIE A. GRAY . . . . . ASSISTANT EDITOR

WESTERN OFFICE — 40 Dearborn Street, Chicago, Ill. CHARLES FFRENCH, Manager.

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TO ADVERTISERS

CHANGES for advertisements should be in this office by Friday noon for the following week's issue.

NEW ADVERTISEMENTS should be in the office not later than Monday noon to assure publication in that week's issue.

COMMENCEMENT TIME.

The present month will see a resumption of work at practically all of our institutions of learning. While discussions have been going on during the vacation season among professional men of every class, there is no department of progress in which more discussion has been raised than in the allied departments of engineering. On the one hand, a set of men properly recognized for their astuteness, declares that only an education very broad in its nature can fit a young man for the battle of life. On the other hand, a set of men equally astute, is proclaiming for specialization along this or that line. Let us hope that the end of another school year will see all of our institutions better equipped to fit the young man for his life work, whether it be as a specialist or as a practitioner on extremely broad lines.

ECONOMICS IN ELECTRICAL ILLUMINATION.

The inefficiency of electric lighting is too well known to need comment, as although electric lights are more efficient than other artificial illuminants, according to our present knowledge only about ten per cent of the electrical energy furnished to the lamp is converted into light. This inefficiency is particularly unfortunate in electric lighting, because it necessitates large installations of costly apparatus, and as the large loss takes place at the lamp itself, it is necessary for all intermediate apparatus to be able to transmit all the lost energy, as well as that which is converted into light. The problem, then, of bringing about marked economies in electric lighting is perhaps second only in importance to that of the more efficient conversion of the potential energy of coal into a more useful form.

New Types of Lamps.

The importance of this problem has been recognized and much time and ingenuity have been expended in improving the various appliances made use of. The incandescent lamp using a carbon filament has been wonderfully improved in all respects. Arc lamps have not been neglected, and experimentation has been carried out along other lines to test the possibility of other means for converting electrical energy into light. We have thus the lamps of the Nernst type, where the luminous portion is a conductor at high temperatures only; the mercury vapor lamp, and the vacuum tube lamp, which is yet in an experimental stage.

Improvements in the Incandescent Lamp Attempted.

The simplicity of the incandescent lamp had led to attempts to combine with the advantage of this type of lamp the high efficiency of the incandescent mantles; and a few years ago an incandescent lamp which was said to have a filament consisting of a carbide of rare earths was described in the technical press. This, it was stated, had a high efficiency and a reasonable life, and was not unduly expensive; but, for some reason or other, the lamp has not been put on the market.

High-Efficiency Arc Lamps.

This same line of work has been extended to the arc lamp, and certain ingredients added to the carbon which give it a higher luminous efficiency. A notable type of this lamp is the Bremer arc lamp, which has found considerable application abroad, but only to a restricted extent in this country. Also a better distribution of light has been obtained, giving a better illumination for the same number of lights.

Importance of Improved Efficiency in the Lamp.

Improvements of this kind are, of course, important, although they only increase the total efficiency to a comparatively small extent. To double the efficiency of a lamp would double the output of every lighting station, and would far more than double the number of lamps used. But an efficiency of even twenty per cent is very far from what we should endeavor to reach.

Improvements in Other Apparatus.

While work is going on in improving the lamp and in search for new and more efficient lamps, other departments of lighting are not being neglected. There has been a wonderful development in the prime mover. The gas engine has been developed from the small size of ten or twenty horse-power to units with a capacity of several thousand horse-power. The steam turbine, after long and patient work, has been brought to a practical state, and there seems to be little hope for much change in prime movers, unless there should be a complete revolution in our methods of converting heat energy into mechanical energy.

Economies in Other Lines.

There have also been improvements in the lamps, tending to decrease the cost of

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maintenance and attendance. In this country the enclosed arc lamp, which will burn for a long time without attention, has been widely adopted. In Europe a long-burning open arc lamp has been developed to compete with the enclosed arc lamp, the construction being such that much longer carbons are used. There are lamps now burning forty and sixty hours, and it is stated that eighty-hour lamps may be forthcoming.

These improvements, as well as others, have reduced the cost at the station, and in this way brought about a considerable reduction in the cost of electric lights; but we are still far from the final solution. What is being sought and what will doubtless be found some day will be the cold light—that is, the lamp to which energy in some convenient form can be supplied, and which will convert a large percentage of this into luminous rays. It is possible that some of the recent discoveries connected with invisible rays may suggest lines of work which will be fruitful. Thus, the so-called N-rays discovered by Blondlot are known to increase the luminous intensity of a glowing body without increasing its temperature. This implies a higher efficiency, whether it be due to a more efficient transformation of the energy the body received before these rays were allowed to fall upon it, or whether it be due to the conversion of these invisible rays—which before were going to waste—into luminous rays. The problem is undoubtedly one of the most important which is facing the engineer and scientist to-day, and no line of investigation which promises the least improvement should be neglected.

It is difficult to foresee the effect the steam turbine will have upon the power station of the future. That it will be an important factor can not be doubted, but it has a strong rival in the gas engine. It is probable that further knowledge of the capabilities of the two types of motor will result in consigning to each its own particular field of usefulness. Further than this the gas turbine is yet to demonstrate its usefulness and practicability. It is likely that it will bear the same relation to the gas engine that the steam turbine does to the steam engine.

THE CONVENTION OF THE AMERICAN STREET RAILWAY ASSOCIATION.

The convention of the American Street Railway Association, holding forth at Saratoga, N. Y., this week, September 2, 3 and 4, will go down in history as another of a long series of meetings which has brought about a better understanding of the ethics of street railway operation. This is the fundamental and essential condition which such gatherings as this are designed to bring about.

The Papers Read.

It is the duty, year after year, of the committee in charge of formulating plans for the convention to bring before the assembly such topics for presentation and discussion as will best serve to show the way to higher efficiency and point out past errors, that newcomers in the field may not fall by the way. The transactions of the American Street Railway Association form a literature which is of inestimable value to street railway students, both in the direction of engineering and economics. The programme for this year does not fall behind those which have gone before in point of variety and in value to the operating railway man.

The Entertainment Provided.

A notable feature of the conventions is the entertainment that is always provided, which, while a side issue, is of great importance in making for harmony and in relieving the stress of what would otherwise be a monotonous attention to detail.

Exhibits of Apparatus.

Another important function which these gatherings have to deal with is the exploiting by manufacturers of all that is new and all that is good in the street railway and kindred lines, for the manager to become acquainted with. The convention brings to a central point the developments of years, and gives a close-range view of a broad line of manufacture.

While the programme committee is to be congratulated upon the presentation of a fine list of topics for serious discussion, the local committees and exhibitors are entitled to a great deal of praise for the efforts they have made to provide an attractive quality of entertainment and a noteworthy exhibit of appliances.

SURFACE CONTACT SYSTEMS IN PARIS.

In this issue our special correspondent at Paris contributes a noteworthy article dealing with two of the surface contact systems of electric traction which have been in successful operation for some time in Paris, France. These are the Diatto system and the Clairet-Vuilleumier system. The Diatto system uses direct current at 550 volts. A number of circular contact blocks are laid between the rails, and a long contact bar, carried under the car, passes over the blocks and brings the current to the motors. The mechanism for distributing the current from the underground feeder to each block as the car passes is contained within the block itself. This consists essentially of an iron plunger which is raised by a magnetized bar carried on the car, and thus completes the circuit for the block. A separate battery is carried on the car, and is used to magnetize the bar which is suspended from the car and which makes contact with the surface blocks. This battery is small, consisting of but eight cells giving eight amperes at sixteen volts.

Distributor System from Station Points.

The Clairet-Vuilleumier system operates also with direct current at 550 volts. Current is sent from an underground feeder to a series of distributors or automatic relays which are placed along the track 100 metres apart. From the distributors a series of small wires is connected and supplies current to each of the contact blocks placed between the rails. These contacts are formed of a small metallic block embedded in the pavement, and are slightly raised above the surface, so that the contact rail which the car carries underneath it can rub over the upper surface. The succession of blocks, each of which receives the current only at the instant when the car passes over it, serves to distribute the current for the motors. As the car continues on its course, its contact rail touches a block which is immediately in front, without having left the preceding one. As the forward contact is connected to the distributor by one of the wires a small portion of current is shunted into the distributor and serves to operate a fine-wire electromagnet of high

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resistance, which forms part of the distributor. The latter acts as a relay and sends the main current into the new block, cutting it off from the receding one. This cycle is repeated as the car proceeds.

The Faults of the Surface Contact System.

A great deal has been said, from time to time, for and against surface contact systems of any description. With the great simplicity of the overhead trolley, where this will be allowed, and the entirely satisfactory service which the third rail gives when properly installed, it is hard to see wherein the surface contact system has any advantage, except from an æsthetic point of view. It certainly is expensive to install, and while there is really nothing in the construction detail of the line and its auxiliary apparatus which is not doing eminently satisfactory work in segregated installations, the combination of the working parts necessary to produce a highly insulated, workable surface contact system is a proposition which calls for an apparatus as delicate in its movement as the works of a watch, and as enduring in its operation as the motor on the car.

Troubles from "Sticking" of Contacts.

In all surface contact systems which make use of electromagnetic devices there is the ever-present tendency to "sticking" of contacts, which is liable to send current to almost any point other than where it is wanted. This may render the system dangerous, or it may simply mean a waste of energy. A great deal of study and mechanical ingenuity have been given up to the elimination of this unacceptable feature, and the systems above noted present working ideas which are well worthy of close investigation.

INTERFERENCE IN WIRELESS TELEGRAPHY.

There seems to have entered the electrical field, along with wireless transmission, a new element—that of unnecessary, and perhaps vicious, interference with a competitor's service. The ease with which electric waves can be sent off into air space and neutralize or render unintelligible legitimate messages sent out by a rival in the same vicinity, apparently has been a temptation too great to be withstood, and during the recent yacht races, on one or two days, wireless transmission to land from boats was a failure. On other occasions, particularly the first and last days, the news was promptly sent out and received. We hope that for the proper advancement of the art, as well as for the honor of the profession, the wireless telegraph companies will reach a better understanding, and that if there have really been any of these dog-in-the-manger tactics, they will instantly cease. They are not at all creditable.

THE GAS ENGINE AND THE GAS TURBINE.

BY GEORGE E. WALSH.

The merits of the steam turbine have been thoroughly tested and demonstrated, and the gas engine of both small and large units has been developed to the point of great practical efficiency; but the gas turbine is still an unknown and uncertain factor in power production. Nevertheless, engineers are turning their attention with renewed interest to the gas turbine, and it is confidently believed that within a short time satisfactory gas turbines will be in operation for running electrical stations. If the gas turbine is an ultimate success it will be the nearest approach of any invention yet made to convert directly the energy of coal into electrical energy.

The gas turbine can be used only when the problem has been solved of producing a continuous combustion of gas under pressure and complete control. At present the gas engine is operated by a series of explosions, one for each two revolutions. It is generally a single-acting, reciprocating machine, and not double-acting as the steam engine; but it possesses other features which more than compensate for this loss. The working pressure in the gas engine is much higher than in the steam engine, and its actual performance is oftentimes greater. The high temperatures under which the gas engine works necessitate the employment of a water-cooling jacket, which causes a loss of one-fifth of the heat delivered to the engine.

The gas turbine should avoid many of the drawbacks of the gas engine, and engineers seem to expect soon to be able to burn gas in such a continuous stream that it will be useful in the turbine form of engine. Already gas has been burned under mechanical conditions in laboratories which would indicate success in this direction. The question of reducing the high temperature in the cylinder chamber produced by the combustion of the gas is not so easily answered. The cooling water-jacket could not be used so readily in a gas turbine as in the gas engine. This loss, however, could be met if the turbine worked successfully otherwise. Until some new method of reducing the high temperature of the cylinder chamber can be invented, the circulation of cooling water will have to be resorted to.

The future of the gas engine itself is far more promising to-day than any other form of power producer; but as a formidable rival of the steam engine it enjoys the unique distinction of being so new in the field that tests have been only partly demonstrated. Both forms of engines have under test given one horse-power for about one pound of coal. Furthermore, the efficiency of both the gas engine and the best types of steam engines has been, between the coal pile and the point of delivery, nearly or quite twenty per cent. The steam engine has accomplished these results for some time past, and the gas engine only comparatively recently. The steam engine has been developed and improved until it would seem as if it had reached the ultimate goal of its efficiency. On the other hand the gas engine has proved its claim to instant recognition at a period in its development when it might be said that it is in its infancy.

Under commercial conditions the gas engine appears to be susceptible to infinite improvements and developments. The adaptability of the gas engine to different kinds of work has been not the least of its good points. Probably the most important field is that of utilizing blast furnace gas. The simplicity of the engines adapted to this use makes it of special value. The pig iron produced in this country is enormous, and the cost in fuel far beyond what it should be. The waste of the gas represents unharnessed power that for generations has been wasted. The employment of this to operate gas engines of small and large units will shortly revolutionize the business. Not only in this country, but in England and Germany, the waste gas of the blast furnaces has not until recently been harnessed. In Germany alone it is estimated that some 600,000 horse-power is wasted annually in making the 8,000,000 tons of pig iron, while in this country the loss in this way is much greater.

The prediction is freely made by experts that in a comparatively short time

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the production of pig iron will be of secondary importance to the generation of gas by the blast furnaces for operating gas engines. In other words, the gas will be of more value than the pig iron. All this gas has been wasted in the past, except such little as was recovered for burning in an uncertain sort of a way for operating blowers and furnace blasts. By burning the gas direct to run gas engines the waste can be reduced to a minimum, which enables operators to sell power for an infinite variety of manufactures.

There is a wide range of temperature in which the gas engine can be used. This enables the manufacturers to use the machines in mills and factories under conditions not found possible with steam. Recently the application of highly superheated steam has enabled mill men to use steam under new conditions, but it is possible that the limit of possible heat efficiency has been reached in this direction.

There are several types of blast-furnace engines which fully illustrate the practical development of this form of power production. More of these engines of large units are used in Germany for driving electrical generators than in this country. They have been found to possess economy and efficiency for this work not equaled by any other engine. In this country many of these different types of gas engines are being installed for electrical generating, and within a few years their appearance will be quite common in all parts of the country. They are built to burn both blast-furnace gas and ordinary illuminating, producer and natural gas. In the Pennsylvania iron region dozens of the largest gas engines have been installed during the current year, and others are being erected as rapidly as possible. In the natural gas belt they are also being constructed to operate the electrical and steam pumps used for pumping of the gas from great depths. The gradual decline in the pressure of the natural gas has compelled owners to resort to pumping and sometimes the pressure required to force the gas to a considerable distance for consumers is so great that the mammoth pumps represent unusual power. In the cities gas engines of smaller type are mostly used, for their work is generally lighter, and they burn for the most part ordinary illuminating gas.

There is such a wide selection of gas engines to-day that the engineer can find in some of them almost all of the latest improvements. On the other hand, with the multiplication of systems of gas engines there comes more difficulty in deciding about the relative merits of each. This will become more difficult in the near future, for with the rapidly increasing demand for this form of power producer there is a wide attempt to manufacture them to meet the needs of manufacturers. The question of which type or system of gas engine is the most satisfactory can not easily be answered to-day, and probably no one is most satisfactory for all work. The tendency will be to specialize the engines more and more to adapt them to different kinds of work. This has already proceeded to some considerable extent owing to the nature of the gas used. We have engines peculiarly adaptable to the natural gas region where the combustion of the gas differs materially from that from the blast furnace. Engines adapted to the blast-furnace gas consumption are more numerous than any other, and they will probably increase in numbers and improvements faster than those used in other industries.

Engines run by producer gas, where the fuel is burnt directly to make the gas for the engines, must show the largest amount of efficiency for a given consumption of gas. Where the outlay for fuel is direct there must be economy in its use, and all waste in the combustion must be eliminated. Probably in this field builders of gas engines will show their greatest skill and ingenuity in reducing the cost of operation. The quality of producer gas differs materially, and the engines will have to be made to utilize gas that shows a difference in calorific power of from ten to fifty per cent. The cost of the coal or other fuel for generating the gas must always enter largely into this question.

The size of the engine and the purpose to which it is put are questions which also obtrude very prominently in the whole matter, and figures submitted by experimenters in the past have hardly sufficient verification to apply in all individual cases. The gas engine is still too much in its infancy as a practical working machine to establish inflexible rules about its actual work under widely different conditions. In the large engines the rate of consumption of both gas and oil has been greatly reduced by the modern improvements, and the economy effected in this way shows definite results in the course of a year's operation. The tendency is probably toward the adoption of the open double-acting four-cycle engines for plants that require only small engines of 300 to 4(
horse-power, and for very large power
1,000 horse-power and upward the tw
cycle engines. This selection of cou
is modified by conditions that pertain
different industries.

Central Electric Power Stations i Gold Mines.

In the use of electric power, says
London *Electrical Review,* in discuss
a paper read by J. W. Kirkland, on "C
tral Electric Power Stations for G
Mines," it was not claimed that it
universally applicable. The author
cepted surface hoisting and
drills. He does not think elec
drills can compete with air drills,
although the electric drill is
more efficient than the best
pressed-air drill, the essential feature
a drill are that hard blows shall be g
and the apparatus producing the
shall be light. For these points, th
drills excel. Contrary to the usual op
the power required for the stamp
does not constitute the bulk of that
at a mine. Figures are given which
cate that the stamps take only about
the power used in the mill itself an
about one-quarter of that required i
mill and mine together. As regard
methods of transmitting power, the a
does not think that rope or compress
can compare with electricity. For d
the stamps the steam engine system
flexibility, and as it for a consid
part of the time is loaded to only
tion of its maximum, it is inefficient
a motor drive the motor may be
vided and efficiency of operation
high. The essential requirements
mill are that it shall be close
shafts, have ample water supply
erected on sloping ground if possi
the other hand, the power-house
be near the railway to permit
nomical handling of coal. These
tions are easily met with in an e
plant, but rather hard to meet if
system is adopted. The mill as
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may be used. The steam turb
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compared with the condensing Co
gine, as the former has a flat
curve. In estimating the efficiency
a system the efficiency of a gener
taken at ninety-four per cent an
ing 5,000 volts as the pressure,
the transmission line, ninety-five
The transformers, ninety-eight
low-voltage distribution, ninety-
cent; motors, eighty-eight per ce
ing a total efficiency of seventy-s
one-half per cent. The efficie
line shaft drive should be from
eighty-five per cent.

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Electric Power in Modern German and English Iron and Steel Plants.

By Frank C. Perkins.

MANY of the largest iron and steel plants in America, as well as in England and in Germany, are now using electric power to a great extent in all parts of the works. Central power plants have been constructed operating electric generators by steam engines as well as gas engines.

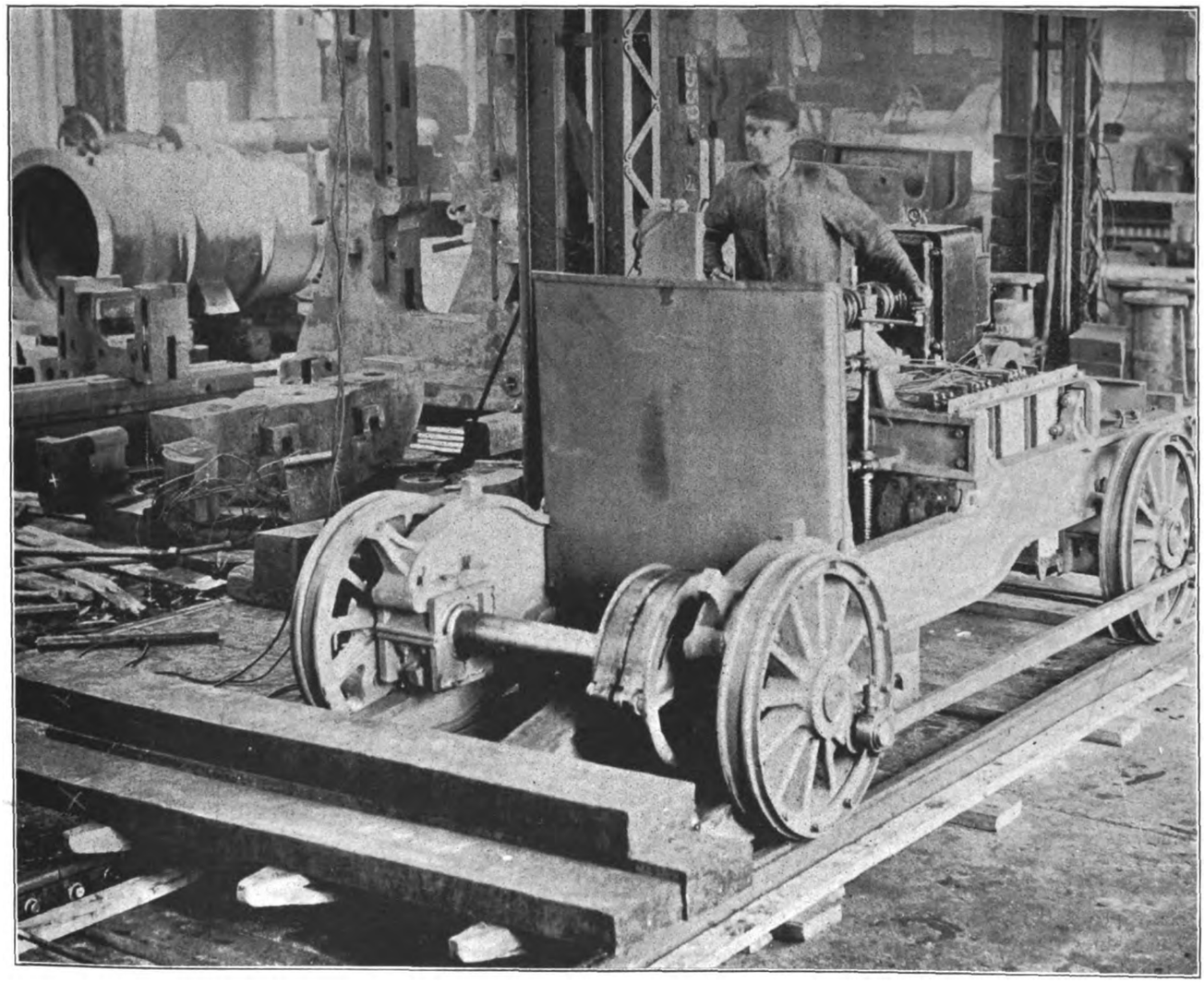
A 600-horse-power, tandem gas engine, using blast-furnace gases, is located at the plant of Gebr. Rochling Hüttenwerk at Volklingen in Saargebiet. It drives a polyphase alternating-current generator at a speed of 120 revolutions per minute, which delivers a three-phase current at 450 volts pressure. This current is conducted about the plant by overhead and underground cables for supplying current to the numerous motors in use.

It may be of interest to consider some of the details of construction and arrangement of the Differdingen plant owned by the Deutsch-Luxemburgischen Bergwerks-und Hütten-Aktien-Gesellschaft. This rolling mill was equipped by the Duisburger Maschinenbau-Aktien-Gesellschaft, formerly Bechem & Keetman, of Duisburg. The main blooming mill has rolls 1,100 millimetres (43.3 inches) in diameter and 2,750 millimetres (nine feet) in length with hydraulic power for operating the screwing gear.

The blooming mill is operated by a double reversing steam engine with cylinders 1,200 millimetres (47.25 inches) in diameter and a stroke of 1,400 millimetres (fifty-five inches). This engine was built by the Elsässischen Maschinenfabrik, of Mülhausen i.Els. It operates at any speed up to 150 revolutions per minute and has a capacity of 5,000 horsepower.

The live rollers for the cogging mill are also operated by a double reversible steam engine. This engine has cylinders 280 millimetres (11.02 inches) in diameter and a stroke of 450 millimetres (17.7 inches). When the blooms have been rolled to a length of twenty-five metres (eighty-two feet) a set of transfer rolls conveys the iron to the hydraulic shears. Directly back of these shears there is a set of transfer rolls, eight metres in length, which is electrically operated.

About fifty-five metres (180 feet) from the blooming mill there are two Toehr mills between which is mounted a double tandem reversing engine with high-pressure and low-pressure cylinders, 860 millimetres (33.9 inches) and 1,350 millimetres (fifty-three inches) in diameter, respectively. This engine has a stroke of 1,250 millimetres (forty-nine inches) and



ELECTRIC TRANSFER CAR FOR BLOOMS OF 8,000 KILOGRAMMES, AT DIFFERDINGEN, GERMANY.

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was built by the Maschinenfabrik Sach & Kiefselbach, of Rath. On one side it is directly connected to a billet mill and on the other side a mill with rolls 700 millimetres (twenty-eight inches) in diameter. The billet mill can handle 400 tons in twenty-four hours, rolling the material to fifty millimetres (two inches) cross-section. On both sides of this mill there are two sets of electrically driven live rolls. The set of rolls in front of the mill is twenty-two metres (seventy feet) in length and behind the mill twenty-four metres (seventy-seven feet) in length. The set of transfer rolls is 108 metres (346 feet) in length. The live rolls as well as the billet shears are operated by electric motors. The pendulum shears are also electrically driven and an electric bloom transfer car is employed for carrying the material from the bloom shears which are operated by hydraulic power.

The Siemens gas reheating furnace is served by a Welman charging machine of American make and it is stated that one man can charge the furnace with 600 blooms in twelve hours. The electric bloom transport car has a capacity for blooms weighing 3,000 kilogrammes. The most modern equipped iron and steel plants, both in this country and in Europe, are now using electricity extensively throughout the various buildings.

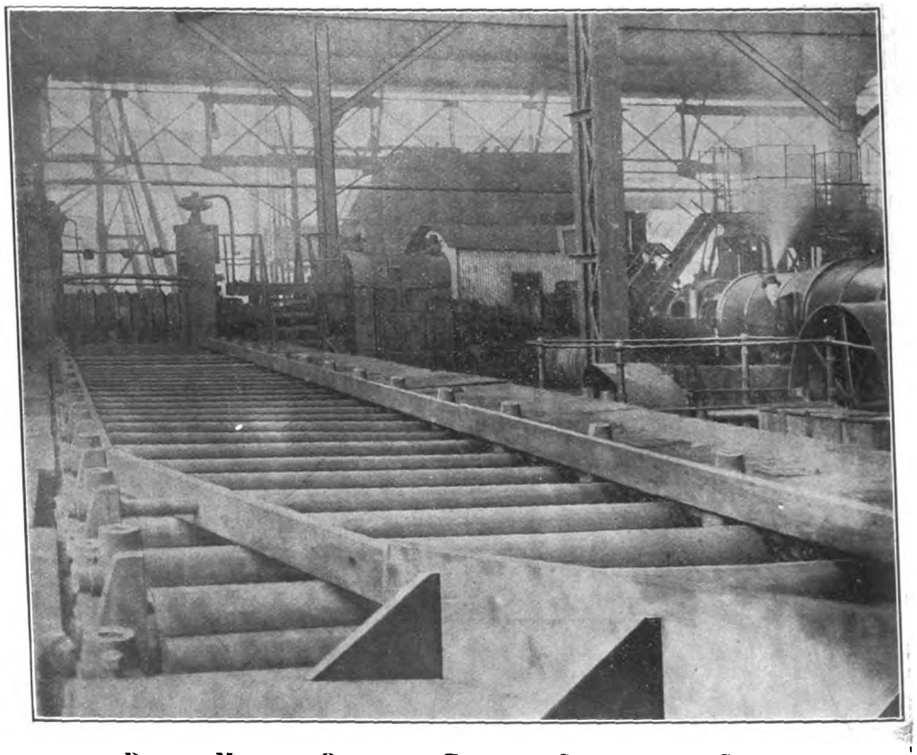
The electric cranes at Differdingen are of thirty-five and forty tons capacity and are driven by several electric motors of varying capacity, lifting, transverse and other motions required in the regular work. All recently constructed plants are equipped with electric ladle cranes, adjusting cranes, loading cranes and transfer cranes, while the latest ingot charging cranes, as well as those for the reheating furnaces, are all electrically operated.

In many plants the boring machines, cutting machines, punching presses, as well as the straightening presses and cold shears, are driven by electric motors of either direct or alternating-current types. There is little question that with the present electrical progress modern steel plants will use electric power more and more.

The power plant of the Port Talbot Iron and Steel Company, Limited, of South Wales, consists of a horizontal, long-stroke, compound engine developing 550 indicated horse-power, driving two 150-kilowatt continuous-current dynamos by rope transmission. The main switchboard is provided with instruments and switches for controlling current for power and lighting about the plant.

The overhead and other cables in the mill supply current to a twenty-five three-motor electric crane over casting pit, a twenty-five-ton three-motor electric crane over the rolling mill, and a ten-ton three-motor electric crane at the reheating furnaces, while one five-ton three-motor electric crane was placed over the reheating furnaces.

The motor equipment includes one eighty-horse-power motor for hot saw, two fifty-horse-power motors for blowers, and twelve twenty to thirty-horse-power motors for live roll and pullover gear. There is also a twenty-horse-power motor for engineers' shop, a twenty-horse-power motor for the dolomite mill, and a twenty-horse-power motor for tin-plate shears and stone-crushers.



Rolling Mill and Reversible Engine at Differdingen, Germany.

A twenty-horse-power motor is used for one straightening machine and a three-horse-power motor for another, while one twenty-horse-power motor is employed for roll-turning lathes and two twenty-horse-power motors for the screw-down gear on rolls.

In addition to the above a ten-horse-power motor drives the cold saw, and the scull-breaking winch is driven by a twelve-horse-power machine. These motors and generators were built by Ernest Scott & Mountain, Limited, of Newcastle-on-Tyne. The engine is of the horizontal long stroke, coupled compound type (non-condensing).

The diameter of horse-power cylinder is nineteen inches and that of the light power cylinder thirty inches, while the length of stroke measures forty inches. The engine operates at ninety revolutions per minute, and the steam pressure is 140 pounds per square inch.

The engine develops 550 indicated horse-power, and has a rope flywheel sixteen feet diameter, the number of ropes being fourteen, and the diameter of ropes one and one-half inches. The engine is fitted with Richardson & Rowland's automatic trip expansion gear to both cylinders.

The dynamo includes two six-pole, continuous-current, compound-wound machines, and each machine is constructed to give an output of 150 kilowatts. The current of each dynamo in amperes is 600 and the potential is 250 volts. They operate at 450 revolutions per minute and develop a total output of 300 kilowatts.

The object in arranging the two dynamos as installed is to enable the total capacity of the plant to be divided into two units, so that in the event of an accident, one machine would be capable of doing the bulk of the work. The machines are constructed so that either can be uncoupled in a few minutes, as the pulley shaft runs between the two centre bearings, and is made with a solid forged coupling at each end to attach to the two armature shafts.

The dynamos are fitted with four bearings, of the self-oiling, self-aligning type and with rope-driving pulley grooved

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receive fourteen driving ropes, each rope being one and one-half inches diameter. The dynamos are mounted on a cast-iron sliding bedplate, with tightening screws and brackets for taking up the slack of the ropes while the machines are running.

An auxiliary lighting plant is provided, although the lights in the mill can be run from the main generators, suitable provision being made for this on the switchboard. The auxiliary lighting plant consists of a Scott & Mountain single-cylinder, vertical engine, and a four-pole dynamo. The steam cylinder is ten inches in diameter and it has a length of stroke of nine inches. It operates at 300 revolutions per minute, the steam pressure being 140 pounds per square inch and develops forty-five effective horse-power.

The engine is fitted with Pickering governor and equilibrium throttle valve, is complete with flywheel of suitable diameter, and drives, by means of a belt, the lighting dynamo.

The lighting dynamo is a four-pole, compound-wound machine and develops twenty-five kilowatts. The voltage is 250 and the current 100 amperes, while the speed is 900 revolutions per minute. The dynamo has self-oiling bearings and sliding bedplate, with sliding bedplate with tightening screws and brackets for taking up the slack of the belt.

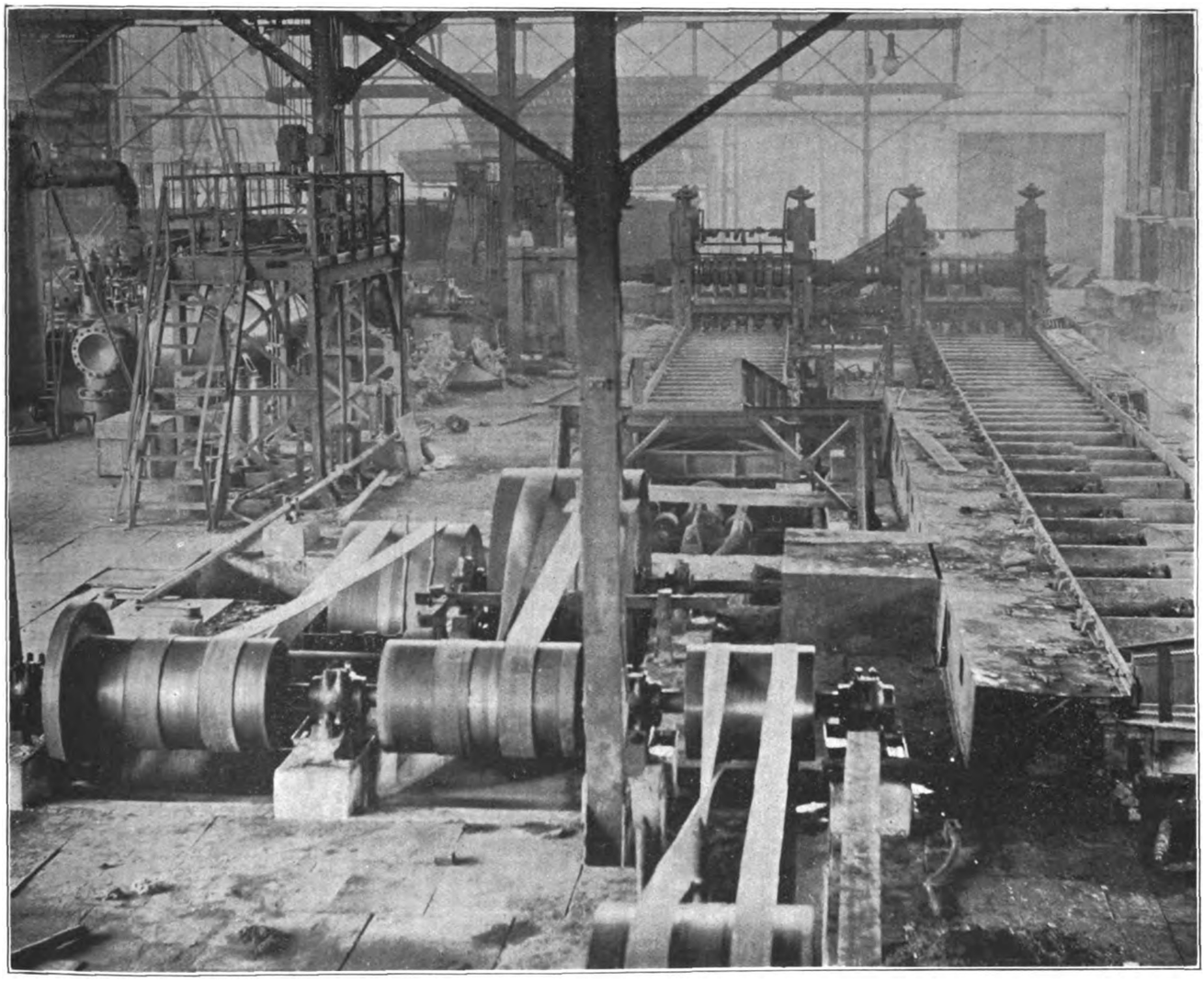
The main switchboard, which is fitted in the power-house, is arranged to control both the power and lighting circuits, and is constructed so that the main generators can be run in parallel or independently, or the lighting can be worked from either the power generators or the auxiliary lighting dynamo, as desired. The board consists of four white marble panels mounted in angle steel framing.

On each of the main generator panels are mounted a double-pole, quick-break lever switch, suitable for a current of 800 amperes, and a single-pole equalizing switch for running the dynamos in parallel. There is also an automatic overload and reverse current circuit-breaker, for 800 amperes, and an amperemeter to read to 800 amperes, as well as a voltmeter to read to 300 volts.

On the power distribution panel there are mounted six double-pole, quick-break lever switches, each suitable for a current of 300 amperes, and six double-pole fuses at the back of the board.

The lighting panel is equipped with a double-pole, quick-break lever switch for a current of 150 amperes, an automatic overload and reverse current circuit-breaker for 150 amperes, a voltmeter to read to 300 volts, and an amperemeter to read to 150 amperes. There is also the necessary distributing switches for the arc and incandescent lighting circuits.

The main cables are provided for conveying the current from the dynamo terminals to the main switchboard; these are lead-covered, and consist of six lengths of cable, composed of thirty-seven wires, No. 12 S. W. G. In addition there are the cables from the auxiliary dynamo to the



ELECTRIC MOTOR-DRIVEN ROLLS AT DIFFERDINGEN, GERMANY.

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switchboard. The whole of these cables are lead-covered and laid in brick culverts.

From the main switchboard to the outside of the power-house the current is conveyed by lead-covered cables to a terminal gantry, from which the overhead cables are run, and the installation is divided into six circuits. The overhead cables are of bare copper, run on insulators, and terminate in distributing switchboards placed at various parts of the mill.

The whole of the cables in the mill are lead-covered, the lead-sheathing forming strong mechanical protection, as well as making the cables perfectly water-tight; they are run in earthenware pipes, or cleated to the wall, and covered with galvanized iron plates where found necessary. Separate circuits are run from the distributing boards to each motor and crane, so that there are no joints of any kind in the cables. The whole of the ten motors for the rolling mill are controlled from the two platforms, each platform having its own distributing board.

The casting pit crane of twenty-five tons capacity is of Scott & Mountain's three-motor type. Its span is forty-six feet six inches, and its lifting speed, full load, is six feet per minute.

The lifting speed at half load is twelve feet per minute, and the lifting speed at light load is thirty feet. This crane has a cross transverse speed at full load of sixty feet, and at light load 100 feet. Its longitudinal travel speed at full load is 120 feet, and at light load it is 180 feet. The crane is fitted with three motors, one for each motion. The lifting motor is of eighteen horse-power, working up to twenty-seven horse-power at 500 revolutions per minute; and the transverse motor develops eight horse-power, working up to twelve horse-power at 500 revolutions per minute; while the traveling motor is of twelve horse-power capacity. The main girders of the crane are of the fish-belly type, the crabs are made with steel sides with adjustable bearings, and the electric motors (which are of the totally enclosed type) are mounted two on the crab and one on the main girders. The starting, stopping and reversing motions of the crane are worked by liquid controllers.

The rolling-mill crane of twenty-five tons capacity is an exact counterpart of the casting pit crane, all parts being interchangeable; the span in this case, however, is about forty feet. The speeds of lift, transverse and travel and the power of the motors are exactly the same as mentioned above.

Of the two cranes over the reheating furnaces or soaking-pits, one crane has a lifting capacity of ten tons and the other five tons. The lifting speed of the cranes at full load is ten feet per minute, and at half load fifteen feet per minute, while at light load it is twenty feet. The cross transverse speed at full load is fifty feet, and at light load 100 feet. These cranes have a longitudinal travel speed at full load of 150 feet, and at light load it is 250 feet.

The lifting motor has a capacity of eight horse-power working up to twelve horse-power at 500 revolutions per minute, while the cross transverse motor is of five horse-power up to seven and one-half at 500 revolutions per minute, and the longitudinal travel motor eight horse-power up to twelve horse-power at 500 revolutions per minute. The lifting speed of the five-ton crane at full load is eight feet per minute, and at half load twelve feet, while at light load it is eighteen feet. The cross transverse speed at full load is seventy-five feet, and at light load 150 feet, while the longitudinal travel speed at full load is 150 feet, and at light load 250 to 300 feet.

This crane is fitted with three enclosed type motors. The lifting motor has a capacity of four horse-power to work up to six horse-power at 500 revolutions per minute, and the cross transverse motor four horse-power up to six horse-power at 500 revolutions per minute, while the longitudinal travel motor has a capacity of four horse-power working up to six horse-power at 500 revolutions per minute.

The hot saw is driven by a Scott & Mountain six-pole motor. It has an effective power at normal working of 100 horse-power, and the maximum output is 120 horse-power, while the speed is 470 revolutions per minute. The motor is fitted with extended bedplate, the pulley shaft being supported by the two outer bearings, enabling the armature to be removed, if required, without disturbing the driving-belt. The armature is coupled to the pulley shaft by solid forged coupling and turned bolts.

The two Thwaites blowers for supplying air to the three cupolas are driven by two continuous-current shunt-wound motors. The effective power of each motor is fifty-two horse-power, and its speed is 700 revolutions per minute. One motor is capable of driving the two blowers, so that practically one of the motors is a standby in case of an accident.

The engineers' shop and the roll-turning lathes are driven by two twenty-horse-power motors. The motors run at a speed of 880 revolutions per minute, and are each fitted with automatic starting switch and sliding bedplate.

The shears, which were made by Messrs. Craig & Donald, are driven by a twenty-horse-power motor running at a speed of 800 revolutions per minute; this motor is mounted on the shears and drives by means of a machine-cut steel pinion and cast-iron, machine-cut spur-wheel, direct on to the main shaft. The whole is self-contained, and the motor is stopped and started by means of a liquid starting switch with screw and hand-wheel. The design of motor adopted on the shears is the same as is used for the roll lathes and engineers' shop, and is of the totally enclosed type.

The straightening machine, which was made by Messrs. Craig & Donald, is driven by a twenty-horse-power motor running at 650 revolutions per minute, and also by a three-horse-power motor running at 1,000 revolutions per minute; these motors driving the machine direct through machine-cut gear.

The dolomite mill, which is of the pan type, together with the friction hoist for elevating the ground dolomite to the furnace floor, is driven by an electric motor of twenty effective horse-power running at 800 revolutions per minute.

The cold saw is driven by an electric motor of ten effective horse-power running at a speed of 1,000 revolutions per minute.

For operating the live roller gear seven motors of twenty to thirty horse-power, at 500 revolutions per minute, are used, and five motors of the same power are also used for working the pullover gear, saw roller rack, and hot bank pullover gear—*i. e.*, a total of twelve motors in all. These motors are all of the enclosed, series-wound type, and each motor has a reduction gear, so that the speed of the motor is reduced from 500 revolutions per minute on the motor shaft to fifty-five revolutions per minute on the line shaft of the various machines.

The motor shaft is fitted with a half coupling, which drives on to a pinion shaft running in two self-oiling bearings. On this shaft a forged steel machine-cut pinion is keyed, driving into a machine-cut, cast-iron spur-wheel on the second motion shaft, which also runs in two bearings. On this shaft a forged steel machine-cut pinion is fitted, driving into an idle-wheel, gun-metal bushel, which again drives into a forged steel machine-cut pinion on the line shaft. This gearing is arranged throughout for continuous lubrication, and suitable wrought-iron covers are fitted, the machines themselves

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being placed underneath the mill floor plates.

The twelve motors are controlled from platforms in the mill in convenient positions. The controllers enable the motors to be stopped, started, reversed, and run at any desired speed; all metallic contacts are avoided, and consequent burning.

Two twenty-horse-power, series-wound, totally enclosed motors are used for screwing down the rolls. These motors run at a speed of about 1,000 revolutions per minute, and drive through machine-cut spur gearing on to a shaft across the two housings, the motors being mounted on the top of the housings. The horizontal shaft raises and lowers the screw by means of worms and worm-wheels.

The motor on this machine is of the enclosed type of twelve horse-power capacity, and drives the small drum through machine-cut spur gearing. The whole drum and motor are mounted upon a combination cast-iron frame fitted with brake and clutch. The gear is very compact, and will lift five tons direct from the barrel at a speed of ten feet per minute.

The offices and engine rooms are lighted by 106 sixteen-candle-power incandescent lamps.

ELECTRICAL NOTES FROM GREAT BRITAIN.

(By Our Special Correspondent.)

The enquiry by the joint committee of the two houses of Parliament into the question of municipal trading has been a very unsatisfactory affair. To begin with, the appointment of the committee did not take place until somewhere about Whitsuntide, and in order to make a report before Parliament rose for the session, it had to curtail the evidence put before it to one item of this very complex question, *viz.*, the methods of making up and auditing municipal accounts. This undoubtedly has an importance of its own, but there are numerous other questions involving a far wider sphere of influence upon municipal trading, such as the repayment of loans and a host of others which many of the municipalities were expecting to give evidece upon which have been left in the same state as they have been for many years past. Thus no general law is provided, and it is left to individual parliamentary committees to decide what shall be in different cases. These committees being of such a temporary nature as they are, often give directly opposite opinions upon precisely the same matters in different years, and thus no continuity of purpose or standardization of principle is possible. Another matter upon which some definite expression of opinion is required, is as to the period of loans to municipalities, which at present vary considerably, and no one seems satisfied with. It is left to the Local Government Board to fix the period, but the basis upon which they are granted no one seems to know. An exhaustive enquiry into the problem bound up with the words municipal trading would take a considerable time, but the present piecemeal method of dealing with the matter will never lead to any result whatever.

The parliamentary session just closed has not been remarkable either for the quality or quantity of its electrical legislation. It started off by causing the promoters of all the tube railway bills in London to abandon their propositions, as the government appointed the Royal Commission on London traffic after the session began, and made it clearly understood that no such bills as tube bills would be passed until the commission reported, which will not be in the immediate future. Probably the main feature has been the comparative success of the gas companies in securing in a number of electric lighting and tramway bills a provision that if after the end of a certain period the revenue did not balance the expenditure upon the undertaking, the charges were to be increased to allow of this. This period was fixed in a few cases at one year and in others at three years. If this year's proceedings are acted upon as a precedent, it will deter a large number of local authorities going into the electric supply business; as it is admittedly almost impossible to make a municipal undertaking of this character profitable during the first few years. The gas companies argued that they were ratepayers in the district, and that they ought not be made to help meet any deficiency upon an undertaking which was a competitor with itself. Beyond this, nothing of exceptional importance has happened. A system of trolley omnibuses was sanctioned to a company which purposes to construct tramways in Gloucestershire, but which wishes to make use of the cheaper mode for some thinly populated districts until they are more developed. A little excitement was also occasioned when a House of Lords committee—which was afterward backed up by a House of Commons committee—refused to exclude certain large towns already owning electricity works from the areas of two new large power distribution companies, thus placing the corporations, for the first time, under competition. Certain conditions are attached to this competition, and in my opinion the ratepayers will benefit, as the fear of such a competition will keep the municipal undertakings to the highest possible pitch of perfection.

The Institution of Electrical Engineers has made an important step toward securing a home for its meetings. At present all its meetings are held in the building of the Institution of Civil Engineers, and are likely to be so for some time. But the Institution has bought some property in Westminster, London, which is regarded as a very valuable site for a building, and the rents from this property are said to bring in as much, and possibly more, than the investments which have been realized for the purpose of the purchase. The Institution has a building fund of over $50,000, but this has not been called upon at present, and some $80,000 worth of ordinary investments has been made use of.

The scheme of higher technical education put forward by Lord Rosebery on behalf of some South African financiers as a means of more effectually dealing with German and other foreign competition has met with the approval of the London County Council, as the technical education authority for London. The idea is to found a college where higher research may be carried out by those without the means to pay for it, and for this purpose a large sum of money has been offered, together with a free site. It is estimated that the college will cost $100,000 per year for upkeep, and the London County Council is willing to contribute to this sum and to have two representatives on the board of control. Nothing further has yet been done in the matter.

It is stated that the Treasurer of the Australian Commonwealth has been notified to the effect that the partners in the Pacific cable will, in all probability, have to face a loss of over $1,000,000 by March, 1904. The loss during 1902 to 1903 was $600,000. The actual expenditure on the cable to March 31, 1903, was over $450,000; the share due from the contributing colonies being $625,500. A. W.

London, August 15.

Pure metallic zinc will last indefinitely in the atmosphere. Soon after exposure it becomes coated with a film of zinc oxide, which protects it from further oxidation. Its use has been suggested in the construction of monuments and other structures, for which purpose it would be more enduring than marble.

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THE DIESEL ENGINE.[1]

BY H. ADE CLARK.

The author first discussed the theory of the Diesel engine and showed how the theoretical indicator card had been modified to comply with practical requirements (plate 1).

The actual Diesel engine has the following cycle of operations:

First stroke takes in air alone at atmospheric pressure and temperature.

Second stroke compresses this air to a high pressure (35 atmospheres = 500 pounds per square inch) and to a temperature of about 1,000 degrees Fahrenheit. This compression is neither isothermal nor adiabatic, since the operations are conducted in a water-jacketed conducting cylinder.

Third stroke is the working stroke, during the first part of which the combustion of the fuel is carried on at constant pressure for a period which is determined by the amount of oil to be sprayed in, which quantity is controlled by the governor. The second part of this stroke is approximately an adiabatic expansion.

Fourth stroke exhausts the gases.

EIGHTY-BRAKE-HORSE-POWER ENGINE.

This size of engine is made by the Vereinigte Machinenfabrik, Augsburg, and Carels Frères, Ghent. On plate 2 is illustrated a longitudinal section and a transverse section of the engine, with standard arrangements of piping for petroleum, lubricating oil, cooling water, air-blast, starting air and exhaust, in fact all the engine connections, except the water-cooling tanks when such are used.

Description—The engine is of the vertical type, with a strong cast-iron A frame, the upper part of which forms the outer wall of the water-jacket; into this upper part is fitted a cylinder of special close-grained cast-iron. The cylinder cover is deep and hollow, being thoroughly water-jacketed; in the transverse section will be seen two valves, the central one is the oil-sprayer, the other is the starting-valve, which may be made to act as the suction-valve for the air-pump. In the longitudinal section three valves are seen in the covers; in the centre is the oil-sprayer, on the right is the air-inlet, and on the left is the exhaust-valve. The oil-spraying valve opens upward or outward, and the others open downward or inward; all three are spring closed, the air and exhaust-valves being kept closed by pressure inside the cylinder. All valves are open by the action of the bent rocking-levers seen upon the right in the transverse section; the movements of the levers are determined by the cams placed upon the horizontal cam-shaft. The cam-shaft is driven at half the speed of the crank-shaft by means of the bevel gearing and the vertical shaft seen on the right in the longitudinal section.

The governor is of the loaded centrifugal type, and is placed at the top of the vertical shaft; its action is explained in connection with the oil-pump.

The piston is of the usual open trunk type, directly connected to a connecting-rod of the marine type. There are seven piston-rings of the Ramsbottom type, six near the top and one much lower, in order that it may pass the lubricating channels.

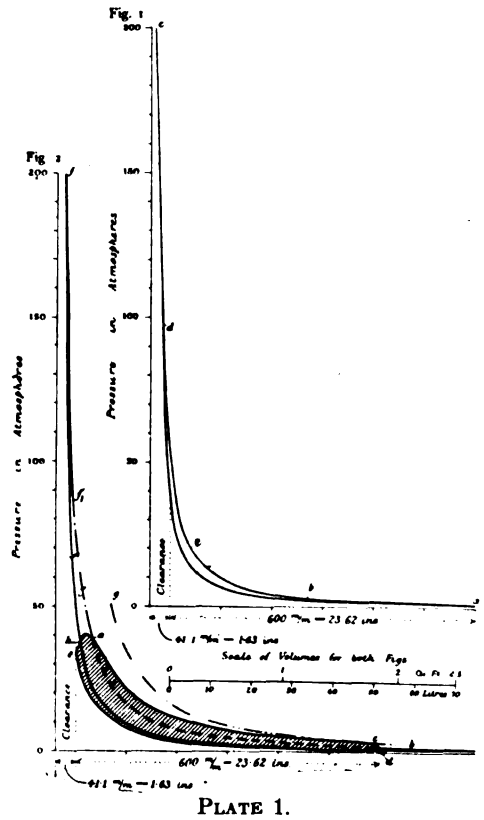

PLATE 1.

Fig. 1.—Theoretical Cycle for Diesel Engine, drawn for the Cylinder of 80-B.H.P. Engine.

a-b Isothermal Compression.
b c Adiabatic Compression.
c-d Isothermal Combustion.
d-e-a Adiabatic Expansion.

Fig. 2.—Comparison of the Indicator Card *d-e-h-a-c* with the modified cycle.

d-h-f Adiabatic Compression.
f-f1-a Isothermal Combustion.
a-b Adiabatic Expansion (broken line.)

The crank-shaft is solid, and has three bearings fitted with ring lubricators. The flywheel is built in halves, and on the inner edge of the rim is a toothed ring into which work two ratchet-pawls, actuated by a rocking-lever; this device is for bringing the engine into the starting position, that is, with the crank just beyond its top dead-centre.

On the left of the longitudinal section, Fig. 3, plate 2, is the petroleum pump. This pump is connected by a pipe to the petroleum-filtering tanks, and by a pipe of small bore to the oil-spraying valve. The plunger of this pump is driven by a crank-pin placed in a disc at the end of the cam-shaft, and also has a constant stroke.

On the right of the transverse section, Fig. 4, is the air-pump; its cylinder is thoroughly water-jacketed, and the plunger is driven by connecting-rod, rocking-levers and connecting links from the small end of the connecting-rod. This pump takes its air from the engine cylinder just before the end of the compression stroke, still further compresses this air, and delivers it to the air-blast reservoir. In the earlier designs the pump took its air direct from the atmosphere, and was then much more bulky and less efficient.

The air-blast reservoir is the smaller one on the right of the cross-section, and is connected to the oil-spraying valve for injecting the petroleum into the cylinder against the high pressure of thirty-five atmospheres already existing there; for this purpose the pump maintains a steady pressure in the reservoir of five to fifteen atmospheres higher, that is from forty to fifty-five atmospheres. It is also connected by an overflow valve to the air-starting reservoir, this valve allowing air to pass from the blast to the reservoir when the pressure in the former exceeds a predetermined value. There may be a similar overflow valve connecting the engine cylinder to the starting reservoir, in order that the maximum compression pressure may be controlled.

The cylinder lubrication is forced by means of the pumps seen on the left of the engine in the longitudinal section, the lubricant entering at five or six points in a horizontal plane, below which one piston-ring passes. The crank is lubricated by the ring and oil ways seen in the longitudinal section. The lubricant is forced to the small end of the rod inside the piston.

The water-jacket is very complete, as the sections show, entirely enveloping the engine cylinder walls and end, and also the air-pump. The water enters at the bottom of the engine jacket, and passes upward through this jacket and the air-pump jacket, from the top to the cylinder cover, the outlet being close to the exhaust pipe.

The oil-spraying or pulverizing valve is illustrated in Fig. 3, plate 2. The horizontal section shows the petroleum and air-blast passages to the central valve, and the vertical section shows the body of cast iron, with the petroleum passage and overflow or test valve, the cen-

[1] Abstract of paper read at the recent meeting of the British Institution of Mechanical Engineers, Leeds, July.

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tral needle valve with its guiding sheath and at the base the pulverizing device, consisting of a set of four metal rings of special form perforated by small holes and separated by four metal bands; the terminating nose piece has narrow channels cut in it, through which the pulverized oil passes to the expanding orifice, and is sprayed into the cylinder when the needle valve is raised. It will be seen that the petroleum pump delivers petroleum to the nozzle by the narrow passage, and that the nozzle is in direct communication with the air-blast reservoir, the pressure in which is kept steadily about 150 pounds higher than the maximum pressure of compression. This device works well.

The petroleum pump is shown in Fig. 3, plate 2. The plunger has a constant stroke, being driven from the end of the valve cam-shaft. Passing through the head of the plunger is a lever working upon an eccentric fulcrum; to this lever is attached the valve-rod which opens the inlet valve against the action of a spring. The fulcrum of the rocking-lever is eccentric to the shaft upon which it is placed, and this shaft is caused to rotate by the action of the governor, thus altering the stroke of the valve-rod and through it the opening of the inlet valve, thus controlling the amount of oil passing to the pump chamber to be forced past the outlet valve to the injecting valve.

There is a controlling device shown, by which the inlet valve can be held open, thus allowing the plunger to pump back the oil to the pump reservoir tank instead of passing it on to the engine by way of the outlet valve. The tappet of this device encircles the valve-rod foot tappet.

Starting and Running of the Engine—The engine is started by compressed air, which is stored in the starting reservoir under a pressure of about fifty-five atmospheres or 800 pounds per square inch, by the air-pump during the previous run of the engine, or, in the case of a new engine, the makers send out these reservoirs ready charged; there is little or no danger of these vessels losing a charge. An engine of this type at the Sewerage Farm at Harrogate was started by air stored at Augsburg eight weeks previously, and in the case of an engine sent to India the vessels were charged four months before the engine was started from them.

On Fig. 5 three pairs of curves are shown, one pair for each of the engines tested by the author, the lower curves (straight lines) show the oil-consumption of these engines as the load varied. These curves of total consumption show well the action of the governor in cutting down the oil-supply to the requirements of the engine, a result not so nearly approached by other types of oil engine; the curves show that the oil-supply is directly proportional to the horse-power, except at very low loads, that is, loads below twenty-five per cent of the normal. In the thirty-five-horse-power engine the total oil-consumption is fairly well given by the equation:

Total oil in pounds per hour = 4 + 0.357 × brake-horse-power for powers over ten brake-horse-power.

In the eighty-brake-horse-power engine the equation is:

Total oil in pounds per hour = 7.5 + 0.336 × brake-horse-power.

In the case of the 160-brake-horse-power engine the equation becomes:

Total oil per hour = 10 + 0.345 × brake-horse-power, for brake-horse-powers larger than fifty when both cylinders are at work.

The upper three curves show the oil-consumption per brake-horse-power-hour; it will be observed that those curves descend to nearly the same value at top loads, and that the rate of increase of consumption is not high, even down to half load; both facts which point to the economy of this engine when distributed in small units, making it unnecessary to concentrate the power in large units and then use expensive transmission to the points where the power is required.

The performance of the 160-brake-horse-power engine under variation of load was as follows:

Load on the dynamo 700 amperes at 115 volts, that is, 108 horse-power, tachometer reading eighty-nine.

The whole load thrown off at once, the tachometer ran up to 96.2 and settled back to 88.7 in about a minute.

The engine running light, tachometer

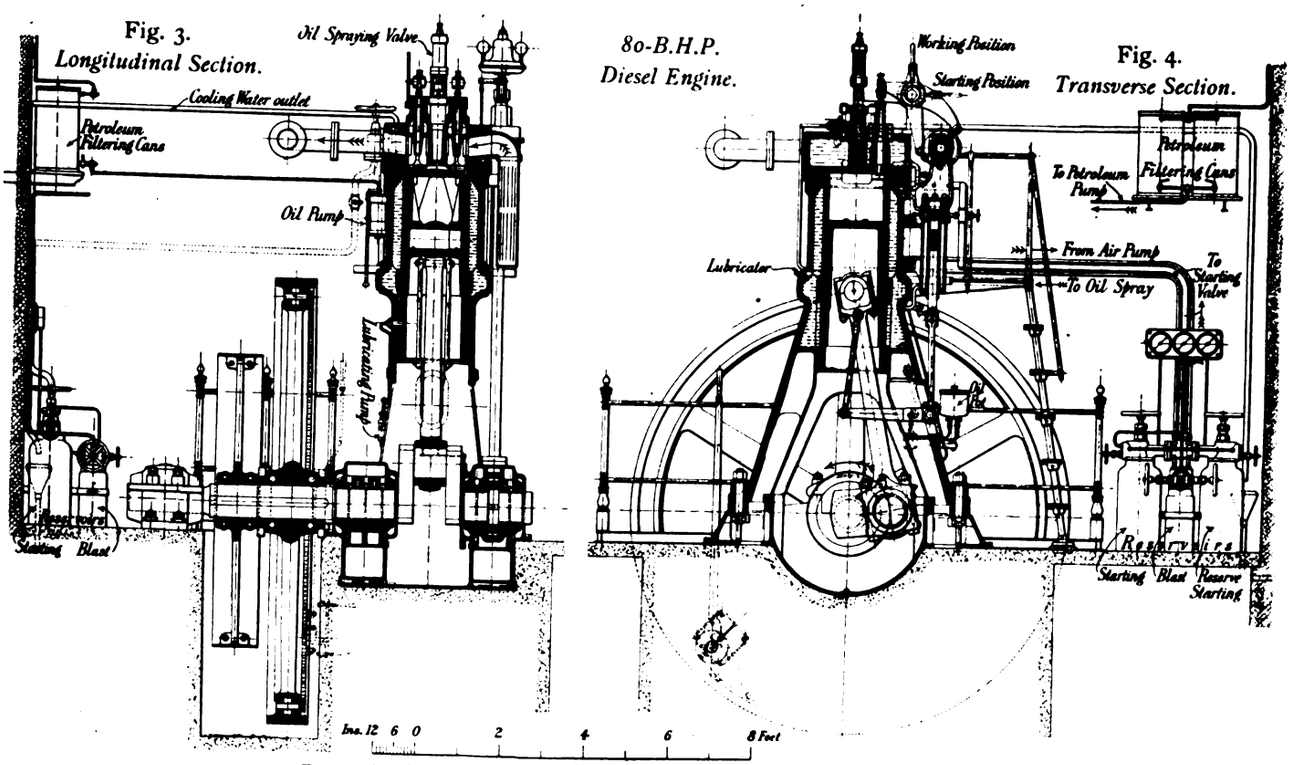

PLATE 2.—LONGITUDINAL AND TRANSVERSE SECTION, DIESEL ENGINE.

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ninety-one, a load of 700 amperes at 115 volts was put on at once, when the lowest reading of the tachometer was 87.8 and the engine settled back to ninety in about half-a-minute.

THE FOLLOWING TABLE GIVES THE RESULTS OF A TEST ON AN EIGHTY-BRAKE-HORSE-POWER DIESEL ENGINE MADE BY THE AUTHOR.

Tests of single-cylinder Diesel engine at Carels Frères, Ghent, on February 7, 1903.

This trial was run in response to the request of A. J. Lawson, engineer to the

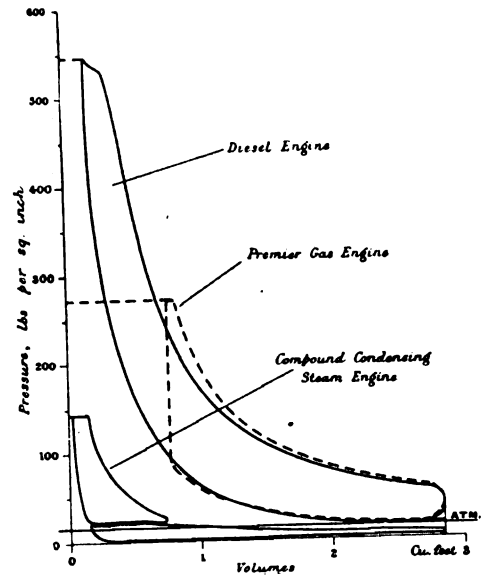

FIG. 6. — COMPARISON OF THE PRESSURES, POWERS, AND CLEARANCES OF STEAM, GAS AND OIL ENGINES.

The indicator cards are drawn to the same scale and for the same total volume of cylinder.
I.H.P. at 160 revolutions per minute.
Diesel Engine = 105. Gas Engine = 66.
Steam Engine 24 × 4 = 96.
(Reduced ½d smaller than original diagram.)

British Electric Traction Company, H. W. Anderson, London, and the author, when on a visit of inspection to Messrs. Carels Frères' works at Ghent. Preparations for running this trial not having been made, it is not so complete as the others.

The transmission to the dynamo consisted of a belt to a line shaft and a belt from the shaft to the dynamo; there was also belted to the shaft a motor which was running light.

In Fig. 6 is shown a comparison of the pressures, powers and clearances of the three types of engine, namely, the compound condensing engine using high-pressure steam with jacketed cylinders, the scavenging type of gas engine using gas of 600 British thermal unit per cubic foot, and the Diesel engine using crude petroleum. The indicator cards there shown are drawn to the same scales and for the same total volume of cylinder.

In the following table a comparative and fairly accurate statement of costs is drawn up for three sizes of engine, namely, 35, 80 and 160 brake-horse-power. The estimate includes interest on plants and buildings, maintenance depreciation, fuel and water.

The gas engine taken for comparison is the Crossley using a Dowson gas-producer. The steam engine compared with is the high-speed compound condensing engine.

The fuels are: For the Diesel, crude petroleum at 45s. per ton. For the gas-producer, anthracite cobbles at 24s. per ton. For the steam engine, coal at 12s. 6d. per ton. In all cases delivered.

The oil-consumption for the Diesel has been taken, in each case, as the mean between the full and half-power rates of consumption.

The fuel-consumption in the case of the gas-producer has been taken at 1.5 to 1.25 pounds per brake-horse-power-hour plus an allowance for stand-by losses.

The fuel-consumption for the steam engine has been taken at four pounds and 3.5 pounds per brake-horse-power for the lowest and highest powers; assuming an evaporation of eight pounds of water per pound of fuel.

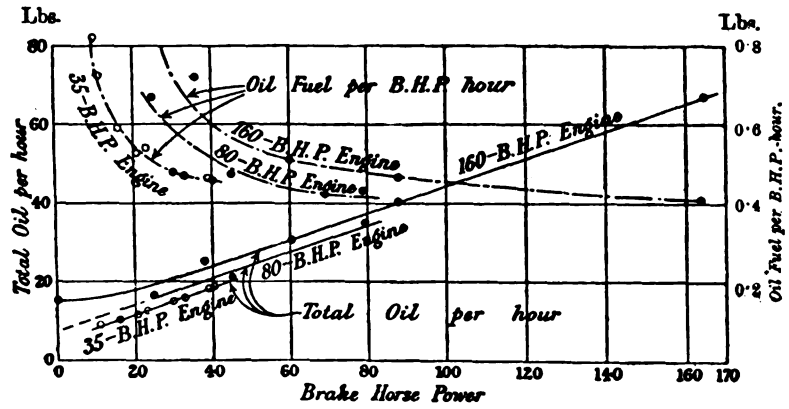

FIG. 5.—OIL FUEL FOR DIESEL ENGINE.

Summary of Results.

1. Load	0.25	0.5	0.75	Full
2. Duration in minutes	30.5	30.1	32	30.75
3. Total revolutions	4,880	4,863	4,800	4,797
4. Revolutions per minute	168	161	160	160
5. Mean effective pressures	48.5	68.4	89.1	109.4
6. Indicated horse-power	46.8	67.0	82.8	101.5
7. Effective horse-power	24 8	45	60.8	79.5
8. Electrical horse-power	17.3	35 6	52.1	68.8
9. Mechanical efficiency	53	67.0	73.5	78.3
10. Total oil in pounds	8.38	10.73	Lost	17.63
11. Oil per I. H. P. hour	0.352	0.320	.....	0.389
12. Oil per effective H. P. hour	0.664	0.477	.....	0.434
13. Oil per electrical H. P. hour	0.952	0.601	.....	0.500
14. B. Th. U.'s per I. H. P. minute	114	104	.....	111
15. Thermal efficiency on the I. H. P., per cent	37.2	40.8	.....	39.9
16. Thermal efficiency on the B. H. P., per cent	19.7	27.3	.....	31.2

The final result is as follows:

Total Cost Per Brake-Horse-Power-Hour.

Engines.	Diesel. Penny.	Gas. Penny.	Steam Penny.
35 B. H. P.	0.59	0.69	0.89
80 B. H. P.	0.89	0.52	0.63
160 B. H. P.	0.32	0.40	0.49

A result which is much in favor of the Diesel engine.

Announcement by the American Electrochemical Society.

The American Electrochemical Society announces that arrangements have been practically completed for supplying free to all members of the society the transactions of the London Faraday Society, the recently formed British electrochemical society. This will be accomplished by supplying the transactions of the American Electrochemical Society free to the members of the Faraday Society. There will be no increase in the dues of the former society on account of this arrangement.

Science Abstracts.

The council of the British Institution of Electrical Engineers has, with the approval of the Physical Society, undertaken the publication of *Science Abstracts* as an institution publication. Mr. Louis H. Walters has been appointed editorial assistant to the secretary and will take up his duties in the autumn. *Science Abstracts* is a monthly publication which gives abstracts of all scientific and technical papers of importance appearing in the scientific technical press. It is published in two sections, one devoted to physical science and the other to applied science, or engineering.

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THE ELECTRICAL DRIVING OF WINDING GEARS.[1]

BY F. HIRD.

The application of electricity to the driving of winding gears forms one of the most recent and important developments in electrical mining work. The improvements, which have made electrical winding a serious rival to steam, are of quite recent date; nevertheless, many electric-

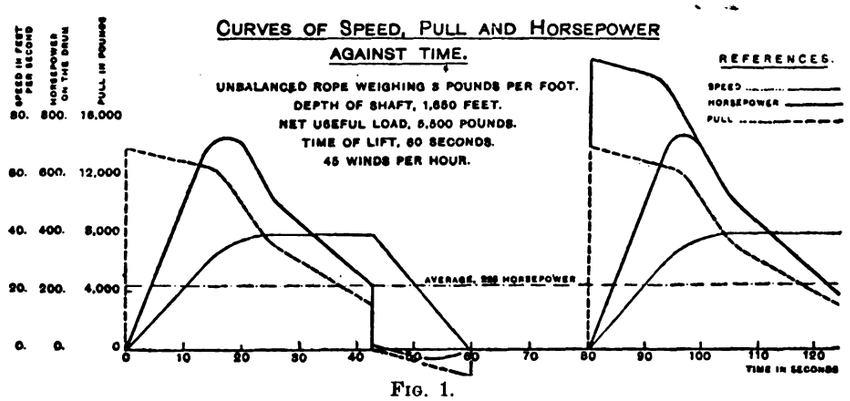

FIG. 1.

al winding gears have already been installed, and have been in satisfactory operation for several years. The earliest applications of electricity have, however, been confined to cases where fuel was costly and water power was available within a reasonable distance. The advantages of electricity as a means of efficiently transmitting power were sufficient in such cases to determine its adoption for driving the winding gears as well as the pumps and other machinery.

It will readily be understood that the chief problem for the electrician lies in finding the most suitable method of control. The motor itself is a well-tried machine, and presents no difficulty, but the controlling apparatus must be designed to meet the arduous conditions of frequent starting and stopping, must provide the greatest accuracy of control, and must permit of steady running at slow speeds for the purpose of repairs, inspection, etc., in the shaft. The usual method of starting an electric motor, by inserting a variable resistance in the circuit of its armature or rotor and gradually cutting it out as the speed rises, is objectionable in cases where the starts are numerous, on account of the heavy loss of energy in the resistance when starting. Messrs. Siemens & Halske, of Berlin, were, the writer believes, the first to devise an electric winding system which efficiently equalizes the power demanded by means of power storage. A winding engine built by the Bergwerksverein Friedrichs-Wilhelmshütte at Mülheim-on-the-Ruhr, and electrically equipped by Messrs. Siemens & Halske, of Berlin, on this system was shown at the Düsseldorf Exhibition of 1902. In this plant two motors are used which are directly coupled to the winding drum without use of intermediate gearing. A battery of electric accumulators furnishes the means of storing power during intervals of no load or of light load, and of assisting the generating station during the times of heaviest demand. During retardation at the end of a trip, the kinetic energy of the moving parts is paid back into the accumulators instead of being wasted in the brakes. The battery fulfils yet another function, namely, that of furnishing a series of voltages for

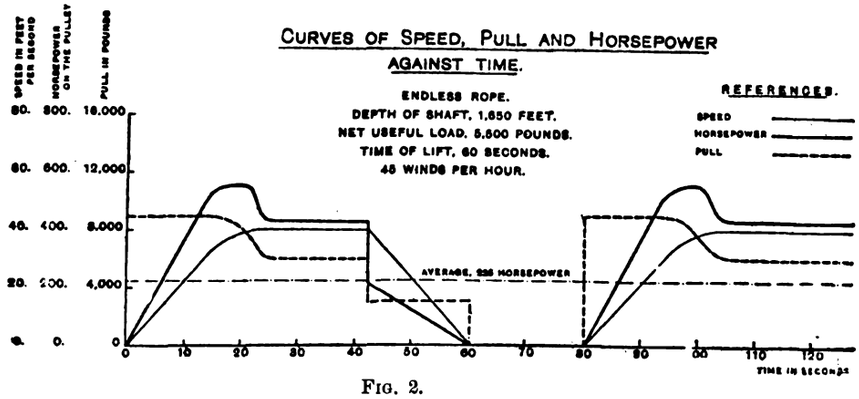

FIG. 2.

effecting the speed control. It is divided into four groups, and the two motors are capable of being connected in series or parallel. The various electrical groupings thus rendered possible give a very satisfactory and efficient speed control. A rheostat is only used to smooth out the steps between successive groupings. The various electrical connections, which have to be made during each journey, necessitate the moving of heavy switching gear, and it is necessary that the correct connections for starting, stopping, paying back energy to the accumulators, and so on, should be effected safely and reliably without any thought or discretion on the part of the attendant. All this has been effected by means of a pneumatic system of control, and the compressed air is also utilized for operating the emergency brakes. The safety appliances are most complete and carefully thought out, and whatever complexity there may be in the switching arrangements is entirely dealt with by the mechanism, and leaves the actual handling unaffected. All the necessary operations are affected in the correct order by the motion of a single handle.

Mr. Ilgner, chief engineer of the Donnersmarkhütte, should be credited with the suggestion of providing for the necessary storage of energy by a suitable high-speed flywheel. The combination of this flywheel with a motor-generator, which furnishes the means of control, constitutes the essential feature of the Siemens-Ilgner system. The control is provided by a motor-generator which consists of the following parts: 1. A motor capable of furnishing the average power required by the winding gear. This motor may be a three-phase induction motor or a continuous-current motor according to circumstances. 2. A continuous-current generator, whose function is to provide the current for the winding-gear motor. This machine is arranged so that the excitation of its field is variable through wide limits, in fact, from its full maximum through zero to its maximum value in the opposite direction. By this means, the voltage or pressure of supply to the motor can be varied through the same range. 3. A small continuous-current machine, whose function is to provide the exciting current for the generator just mentioned, and also for the winding-gear motor. This special exciter is necessary, in order to ensure stability of the field and, therefore, of the pressure, which could not be attained through such a wide range, if the generator were allowed to

[1] Abstract of a paper read before the Institution of Mining Engineers, London.

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furnish its own exciting current. And (1) a heavy steel flywheel, specially designed for high circumferential speeds, so as to store a large amount of energy in proportion to its weight. The current from the generator is taken straight to the armature of the motor, which drives the winding drum, without passing through any switches, fuses or controlling gear, for it is one of the special advantages of this system that no manipulation of the heavy main current is required, the whole of the control being effected by light switching gear dealing only with the small currents used for exciting the field magnets. The motor for actually driving the winding drum is of the continuous-current type. The drums may be driven through gearing, but for powers over 100 horse-power it is considered better practice to couple the motor directly to the drum without any intermediate gearing. The slow speed thus necessitated makes the motor somewhat larger and more expensive in the first place, but the disadvantages of gear for heavy powers, together with the noise and the wear and tear, which are inseparable from its use, more than set off the extra cost. The necessary control is effected by the motion of a single lever which is arranged to work in either of two slots provided in the supporting frame, one for each direction of motion. When the lever is drawn back to its extreme position, and there is, therefore, no current on, it can be passed from one slot to the other. The effect of this motion is to throw over a reversing switch, which controls the direction of the current in the field circuit of the generator. This determines the direction of the main current furnished to the winding motor, and, consequently, the direction of its rotation. The motion of the lever in either of the slots has the same effect; it gradually cuts out the resistance which is connected in the field circuit of the generator, which thus acquires a stronger field and, therefore, provides a proportionally greater electrical pressure to the winding motor. The excitation of the field of the motor, however, is kept constant and, since its speed is proportional to the pressure of its supply, the forward motion of the lever determines a corresponding increase in the speed of the winding motor. For each position of the controlling lever there is a definite speed of the winding motor; and this is quite stable and independent of the load and can have any desired value from nothing up to the maximum rate of speed.

Too rapid motion of the controlling lever is prevented by means of an adjustable oil dash-pot. A depth indicator is provided which consists of two vertical screws suitably geared to the drum, each having a traveling nut, representing one of the winding cages. These nuts are provided with curved steel fingers, which come into operation near the end of their travel and push back the control lever to a position which allows only of a greatly reduced speed. The attendant can then no longer increase the speed, but, as the lever is free to go further back, he has complete control as regards further slowing down or stopping. Should he, however, through any accident or negligence, miss stopping at the right moment, a second finger on the nut pushes the control lever into the off position and applies the emergency brakes. There are usually two sets of brakes provided, the working brakes and the emergency brakes. The former are applied by the action of a piston working in a cylinder to which compressed air can be admitted. The valve for admitting the compressed air is operated by a handle, placed conveniently near the controlling lever, and connected with it in such a manner that when it occupies the off position the brakes are applied, and they are released when it is moved to the starting position. It should be noted that normally the brakes are only used to hold the load, and that there is no absorption of power, any excess of energy in the moving system at the end of the journey being taken up electrically. Thus, when the winding cages are traveling at full speed, if the control handle be moved back nearly to the off position, the pressure of the generator is reduced below that which the winding motor can produce, the latter, therefore, works as a generator, pays back energy into the motor-generator, accelerates its speed and thus stores energy in its flywheel; and meanwhile it draws its generating power from the energy of the moving system and thus produces the necessary braking effect. After a little practice, the right moment for drawing back the control lever is ascertained and the winding cage is brought to rest at the right place without using the compressed air brake until the last moment. The emergency brakes are entirely distinct from the working brakes and are applied by means of a counterbalance weight, which is normally supported by the pressure of the compressed air on a piston, and by this means the brakes are held off the drums during working. The brakes are, therefore, applied if through any accident the air-pressure fails; they are also applied by a special trigger on the depth indicator should the cage overrun the bank as mentioned already, and they can also, in the case of emergency, be applied by hand. In any case, the fall of the weight is arranged to open a special emergency switch which entirely disconnects the winding motor. It will be seen that very ample provision has been made for security and to guard against misuse or negligence.

The writer will now consider, in a little more detail, the exact action of the flywheel on the motor-generator, as this forms an important feature of the system. In Figs. 1 and 2 the thick black lines represent the horse-power momentarily required on the drum or pulley. Fig. 1 represents the case of an unbalanced rope, and the fluctuations of horse-power are naturally much greater than in Fig. 2, where there is an endless rope passing over pulleys at the top and bottom of the shaft; the average horse-power, however, is the same in both cases. If we succeed, therefore, in completely equalizing the demand for power by means of flywheel storage, the demand for power will be the same in both cases; we shall, however, require a larger flywheel in the first than in the second case. Taking the first case, we find from consideration of the curve that the amount of stored energy available must be 9,000 horse-power-seconds, or 4,950,000 foot-pounds. To store so large an amount, the flywheel must be made entirely of steel, and run at a peripheral speed of about 16,000 feet per minute. Under these conditions, a fourteen-ton flywheel would give out 9,000 horse-power-seconds with a reduction of speed of about ten per cent. In practice, the flywheel would be made of a weight of about twenty tons, so as to allow for the inevitable loss of energy in the double conversion. The total amount of energy stored is, of course, much greater than the amount mentioned above, but it is only available by admitting of a greater reduction of speed than is advisable in normal working. Should, however, any accident occur, which involves the entire cutting off of the electric supply, the energy stored in the flywheel would all be available, allowing only for electrical losses. The net stored energy in such a flywheel is about 380 million foot-pounds, of which at least seventy-five per cent is available for effective work on the net useful load.

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The useful work to be done in one lift is 5,500 pounds by 1,650 feet, or 90.75 million foot-pounds. Consequently, it will be recognized that there is enough energy stored for three lifts after the total cessation of the electric supply. At the beginning of a journey, the motor-generator may be assumed to be running at nearly its maximum speed. When the lift commences, the power is at first supplied entirely by the generating station, but as soon as the demand has become greater than the average, the motor-generator begins to slow down and its flywheel furnishes the excess of power required; as soon, however, as the demand for power has fallen again below the average, the motor-generator begins to speed up again, storing power once more in its flywheel. It continues to do so after the completion of the trip and before the next lift begins, drawing this power from the generating station and providing it with a load during the period of rest. If the plant is well proportioned for the conditions of the work, the motor-generator will have nearly reached its maximum speed when the next call for power comes upon it. Should an unusually short rest occur, it will not have reached so high a speed and will run somewhat slower for one or two trips, while, if an unusually long stop occur, it will reach its full speed before the next lift commences, and its demand on the generating station will begin to fall, so that the equalization of load will not be complete. In practice, however, with a fair margin in the flywheel, the equalization will usually be pretty complete, and if the generating station be used for other work, or if there are several electric winding engines at work, the actual fluctuations in the demand on the generating station will be practically negligible.

The steam consumption of winding engines varies through an enormous range according to the nature of the work, of the engine itself, and of the attention it receives; but, in any case, it is extremely high as compared with ordinary steam practice on fairly steady work. It is clear, therefore, that the conditions of steam winding are unfavorable for economy. The engine has to be capable of very great though short overloads, the load itself is extremely intermittent, and there are intervals of standing idle during which steam is being condensed in the pipes, and, very possibly, it is blowing off from the boilers in great quantities as well. Again, the engine must be capable of running in either direction and of starting from any position These conditions are in themselves unfavorable for economical valve-setting, but they have the still greater disadvantage that the steam distribution has to be largely under the control of the operator, and this in itself is a most prolific source of waste. A trial has recently been made on the large twin-tandem winding engine of the Rheinebe III colliery, the property of the Gelsenkirchen Mining Company. The trial extended over one shift of nine hours, and the consumption of steam was found to be 114 pounds per effective horse-power-hour. (All the steam consumptions given in this paper are per horse-power-hour on the net useful load lifted in the shaft.) During this trial the winding engine was handled in the usual manner by its ordinary attendant, and the conditions were those ordinarily obtaining. A second trial of nine hours was next taken, in which the only difference was that the operator was strictly supervised during the whole extent of the trial by an expert engineer. The result was a consumption of seventy pounds per effective horse-power-hour. These figures speak for themselves, but they have a special significance from our point of view, as will presently be seen. In the preceding trials, the steam exhausted into the atmosphere, and a further trial, under condensing conditions, with the same careful supervision, gave a steam consumption of fifty-seven pounds per effective horse-power-hour, Other searching trials, extending over long periods, have been made by Mr. Buschmann on the winding engine at the Heilbronn salt mines, and this engineer concludes that with such care and attention as can be realized in practice, seventy-seven pounds of steam per effective horse-power-hour can be attained, though with special supervision of the operator he reached so low a figure as sixty-eight pounds. We shall, however, err greatly if we suppose that such figures represent a fair average of what is taking place in the winding engines actually in operation. These results were obtained with modern engines of the best and most economic type, and care was taken that the engines should have full duty during the trial; but if we take into account the losses incident to times of slack lifting or of total cessation of work, a figure of about ninety-five pounds will be nearer the mark; while if we consider cases such as are unfortunately too common, where very low pressures, late cut off and generally obsolete and inefficient machinery and methods are in use, it is hard to say what extravagant figure may not be reached. We are now in a position to understand the full importance of an equalized load on the prime-mover. For it may be observed that the extravagant steam consumptions just given are almost entirely attributable to the intermittent nature of the work. On the other hand, given a fairly uniform load moving at a constant speed, and there is clearly nothing to prevent us availing ourselves of the best modern practice in the economical generation of power. In making a comparison with the tests just quoted, however, we will not assume the very highest attainable economy, but a moderate working figure. A fair average steam consumption for a modern generating plant under the conditions of daily work with moderately fluctuating loads, such as we may expect in this case, is twenty pounds of steam per electrical horse-power-hour, and this value will be taken as the basis of our comparison. Experience with existing electrical winding gears and a careful consideration of all the working conditions with the Siemens-Ilgner system leads one to expect a total efficiency of sixty per cent under daily working conditions. That is to say, of the total electrical energy supplied to the terminals of the motor-generator, sixty per cent appears as net work in raising the useful load in the shaft. To be on the safe side, however, an efficiency of only fifty per cent will be taken, from which we deduce a steam consumption of forty pounds of steam per effective horse-power-hour on the useful load, a great deal less than the best result with steam, and less than half what may be regarded as an average working result with steam winding. No negligence or mishandling on the part of the operator can appreciably affect this figure. The steam distribution in the engine cylinders is entirely out of his control and the chief cause of waste is thus removed. Practically, the only harm that he can do is to make a bad stop with an undue amount of braking, but even this has little effect on the economy, for with this system the energy of the moving parts is not wasted in friction but stored in the flywheel and at least seventy-five per cent of it may be recovered. It is, in the writer's opinion, one of the chief advantages of the system that it removes from the attendant the dangerous power of controlling the steam consumption. It is, of course, advisable in this, as in any system, that attention should be paid to the correct operation of the winding engine, for only in this way can rapid and uniform handling of the output be attained, but any lack of care is not attend-

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ed with the direct and disastrous losses which occur in steam plant.

The writer must not close this paper without briefly referring to the subject of the first cost involved in electrical plant. Naturally, it is not possible to say anything very definite on this point, since it greatly depends upon the particular circumstances of each case; but, broadly speaking, one may say that the cost of an electrical winding plant, with motor-generator and all safety and controlling devices complete, would be about the same as that of a good modern steam winding plant of the same capacity. We have, of course, to consider the means of generating the electricity in addition. The cost of this will depend greatly upon circumstances, but it will not usually be a heavy item. In most cases a generating station would be erected for other work besides winding, and the average power only has to be supplied. In such cases the fair share of the cost attributable to the winding gear would probably not exceed the sum saved in boilers, stokers and steam pipes, which would be dispensed with owing to the smaller steam consumption.

International Conference on Wireless Telegraphy.

The countries represented at the International Conference of Wireless Telegraphy were the following: Italy, Germany, England, France, Austria, Russia, Hungary and the United States. Each country sent representatives to the number of forty-four, belonging particularly to the administration of Posts and Telegraphs of the countries mentioned.

As is known, the conference had for its purpose to prepare solutions of the problems raised by wireless telegraphy between the different countries, but without that its deliberations had a definite character.

The first meeting took place in the Assembly Hall of the Bureau of Imperial Posts, Berlin, Germany, and was opened by M. Krätka, who welcomed the members in the name of his government. It was decided to keep the deliberations of the commission rigorously secret.

One notice connected with the conference is that of the experiments of Professor Slaby on wireless telegraphy, which he is conducting now at Berlin. To continue his researches on wireless telegraphy he has received a subsidy of 25,000 francs from the "Jubilee Funds of the German Industrie." Now, on the occasion of the above-mentioned conference, Professor Slaby presented to the commission a preliminary report on the results obtained.

Up to the present, the part played by the earth in wireless telegraphy was an unsettled question. By creating a kind of artificial earth by means of an extended structure of zinc, the author had been able to detect the presence of stationary waves, putting in evidence a remarkable concourse of the earth in phenomena for this purpose.

The theory of closed transmitters has not been able to explain the effects at a distance and Professor Slaby established a new theory, explaining them by harmonics.

The most important part of the present researches was given the construction of apparatus for easy manipulation. More than twelve types for this purpose being described. E. BIGNAMI.

Berlin, August 22.

PNEUMATIC AND ELECTRIC LOCOMOTIVES IN AND ABOUT COAL MINES.[1]

BY A. S. E. ACKERMANN.

The seams worked in America are much thicker and nearer the surface than in Britain, and the dip is very much less, five per cent being about the maximum, while faults are almost unknown. The roofs are usually good, fire damp is rare, and a large percentage of the mines are drift ones. In this country electrical energy is transmitted to the pit bottom where it is used for driving one of the rope-haulage systems, but in America the twenty-one cases that the author saw were on the overhead-trolley system and were worked with locomotives. Pneumatic locomotives are much more cumbersome than electric locomotives, owing to the two large steel compressed-air vessels which they carry, and hence they can only be used on the main haulage lines and where there are no sharp curves. The usual arrangement is to have electric haulage even where cutting is done by pneumatic machines.

The electric trolley wire is very simply fixed from the roof where it is good, or from the cross-timbers where it is bad, and the rail is used for the return, though, in the case of coal-cutters, there are usually two bare wires, both supported from one set of brackets fixed to the roof and with the earthed wire on the outside, so that it slightly protects the positive or live wire. It has been said that a man can lay a greater length of electric cable in a day than he can pipes in a week. The cost of the electric locomotive compares favorably with that of the pneumatic. In upkeep the electric system also has the advantage, and the efficiency of electrical transmission of energy is considerably higher than that by air. The weight of the rails is usually forty pounds per yard, but in nearly every mine they wished they had heavier metals, whatever their actual ones happened to be. The mines are systematically worked on the pillar-and-room system, electric trolley haulage is used on the headings, and the men who load the tubs in the rooms push them to the entries where they are picked up by the electric locomotives.

Electric locomotives are much smaller than the pneumatic ones of the same weight; the overall dimensions of a thirteen-ton electric locomotive being about three feet in height, four feet eight inches in width and twelve feet six inches in length, with a wheel-base four feet eight inches in length, gauge three feet six inches (the gauges vary in different mines, but three feet six inches may be taken as the average) and capable of exerting a draw-bar pull of 4,300 pounds. Much smaller electric locomotives can, however, be obtained, as for example, one which is only two feet five inches in height, three feet six inches in width and nine feet three inches in length, with a wheel-base three feet in length, weighing four tons, and having a draw-bar pull of 1,000 pounds. This is, of course, a great advantage, and they run at about the same speed—namely, about eight miles per hour. At first there used to be considerable trouble on account of the armatures being burnt, owing to overloading and the heavy starting current. Now, even an eleven-ton electric locomotive is fitted with two forty-horse-power motors, one on each axle.

In drift mines the external part of the system is like a small overhead trolley-tram system, the conductor being attached to cross-wires supported by two rough wooden poles, one on either side of the line. The trolley wire in such cases is usually, but not always, kept at such a height as just to clear one's head. Electric storage battery locomotives have also been made, but the author did not meet with any; 250 and 500 volts were the only pressures met with, and all were continuous current, though in one mine three-phase current was used for working the pumps. The tendency in America is undoubtedly to use electric locomotives and coal-cutters more and more. In the Windber mines, seven power-houses have a total capacity of 2,500 kilowatts. There are seventy-five miles of trolley line, worked by forty-three thirteen-ton electric locomotives of which the combined power is about 3,400 horse-power; the output from one mine is 2,000 tons per day, and the others have about the same output each. In addition to rope haulage they had eight mules and eight drivers costing £4 per day for an output of 200 tons, that is sixpence per ton. When two thirteen-ton electric locomotives were installed the output increased by 1,000 tons per day at a cost for haulage of £1 12s.—or less than one halfpenny per ton.

[1] Abstract of a paper read before the Institution of Mining Engineers, London.

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Surface Contact Systems on the Paris Traction Lines.

By C. L. Durand.

PARIS contains a great variety of electric traction systems, owing to the fact that the trolley is not generally allowed within the city limits. The lines which pass through the city and thence to the suburbs are obliged to adopt a method of traction within the city limits which will avoid the use of the trolley, and as the lines are owned by many different companies, each choosing its own method, nearly all the existing systems have been given a trial. A great number of lines use the accumulator system within the city and also in the suburbs. One line has an accumulator locomotive which is switched off at the city gates and the car continues over a trolley line. The underground conduit is now working very successfully upon a large system of lines, while the surface contact is also proving a favorite. Two of the leading surface contact systems will be here described. Both of them have been given a thorough test during a number of years.

The Diatto system of surface contact is now in use on a number of important lines which pass from the city to the suburbs in different directions, using the surface contact inside the city and the trolley for the suburban lines. The different lines on the west bank of the Seine

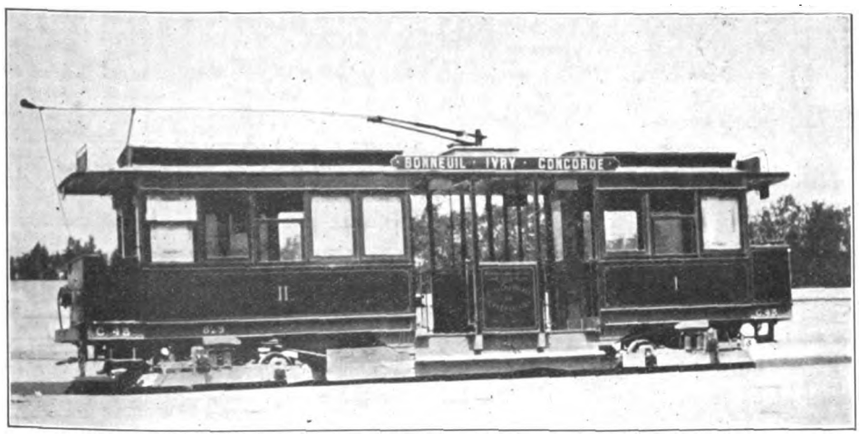

FIG. 1.—CAR ON DIATTO SYSTEM, PARIS, FRANCE.

are supplied from the large Moulineaux station which has been recently described. The three-phase current at 5,000 volts is transformed to 550 volts, direct current, by a series of substations which supply each road. Fig. 1 shows the standard type of car which is used on all the Diatto lines in Paris. The first and second-class compartments are separated by a large central platform. These cars carry forty-eight passengers in all, and use two Westinghouse motors of thirty-five horse-power each. The Diatto system uses a number of circular contact blocks, which are laid between the rails. A long contact-bar carried under the car passes over the blocks and brings the current to the motors. The mechanism for distributing the current from the underground feeder to each block as the car passes is contained within the block itself. It consists essentially of an iron plunger which is raised by the magnetized bar carried on the car, and thus completes the circuit for the block.

The working of the Diatto contact block will be observed in the accompanying diagram (Fig. 2). A circular disc of soft iron A, which forms the rubbing portion and is slightly rounded at the upper surface, is fixed in the centre of the plate U which is cast in non-magnetic metal and is of such a shape as to resist hard shocks. This external plate is fixed in turn by means of three bolts into a bronze collar C, and the latter is imbedded in an asphalt block B of considerable size. This block is hollow inside and forms a receptacle which contains all the working parts. The block is fitted in the pavement, coming about flush with the road level, and its hollow interior part is continued down to the ground by the earthenware pipe T, which rests directly upon the surface of the ground. To the soft iron piece A is fixed a cup-shaped brass cap *e* which is in turn fastened by means of three bolts to an ebonite chamber or vessel Q. This lower vessel which is enlarged at the top tapers down to a cylinder in the lower part and contains a cylindrical iron piece *r* which can move up and down freely.

The tube is closed at the lower end and contains a certain quantity of mercury which surrounds the lower part of the cylinder *r*. The chamber thus formed by the cap *e* and the ebonite piece is hermetically closed by means of a rubber gasket at the joint. The cylinder *r* floats in the mercury and its weight is so proportioned to the quality of mercury that a very slight mag-

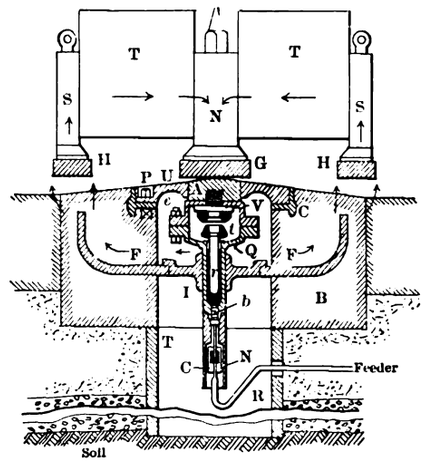

FIG. 2.—DIATTO SURFACE CONTACT SYSTEM.

netic attraction will suffice to lift it up. To the upper end of the cylinder is fixed a conical shaped piece of carbon which is specially prepared so as to be very solid, and has a high conductivity. A second carbon piece V which is turned in the interior to form a conical socket is fixed to the soft iron screw which serves to hold the cap *e* against the piece A. The lower part of the ebonite cylinder Q is stopped up by the copper screw plug which serves to make electrical contact with the mercury in the cavity. A copper wire inserted in the plug passes down inside of a second ebonite tube N which is fixed below the first; this wire serves to bring the current from the underground feeder. The cylindrical part of the device is held in the middle of a soft iron disc I which forms a socket, and the disc is supported at either end upon two curved pieces of soft iron FF′ which have a high magnetic permeability. These soft iron pieces serve as a mechanical support, being embedded in the asphalt block, and also complete the magnetic circuit through the central part of the device and the rails which are carried upon the car above, and the attraction exerted upon the mechanism by the bar is greatly increased. Owing to this construction the whole device is solidly fixed inside the asphalt block, and by lifting up the block from the pavement the whole ap-

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paratus is taken out without any further operation.

An automatic connection is made below by a special form of contact device. The lower tube N contains a small metal cylinder or cup C which contains a certain quantity of mercury. This cup is fixed to the end of the feeder wire R which is rigid and holds it in place in the vertical position, so that when the block is inserted in the pavement the copper wire projecting from the screw plug *b* comes down into the mercury cup and completes the circuit. The contact is well protected by the ebonite cylinder which encloses the whole and besides acts as a protecting device should the hollow interior become filled up with water. In this case the air is compressed in the upper part of the cylinder N and prevents the water from reaching the mercury contact.

The magnetic device by which the circuit is closed when the car passes over the block is of a very simple character. The car has a long iron rail suspended underneath it and magnetized by solenoids. The rail rubs over the upper side of the contact block A and in this position it attracts the cylinder *r* which is partly lifted out of the mercury and comes against the under surface of the block. In this way a contact is made between the two carbons, but without lifting the cylinder completely out of the mercury. It still makes contact with the lower circuit and the current passes up from the feeder R through the carbon contacts to the rail under the car which is connected electrically with the motor circuit. The current passes to the motors and thence to ground. As the use of a simple bar would probably not give a sufficient magnetic pull on the cylinder, the effect is strengthened by the device shown in the diagram. The main bar G in the centre, which runs along the whole length of the car, has two similar bars III′ on either side, separated by a short space. The bars are connected across at intervals by a series of iron covers on which are mounted the solenoids TT. The current from the motor circuit passing in the solenoids magnetizes the system so that the middle bar forms a N pole and the side bars two S poles. The magnetic circuit is completed below through the contact block by the side pieces F which are curved up and come very near the surface so as to leave as short an air-gap as possible. The arrows show the direction of the magnetic circuit.

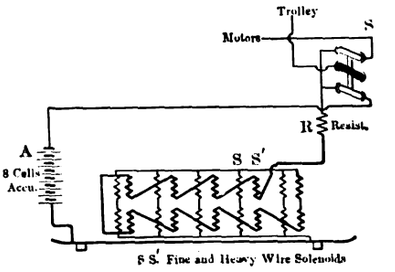

Fig. 3.

As will be noted, the outer edges of the asphalt block are on a level with the pavement, but the block slopes up toward centre so as to allow the metal contact disc to project about two centimetres above the street level. The interior of the block is inspected by removing the three bolts *p* which hold down the cap U, when the whole device can be lifted out of the casing. When replaced, the contact with the feeder is automatically made by the mercury cup C. The contact blocks are spaced along the middle of the track between the rails, and the space between them is less than the length of the contact bar, so that there is always one block in contact.

A simple device has been adopted in order to avoid breaking the current between the carbon blocks and thus forming an arc inside the apparatus. The rear end of the contact rail is curved up slightly, so that as the rail passes ahead the current is broken between the rail and the block at the curved part, but as the rail is still over the block its magnetism is sufficient to keep the cylinder still lifted up against the top, so that the carbons are held together for a short period while the current is being broken above. As the rail passes on the cylinder falls and separates the carbons, but as they are no longer carrying current there is no arc or spark formed in the interior when all else is working properly. As the good working of the system depends in a large degree upon the carbon contacts, special attention has been paid to this point, and at present a very hard graphite carbon is used which is very pure and quite homogeneous. The carbons are very hard and can be turned down in a lathe to the required form and given a high polish. A perfect fit is secured between the head and the upper socket, and owing to the great surface which is employed there is little liability of sticking.

The solenoids which connect the magnetized bars on the car are wound in two circuits, as shown in the diagram (Fig. 3); a heavy wire winding carries the main current from the motors, while a second fine wire winding is used with a small battery of accumulators which is carried on the car in order to magnetize the bar. This is necessary at starting and in some special cases a small battery of eight cells, giving eight amperes and sixteen volts, is used for this purpose. A double-throw switch is used for changing over from the trolley to the underground circuit.

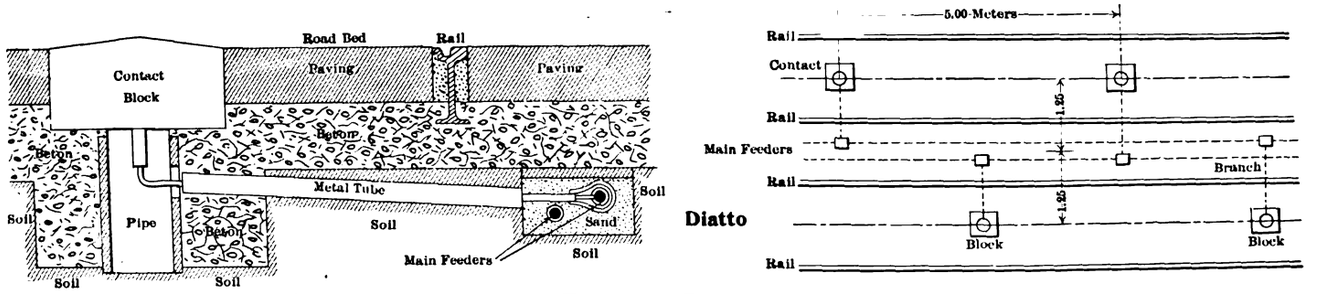

Fig. 4.—Method of Laying the Track and Feeder Connections, Diatto System.

The method of laying the track on the Diatto system is indicated in the section, Fig. 4, which shows the asphalt block in the centre of the track, with the central cavity which is continued down to the soil by the earthenware pipe. Thus any water which might accumulate is drained off directly into the soil. The two feeder wires, one for each track, run along between the two tracks in a trench filled with sand. The feeders are formed of armored cable of fifty square millimetres section. From the cable passes a rubber-covered copper wire which connects the feeder with the contact block. The wire is surrounded by a metal tube of large diameter

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which serves to protect it. The asphalt block is supported on a bed of cement beton and is surrounded by the wood or stone paving, as the case may be. The contact blocks instead of being all connected to the same feeder are branched alternately on the first and second feeders, as shown in the plan of the track, so that in case of accident to one of the feeders there will always be a certain number of live contacts on the other feeder and as these will now be spaced ten metres apart or double the distance, the cars will continue to run provided they do not stop on a dead block.

The Clairet-Vuilleumier system of surface contact is now in very successful operation on the Trinité-Enghien line which runs from the centre of the city to the suburbs. The engraving shows a motor car and trailer at the city terminus, with the disposition of the contact blocks. This line is operated by the Compagnie des Tramways Electriques Nord-Parisiens, whose secretary, M. Durangel, has kindly furnished the following data. The surface contact system is used exclusively within the city, but on arriving at the suburbs the cars change over to the usual trolley system. One peculiarity is the use of a double trolley on the cars. This was made necessary as the line uses a section of track which belongs to a system of accumulator cars and the rails were consequently not bonded, therefore a rail return could not be used. After passing over this section, which has a double overhead wire, the single overhead line is

CLAIRET - VUILLEUMIER SYSTEM — CAR AND TRAILER AT TERMINUS OF LINE—SURFACE CONTACT BLOCKS PLACED CLOSE TOGETHER AT THE TERMINUS TO ALLOW THE CARS TO APPROACH.

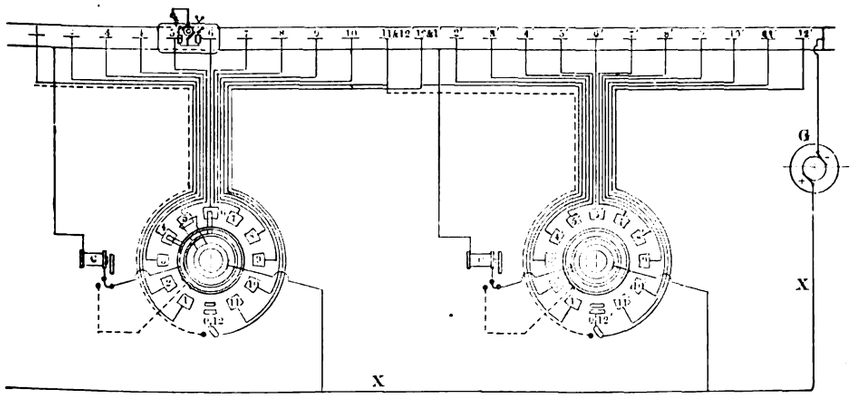

FIG. 5.—CLAIRET-VUILLEUMIER.

reached and one of the trolley poles is lowered by the conductor and held down by a hook. The cars, which are of handsome design, are equipped with two Westinghouse motors of thirty-five horse-power each. The cars have two compartments for first and second-class which are separated by a central platform. The conductor has at hand a small controller drum which enables him to change over from the underground to trolley and also from double to single trolley. The method of supplying the current to the contact blocks and from thence to the car by a friction-bar will be understood from the following figures: The current for the line is furnished by the large three-phase station which is located at Asnierès. Two substations near the track lower the voltage to 550 volts, direct current, by a set of transformers and rotary converters.

The current from the central station dynamo G (Fig. 5) is sent by an underground feeder X to a series of distributors or automatic relays which are placed along the track every 100 metres. From the distributors start a series of small wires which supply current to each of the contact blocks placed between the rails. These contacts are formed of a simple metallic block imbedded in the pavement and are slightly raised above the surface so that the contact rail which the car carries underneath it can rub over the upper surface. This succession of blocks which receive the current only at the instant when the car passes serve to distribute the current for the motors. As the car continues on its course its contact rail touches the block which is immediately in front without having left the preceding one. As the forward contact is connected to the distributor by one of the wires, a small portion of current is shunted into the distributor and serves to operate a fine-wire electromagnet of high resistance which forms part of the distributor. The latter acts as a relay and sends the main current into the new block, cutting it off from the preceding one, as will be further indicated. From this time on the current for the motor is furnished entirely by the new block until it is in turn replaced by the succeeding one, and so on.

The method of laying the track on the Clairet-Vuilleumier system is shown in the plan view and sections, Fig. 6. Between the rails are the contact blocks p which are spaced 2.50 metres apart. They are formed of a box-shaped steel casting and have about the same shape as the ordinary paving block which they replace. The block is insulated from the paving by asphalt. A copper wire of seven millimetres section is riveted to it to carry the current. The different wires which bring the current from the distributor to the blocks are lodged in an iron tube C which runs along between the rails. Its position is also shown in the sectional view, where CD is the section through the block and AB a section at one of the junction boxes C along the iron piping. A pair of blocks is connected together elec-

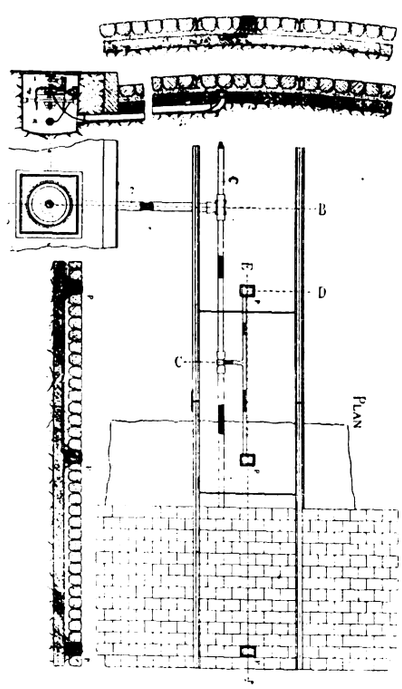

FIG. 6.

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trically and is fed by a common wire. The tube carries all the wires that belong to a single distributor, which generally feeds thirty-eight blocks. One of the distributors is seen on the left. It is contained in

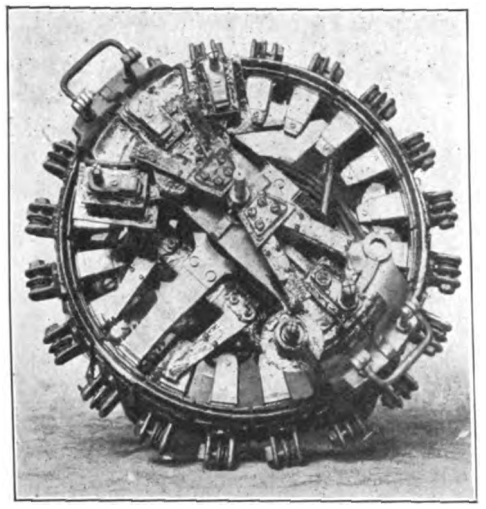

FIG. 7.—CLAIRET-VUILLEUMIER SYSTEM DISTRIBUTOR—TOP VIEW.

a cement vault which is sunk below the level of the sidewalk and has a manhole with a flush cover.

The distributor is a simple and ingenious device which serves to connect one after another of the blocks to the main circuit upon the passage of the car. Contrary to the Diatto system, where the mechanism is contained in the block itself, in the present case the block is a simple piece of metal and the contacts are shifted from one block to another by a kind of progressive relay or rotary switch. The photographs show one of the distributors for nineteen contacts or thirty-eight blocks (two blocks being connected together). The engraving, Fig. 7, shows the top view of the distributor, and Fig. 8 a view from below, while the diagrams, Figs. 9 and 10, explain its ac-

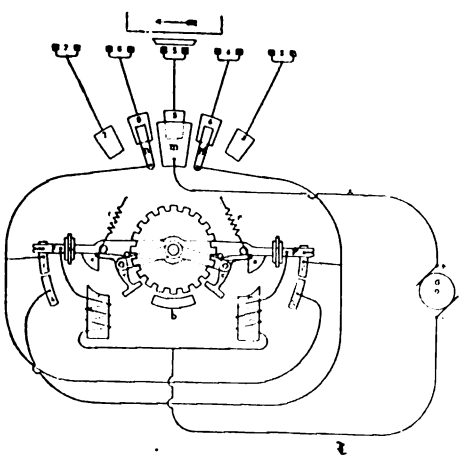

FIG. 9.

tion. The distributor is provided with twenty contact plates which are mounted on a circular metal casting. These twenty switch points are insulated from each other. The circle is held upon a central plate provided with vertical feet or supports, as seen in the lower view. The base-plate carries a bearing which supports the central shaft carrying the revolving parts. On the shaft is carried a wheel which contains a certain number of notches corresponding to the number of switch points, also three contact plates, *n, m, n,* which are solid with the notched wheel. The three contact plates are insulated from each other and rest upon three consecutive switch points. There are three brass rings which form a collector and maintain the electrical connection between the three contact plates and the three binding-posts on the frame of the apparatus.

The middle plate *m* serves to distribute the current which it receives from the main feeder cable X. It is larger than the interval comprised between two switch points, so that it comes in contact with the following point before it leaves the preceding one. The two other plates *n n'*, placed symmetrically on each side of the

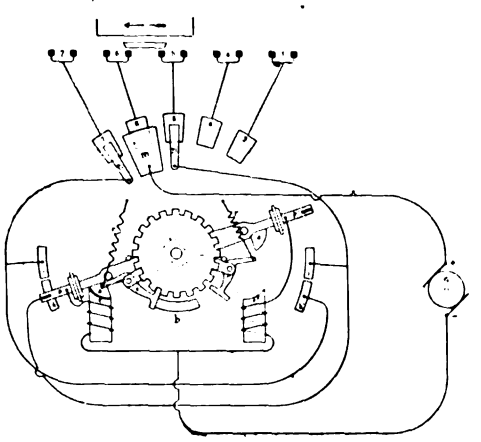

FIG. 10.

larger one, are of smaller size and leave one point completely before engaging with the second. Each of the three plates is connected by means of a commutating device with the entry wire of an electromagnet and the outer wire of the magnet goes to the rails of the track or to ground. There are two such electromagnets which will be noticed below the frame. They are provided with an armature in the form of a double anchor which is solid with the swinging bar of the commutator. This armature oscillates to and fro between the poles of the magnet. The action of the distributor will be clearly observed from the diagrams, where the parts are shown in simplified form. The electromagnet *e* on the left is the only one to be considered at present, as the second magnet is used when the car travels in the opposite direction on the track. In Fig. 9 the car is passing in the direction of the arrow and takes current from the pair of blocks No. 5. As the car passes to the left it takes the position which is shown in the second diagram. By means of the contact rail on the car, a circuit is formed between the main

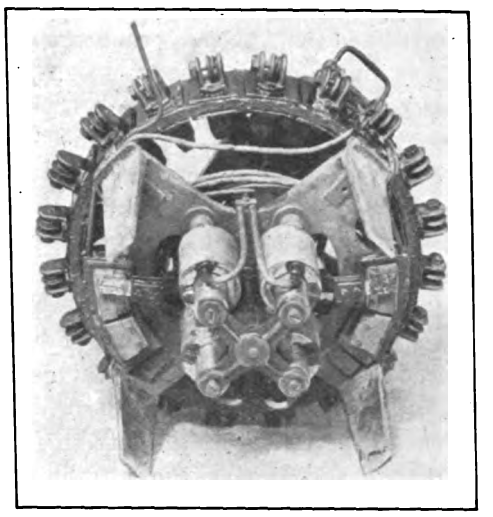

FIG. 8.—CLAIRET-VUILLEUMIER SYSTEM DISTRIBUTOR—BOTTOM VIEW SHOWING SOLENOID WHICH OPERATES THE MECHANISM.

switch plate *m* and one of the small ones *n'* which has the effect of exciting the corresponding electromagnet or that on the left-hand side *e'*. The magnet causes the armature to swing in the direction as shown in the second case, Fig. 10, and as the armature is drawn down the pawl *c* engages with one of the teeth of the ratchet wheel and thus causes the wheel and the main contacts which are fixed to it to advance by one-twentieth of a revolution. By this movement the three contact plates *n, m, n'* are made to shift by one switch point and the car is now supplied with current by the following pair of blocks No. 6. At this moment the pawl is stopped by a piece *b* which limits its course and in consequence the rotary movement of the armature and the three plates. This condition holds good until the car has advanced beyond the block No. 5. Then the shunt current ceases to pass in the electromagnet and the pawl is brought back by a spring which works against the action of the magnet. This causes a reverse movement

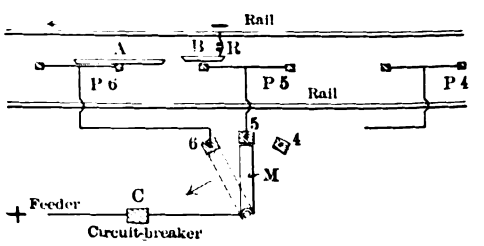

FIG. 11.

of the armature and bar, and brings them back to the starting point, that is, in a position which is symmetrical with respect to the electromagnet (Fig. 9).

In the back movement the spring draws

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the pawl out of the ratchet wheel so that the latter remains in its newly acquired position, and with it the plates *n, m, n'*, which have thus been made to advance by one-twentieth of a revolution. As the car continues, the shunt current is again established in the electromagnet and the same operation takes place, shifting the contact pieces by another twentieth of a revolution, and so on, and the blocks of the section are thus supplied with current as the car advances. After passing the twentieth block the distributor has made a complete revolution. The car then comes on to the blocks which are fed by the second distributor and the action continues in the same way. The first distributor is then ready to operate with the next car. The different distributors are connected together by a circuit which allows the shifting from one to the other to take place properly.

The rail which is carried underneath the car in order to take the current from the blocks to the motor circuit is formed of a piece of angle iron 3.30 metres long with the flat surface presented to the blocks. It is supported by a spring device which presses it against the blocks.

The car carries a second contact rail which is placed behind the main rail and acts as a safety device. The second rail is a short piece of flat iron about one metre long. The diagram, Fig. 11, shows the action of this device. It serves to cut off the current should anything happen to a distributor. At A is the main contact rail and B the small rail. The latter is connected through a low resistance R with the track. Below are shown three of the switch points 4, 5 and 6 corresponding to the pairs of blocks P 4, P 5, P 6, as above indicated. As the car advances in the direction of the arrow it leaves P 5 and comes upon P 6. Hence the revolving contact *m* should have been shifted on to the switch point 6, as shown by the dotted lines. Should the apparatus fail to work at this point, *m* will remain in No. 5 as shown. When the back rail B comes upon P 5 the circuit is completed directly through *m* and B to ground. The strong rush of current is sufficient to open the automatic circuit-breaker C, and the distributor is now cut off from the main feeder. The blocks of the section no longer receive current and the car comes to a stop. The distributor is then inspected to remove the trouble. When the car arrives on the trolley section the motorman takes off the small rail and stores it on the car. The main rail is raised up off the track by a lever device which is worked by a handle at the side of the car.

AN INTERVIEW WITH MR. MARCONI.

THE FAMOUS YOUNG ITALIAN INVENTOR ARRIVES IN NEW YORK WITH SEVERAL NEW IDEAS FOR THE DEVELOPMENT OF HIS WIRELESS TELEGRAPH.

Mr. William Marconi, the inventor of the Marconi system of wireless telegraphy, arrived in New York, Saturday morning, August 29, on the Cunard steamship Lucania. It was known that Mr. Marconi on this occasion had brought with him the practical consummation of several new ideas which are to be applied to the working out of the system of telegraphy of which he is the inventor.

One of the characteristics of Mr. Marconi is that he is at all times approachable and is willing to concede to the public as much information as it is possible to give under ordinary circumstances. The representative of the ELECTRICAL REVIEW called on Mr. Marconi and found him entirely willing to discuss his invention, and only sorry that he could not give out more detailed information because of the patent situation covering the latest applications of his apparatus. Mr. Marconi is possessed of a peculiarly frank disposition, and a talk with him gives one the instant and distinct idea that there is a bona-fide proposition behind everything which Mr. Marconi stands for.

With regard to the service of the wireless telegraph system during his trip from England, Mr. Marconi stated that the Lucania had been in constant communication with both sides of the Atlantic. The latest news from Paris and the Continental capitals was received simultaneously with the most recent information with regard to events in the United States. While the work that he intended during this trip was purely of an experimental nature, he had reason to be pleased with the absoluteness of communication which was established and maintained throughout the trip.

"Are messages being sent regularly between Poldhu and the Canadian station?"

"Not regularly; messages have been sent—not as many as some people might believe—but sufficient has been done to demonstrate that this is absolutely practicable, though, at the same time, everything that has been done is of a purely experimental nature."

"Does the new apparatus which you have developed and are developing, relate to both the receiving and sending apparatus?" "Yes; with these devices there will be a material difference in the height of the sending and receiving antennæ, and also a difference in the method and speed of operation, both in sending and receiving wireless messages."

When asked for his opinion as to the part the earth played in the transmission of wireless messages, Mr. Marconi stated it was his profound opinion "that the earth played a very important part in making wireless transmission possible. It does not play the all-important part, but its part is very significant."

"Have you kept in touch with what has been done at the recent conference at Berlin?" "Yes, I have kept in close touch with the latest developments that are being made in wireless telegraph systems everywhere, and I am possessed of full information as to what has been done at the international conference on wireless telegraphy at Berlin."

"Have you said that wireless telegraphy on a commercial basis would be established within three months?". "No, I do not talk like that; I am not responsible for such statements. I wish to be understood as conservative, and am adverse to having any of my information effected with a 'thrill.'" Mr. Marconi felt confident that ultimately, and at no very distant day, commercial wireless telegraphy would be established, but he would not say in how many days this would be accomplished.

"Is Mr. Edison cooperating directly with you?"

"Well; not directly, but rather in a consulting capacity; I have just talked with Mr. Edison, and told him a few of my ideas, and Mr. Edison has told me a few of his. I am greatly pleased to have Mr. Edison's confidence and to have had such a pleasant day with him."

Mr. Marconi said that just at present he was very busy with his patent attorneys, and that, while he appreciated the interest the public had taken in everything he had done, and the widespread desire there was for information as to the workings of his system, he had not found time to prepare any literature other than those addresses which he had delivered before the Continental and other learned societies. He was pleased at all times to give information whenever possible. At the present time, the technical details of his new apparatus would not be available, owing to the patent situation. After consulting with his patent attorneys, it was Mr. Marconi's intention to go to Canada to install new apparatus and conduct extensive experiments with these devices.

"How is the Canadian Government treating you now?" "The Canadian Government," Mr. Marconi said, "is very kind and has given me every encouragement, and I can only speak of it with the utmost courtesy."

Referring to the technical press, Mr. Marconi said that the press of the United States had been uniformly kind and that he appreciated this action on the part of the American editors very much.

Personally, Mr. Marconi has a delightful manner of speaking and impresses one with his frankness and modesty.

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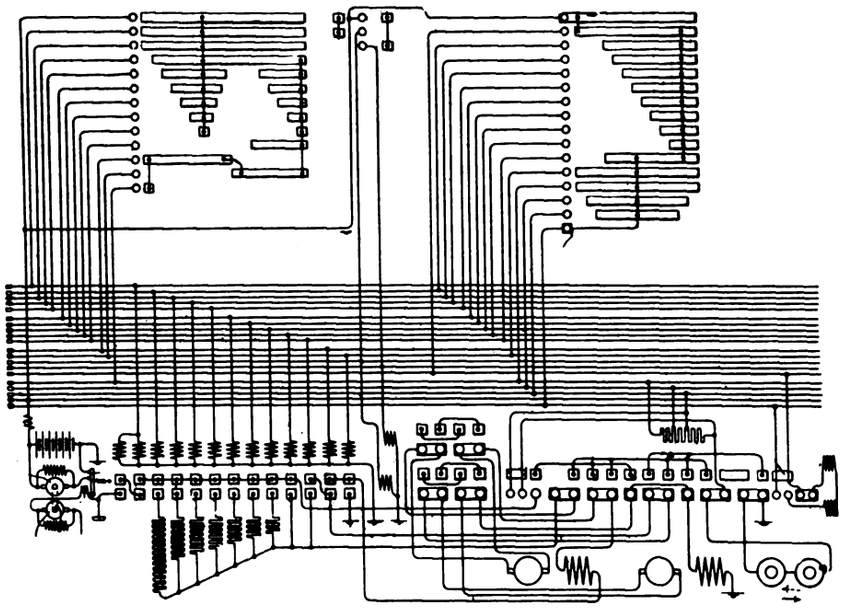
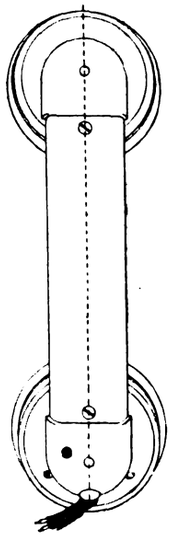
Electrical Patents.

In order to obtain the greatest tractive and accelerating effort on a train propelled by electric motors, it is necessary to divide the motive force into a number of units and to apply the several units to the axles of the different cars. To successfully operate a train having a number of motor-cars, it is necessary that the controlling be done from a single point on the train; otherwise the motor of one car may be called upon at times to do an amount of work which differs materially from the amount being done by the motors of another car. To reduce the complications of a train system to a minimum and to enable the train to be conveniently made up of different lengths, as may be required, it is desired to make each motor-car a complete unit in itself—that is to say, to provide it with a contact device, motor or motors, and a suitable controlling mechanism, which is arranged to work in conjunction with other controlling devices on the train. The system should be so arranged that any number of similar cars may be coupled together in any desired order or position, and that all the motors of the train may be controlled from any one of the cars. Further, it is highly desirable that the contact devices on each car should take current sufficient for the needs of that particular car only and that the heavy currents which actuate the motors should not pass from car to car. A patent has been granted to Frank E. Case, of Schenectady, N. Y., and assigned to the General Electric Company, of New York, on a new system of train control, the principal object of which is to provide a system of train control fulfilling the requirements above set forth, such that from any selected point on the train all of the machines may be made to act simultaneously and equally to accelerate the train or to maintain it in motion in either direction or to retard it evenly and strongly and that all of these actions in all cars of the train may be under the control of a single motorman. In carrying out the invention, the motors of the train are divided into sets, each set preferably comprising the motor equipment of a single car, and to govern each set of motors by a separate set of motor-controlling devices, and further, to provide at a number of selected points on the train master-controllers so arranged that each desired master-controller will actuate all of the motor-controllers. It is obvious that with the arrangement above outlined at any particular time the train as a whole will be operated from a single selected point. It is one object of the invention to provide means sufficient to prevent any successful attempt from any other point to interfere with such operation. To this end an interlocking arrangement is provided, preferably electrically controlled, such that any movement of either of the master-controllers from its off position will automatically lock all other master-controllers of the train. These devices are preferably so arranged that as long as all of the master-controllers are at the off position any one of them may be operated, while the operation of that one will lock all of the others. It is another feature of the invention to provide each of the master-controllers with three switches—the power switch, the reversing switch and the breaking switch, respectively, and to divide the motor-controllers into corresponding switches or divisions. A still further feature of the invention is to accomplish a part of the motor control, as the usual series-parallel and resistance steps, by a number of separate contacts or switch-blades, while the other steps are provided by the action of controller cylinders or their equivalents. All of these devices should be controlled or actuated by electromagnetic means.



System of Controlling Electric Cars.

A telephone of novel construction has been patented by John A. Barrett, Louis A. Falk and Herbert E. Shreeve, of Boston, Mass., and the patent assigned to the American Telephone and Telegraph Company, a corporation of New York. The invention relates in particular to such telephones as have the transmitter and receiver combined in a single instrument, and are therefore especially adapted for use of linemen, inspectors, or other employés. It is comprehended in a telephone instrument having a handle-bar to be grasped by the hand of the user, to the ends of which the receiver and transmitter are respectively attached in such wise that the former can be held in approximation to the ear and the latter held simultaneously near the mouth of the user. The object of the invention is to provide a combination instrument which shall be compact, of light weight and high efficiency, and which, though utilizing a granular carbon transmitter, shall ensure that when in use with the mouthpiece and receiver in proper juxtaposition to the lips and ear of the user the granular variable resistance button shall be held in



Telephone Transmitter.

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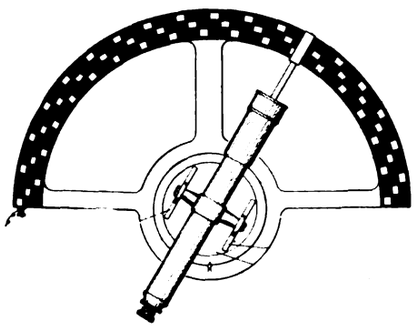
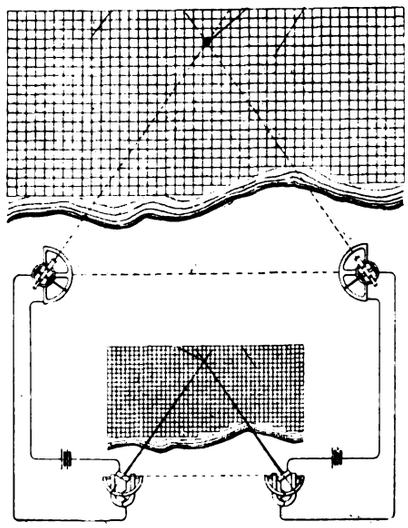
a position most favorable for successful operation. By the present invention the great advantages inherent in the use of the granular carbon transmitter may be obtained without introducing any counterbalancing mechanical defects. Accordingly a prominent feature of the invention consists in certain improvements in the construction of the handle-bar, the transmitter, and the means for attaching one to the other, whereby it is provided with certainty that when the combined instrument is in use the diaphragm and carbon-containing button attached thereto shall be caused to assume a position inclined at a moderate angle from the vertical, such position being adapted to ensure the highest operative efficiency of the transmitter, the mouthpiece or passage directing the sound-waves of the voice upon the diaphragm being at the same time brought into an effective position to receive the said sound-waves substantially opposite to or in front of the lips of the user. The invention consists also in providing a cap or socket, each of corresponding shape to the one end of the handle-bar, at the back of the transmitter and receiver, in making the handle-bar hollow to contain the connecting-conductors, and in socketing and securing the ends of said handle-bar in the correspondingly shaped caps or sockets of the said transmitter and receiver; the cap or socket of the transmitter being formed with an orifice for the ingress of such circuit-conductors as are required. The caps or sockets are preferably removably secured to the transmitter and receiver.

An electrical range-finder has been patented by Harry Shoemaker, of Philadelphia, Pa., and has assigned one-half



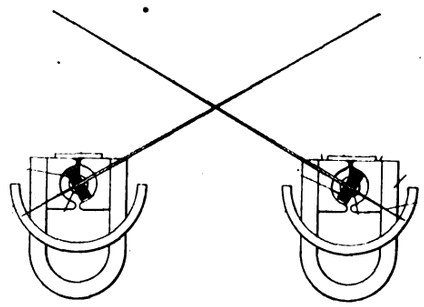
ELECTRICAL RANGE-FINDER.

to Marie V. Gehring, also of Philadelphia, Pa. The invention relates to a system for determining the relative position of an object as, for example, the position of a vessel with respect to fortifications. The object of the invention is to indicate at any point or station the relative position of a distant object, so that an operator or gunner at such point or station may without observations of his own properly direct and control his apparatus. The system and the apparatus therefor constitute a range-finder whereby a gunner may be constantly advised of the relative position of the object upon which he is to train his gun, though such object may not be visible to him. In the system two indicators are independently controlled by as many independent sighting instruments, and it is upon the resultant indications of these two indicators that the gunner depends for his information. Each sighting instrument controls its indicator by electrical means, and these indicators cooperate to indicate the point upon a chart, such point signifying to the gunner that the object at which he is to fire is located in the same



ELECTRICAL RANGE-FINDER.

relative position as this point on the chart. The sighting instruments comprise telescopes rotatable in a horizontal plane about a vertical axis and means operated by the motion of such telescope to vary a characteristic of an electric current. The electric current in the circuit of the instrument controlled by the telescope has a different characteristic or is of a different magnitude for each angular position of the telescope. Each indicating instrument is, in fact, a Deprez d'Arsonval galvanometer consisting, as is well known, of a permanent magnetic field in which is mounted for movement about its axis a coil connected in the circuit controlled by the sighting instrument. Attached to the movable coil is a long slender needle or pointer, which by the system will always be at the same angle with respect to some reference line as between the longitudinal axis of the telescope and a corresponding reference line. In other words, the needle or pointer of the indicator follows accurately and smoothly every movement of the telescope of the sighting instrument. Two sighting instruments and two indicators are employed. Each sighting instrument is trained upon the distant ship or object, and this results in the indicating pointers or needles following the movements of their respective con-



ELECTRICAL RANGE-FINDER.

trolling telescope and the point of intersection of the needles or pointers corresponding with the location of the distant ship or object.

Fourth General Meeting of the American Electrochemical Society.

The fourth general meeting of the American Electrochemical Society will be held at Niagara Falls, N. Y., September 17, 18 and 19. The society's headquarters will be at the Cataract House. Papers will be read in the morning, and Thursday and Friday afternoons will be devoted to visits to power-houses and certain electrochemical plants. The evenings will be given up to social entertainments. Saturday evening a trip will be made to Niagara-on-the-Lake, Youngstown and Port Niagara by boat and trolley.

The following titles of papers have been announced: "A new Type of Electrolytic Cell," P. G. Salom; "Manufacture of Ferro-Alloys in the Electric Furnace," Dr. George P. Scholl; "Electrolytic Copper Refining," Dr. W. D. Bancroft; "Electrometallurgy of Gold," Dr. W. H. Walker; "Some Theoretical Considerations of Resistance Furnaces," F. A. J. Fitzgerald; "On the Supposed Electrolysis of Water Vapor," F. Austin Lidbury; "Efficiency of the Nickel-Plating Tank," Professor O. W. Brown; "Electrolysis of Sodium Hydroxide, by Alternating Current," Carl Hambuechen; "A Practical Utilization of the Passive State of Iron," Professor C. F. Burgess; "The Present Status of the Theory of Electrolytic Dissociation," Dr. E. F. Roeber; "Berthelot's Law of Electrochemical Action," C. J. Reed.

One session will be devoted to the discussion of the theory of electrolytic dissociation, to be opened by Dr. W. D. Bancroft.

Further information as to the meeting may be obtained from the local secretary, C. L. Collins, 2d, Niagara Falls, N. Y.

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Reviews of Current Engineering and Scientific Literature.

New Properties of Coherers.

In studying the variation of resistance of coherers as a function of time during which they are acted upon by electrical waves, it is found that a certain minimum exists. If the stable equilibrium corresponds to a value in the neighborhood of this minimum, the condition is that of an ordinary coherer. If, on the contrary, equilibrium is unstable, the coherer can decohere itself spontaneously, becoming self-decohering; or, due to the action of the electric waves, becoming anti-cohering. M. Hurmuzescu has studied this phenomenon, and offers the following explanation of the behavior of the coherer under the different conditions: The action of the electric waves produces between the metallic grains sparks, which cause them to weld, producing real coherence, or brush discharges which oxidize the grains and increase the resistance of the metallic chain, producing anti-coherence. If the metal is not in an oxidizing atmosphere and the cohesion is not determined by welding, the brush discharge ceases at the same time with the electrical waves and the resistance increases, producing auto-coherence. — *Translated and abstracted from l'Industrie Electrique (Paris), July* 25.

An Italian 30,000-Volt Power Transmission.

The Societe des Forces Mortrices du Mont Cenis, Italy, has under construction a plant for the transmission of power to the city of Turin from the small Alpine river, the Cenischia, at the foot of Mount Cenis. The available head of water is one of the largest utilized on the Continent. The height is 865 metres, which is divided into two parts, a lake being situated half way down. The total power available is about 12,000 horse-power. By using the lake as a reservoir this may be increased to about 16,000 horse-power. The station now existing includes three sets of 1,600 horse-power each. Each set includes a turbine direct-coupled to a three-phase alternator. The turbines have a normal power of 1,600 horse-power and are connected by Zodel elastic couplings to alternators rated at 1,400 kilowatts. The latter are three-phase machines of the revolving-field type, twelve poles, and at a normal speed of 500 revolutions per minute generate 3,000 volts, fifty cycles, with an output of 270 amperes. The generator full-load efficiency of the alternators is 96.5 per cent; at three-quarters load it is ninety-six per cent and at one-half load it is ninety-five per cent. The machines are excited by a separate generator driven by a small turbine. The voltage of the transmission lines is 30,000, the length of line between generating station and the city of Turin is forty miles. The transformers are of the shell oil-bath type, the oil being cooled by water circulating in rings in the top part of the transformer casings. Electric pumps are used to circulate the cooling water. The transformers are of the single-phase type connected in sets of three, there being four in each group, one transformer being held in reserve. The switchboard is divided into generator and feeder panels, and is equipped with automatic oil-break switches to avoid the use of fuses. High-tension ball lightning arresters and static ground detectors are provided. The switchboard was tested to double the working pressure of the installation.—*Abstracted from the Electrician (London), August* 10.

Recent Work on Thorium.

In this article Mr. C. F. Soddy describes the work recently carried out by himself and Professor Rutherford on radioactive substances. Thorium and radium, but not uranium, were found to be giving off a gas of no chemical affinity and in very small quantities in addition to their radioactive property. This gas can only be ascertained by the fact that it gives out rays like those of the substance from which it comes. The material character of these emanations was established recently by the aid of liquid air. By means of this they were condensed and the boiling point found to be minus 130 degrees centigrade. Mr. Soddy points out the extreme delicacy of the electrometer, which for this work far surpasses not only the most delicate balance but even the spectroscope. It is found that the rays from the emanations of these substances do not go on forever like those of the radioactive substance, but decay rapidly and disappear. They leave, however, an invisible film of radioactive substance on any solid with which they come in contact. If this film is scraped off with sandpaper and dissolved in acid it continues to give off these rays, gradually dying out, but the substance can be traced through two more metamorphoses before it finally becomes inert and commences to decay. Although thorium is an element, yet all this radioactivity can be concentrated into a very small part of it. If ammonia is added to a thorium solution the thorium is precipitated in a very inactive condition, while the little remaining in solution retains all the radioactivity. This it gradually looses, while the rest of the thorium regains its activity at the same rate. This process may be repeated. To explain by what process a chemical element like thorium may come to be the progenitor of five new forms of matter, the following ideas are given: As each atom breaks up and emits its rays, a new system remains, this latter is also unstable and in its turn breaks up and emits its rays. This process goes on to the fifth stage, after which all is at an end so far as experimental researches have been able to determine. In answer to the possible objection that such large quantities of energy can not evolve from such small masses, the suggestion is made that this should not be considered an objection, because this is our first experience with atomic energy, and we have nothing to compare with.—*Abstracted from the McGill University Magazine, July* 1.

The Danger of Shock to Firemen through Squirting at High-Tension Mains.

This gives an abstract of the recent German paper by Herr F. Heinicke, who has carried out some experiments to determine what danger there is to firemen when there are high-tension transmission lines close to a building which may be struck by the stream of water from the fire hose. A stream of water at a pressure of five atmospheres was taken from a hose with an unusual diameter of twelve millimetres and was directed at a bare wire carried on well insulated supports. The full section of the stream was allowed to hit the wire and the voltage from the nozzle to the earth was measured by means of a standard voltmeter, the copper mouth of the hose being insulated thoroughly from the earth. Experiments were carried out with continuous and alternating currents, and with various distances between the nozzles and the wire. Ordinary city water was used first and then one-half per cent of soda was added to increase conductivity. Experiments carried out by Weber and Kath have shown that a human being can stand a current of 0.03 ampere without fatal re-

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sults, although a severe shock would be experienced. The following are the results of the tests: On a three-phase, star-connected circuit, with 6,000 volts between lines and the neutral earth, the tests show that a distance of 300 millimetres is sufficient for safety with pure water, with the soda solution the distance must be increased, before the current falls to 0.03 of an ampere. On a three-phase circuit with 125 volts between lines with one of the mains grounded, the distance between the nozzle and the wire could be reduced to thirty millimetres. On a continuous-current traction circuit supplied from accumulators at 550 volts with a negative pole earthed, with pure water, and a distance from nozzle to wire of thirty millimetres, the current was only 0.016 ampere. With the soda solution and the same distance, the current was 0.03 ampere. With a 240-volt continuous current the value of current was not reached at all with either pure water or soda, although the distance between nozzle and wire was reduced to fifty millimetres. These figures seem to show that the danger from this source is not so great as is usually supposed.—*Abstracted from the Electrical Engineer (London), August 7.*

The Hampshire, England, Electric Railways.

This gives a detailed description of the system of electric railways which has recently been completed in Hampshire, England, by the Hampshire Light Railways Company. This railway serves a purely country district and extends from the outskirts of Portsmouth to Horndean, a distance of about six miles; and as the road was opposed by landowners, a private right of way was acquired. The system is worked in conjunction with the Portsmouth municipal railway system, and the necessary electrical energy for operating the line is purchased from the Portsmouth Corporation. The rails are of the ordinary grooved girder type, weighing ninety-six pounds to the yard, and made in lengths of forty-five feet, with a percentage of shorter lengths, to avoid cutting rails in the construction of loops. The overhead construction combines a special form for light railway work with the ordinary form of bases, brackets, etc. The system adopted is centre-running, the trolley wire—which is No. 00 B. & S. gauge—being in duplicate and carried over the centre of the track. The trolley line is divided into half-mile sections, a feeder pillar being erected at each place, having, in addition to the usual four-line switches, a sufficient number of main switches to allow the main cables to be disconnected for making a loop test in case of a breakdown. The switches are mounted on marble panels and fitted with cast-iron pillars with water-tight doors. As the end of the line is a considerable distance from the Portsmouth power-house, power is transmitted to this section at 6,000 volts, three-phase. There are two motor-generator sets in a substation about midway along the line. Current is carried by a specially constructed three-core cable to the substation. The cable is lead-sheathed, and under this lead-sheathing is bound a copper earthing strip. The insulating material used is specially impregnated paper which has been tested after the cables are constructed at 20,000 volts, alternating current, for fifteen minutes. All cables are laid on the solid system. The cars are the double-deck type and weigh, equipped, about seven tons ten hundredweight. They are provided with an electric rheostatic brake and a mechanical track brake.—*Abstracted from the Tramway and Railway World (London), August 6.*

The Auvert Train Lighting System.

The Auvert system of train lighting is discussed in this one of the series of articles on train lighting by Herr R. Geotze. This system belongs to the class of complete car equipments consisting of a dynamo and a storage battery. It may be considered as a modification of the Stone system and it has been put in use on some trains of the Paris-Lyon-Mediterranean Company. The difference between the Auvert system and the Stone lies in the method of driving the dynamo and of maintaining a constant voltage. The dynamo is hung from the car frame on an axle parallel to the length of the car, this arrangement preventing much of the side jarring. It is driven through an extended shaft also parallel to the length of the car and upon the end of which is a leather friction wheel which is pressed against the side of the running wheel of the truck by means of springs. The normal output of the dynamo at 1,350 turns per minute is thirty amperes and 15.5 volts. The accumulator equipments consist of eight elements of the Boese system with a capacity of 180 ampere-hours. A current of twenty amperes is necessary for lighting the car, so that the batteries are sufficient for eight or nine hours. The battery cases are celluloid enclosed in wood, four batteries being assembled in a set and the two sets arranged distribute the load equally on the car. The voltage is regulated by a small two-pole series motor carefully boxed in and placed under the car where it is easily inspected. The axle of this motor carries a bronze pulley against which a brake is pressed by means of springs. The tension of the springs is so regulated that the frictional resistance of the brake is sufficient to hold the motor stationary until the current exceeds twenty-eight amperes. If the speed of the train exceeds fifty kilometres per hour, the output of the generator is greater than twenty-eight amperes and the motor begins to run setting up a counter-electromotive force which reduces the voltage at the lamps to the normal. The greater the speed of the train the greater the counter-electromotive force. The system makes use of automatic electric switches and pole changes for cutting in and cutting out the dynamo and reversing the generator connections when the direction of motion is reversed.—*Translated and abstracted from Centralbatt Für Accumulatoren-Elementen-und Accumobilen Kunde (Gross-Lichterfiede-West), August 1.*

Reduction of German Cable Rates to the Orient.

The Imperial German Post and Telegraph Department recently issued an order reducing the cable rates for messages to China, Japan, Korea, Manchuria and the Philippines on and after July 15, 1903. It now costs to send messages to the following countries, per word not exceeding fifteen letters:

To China, Manchuria excepted.....	$1.08
To Korea:	
Chemulpo, Fusan and Seoul.....	1.21
Other places.....	1.29
To Japan.....	1.21
To the Philippines:	
Luzon.....	1.08
Panay, Cebu and other stations....	1.18
To Manchuria.....	1.08

These rates are for messages *via* Emden, Vigo, Vladivostock and Nagasaki. It is further announced by the postal authorities that after July 15, 1903, the use of cable codes may again be resumed in sending messages to Spain. Cablegrams for Honduras, Venezuela, Nicaragua, Costa Rica and Columbia will only be sent at the sender's risk.

The British Iron Trade Association points to the remarkable activity of German iron and steel manufacturers in the distribution of their products in Great Britain, while American manufacturers are becoming lethargic competitors. The report expresses the opinion that Germany's exports of iron and steel manufactures will in a short time equal those of Great Britain.

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INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Development of Enclosed Fuse Protective Devices.

No recent development in electrical construction devices has met with more rapid advancement and success than the so-called enclosed fuse which is to-day supplanting nearly all forms of open fuse protective devices. Actual commercial exploitation was begun but five years ago; yet to-day the enclosed fuse has been accepted almost universally and is to-day being demanded by the underwriters, and in fact it finds a place in almost every new plant. At first it was thought that the increased cost of the necessarily more expensively constructed enclosed fuse device would to a great extent prohibit the universal application of this meritorious protective device; yet it was soon found that the many advantages accruing from the use of enclosed fuses warranted the additional expenditure.

The development of enclosed fuse protective devices is somewhat noteworthy, as their application has been almost universal, not only to ordinary interior work, but for street railway motor protection, transformer protection, switchboard work, and a multitude of other service. The Sachs "Noark" enclosed fuse, marketed by the H. W. Johns-Manville Company, sole agent, was one of the pioneers in the enclosed fuse field. The basis for the development of this now well-known protective device began more than a dozen years ago. The original Sachs patent of 1894 is claimed to be the first showing the modern form of constructing enclosed fuses.

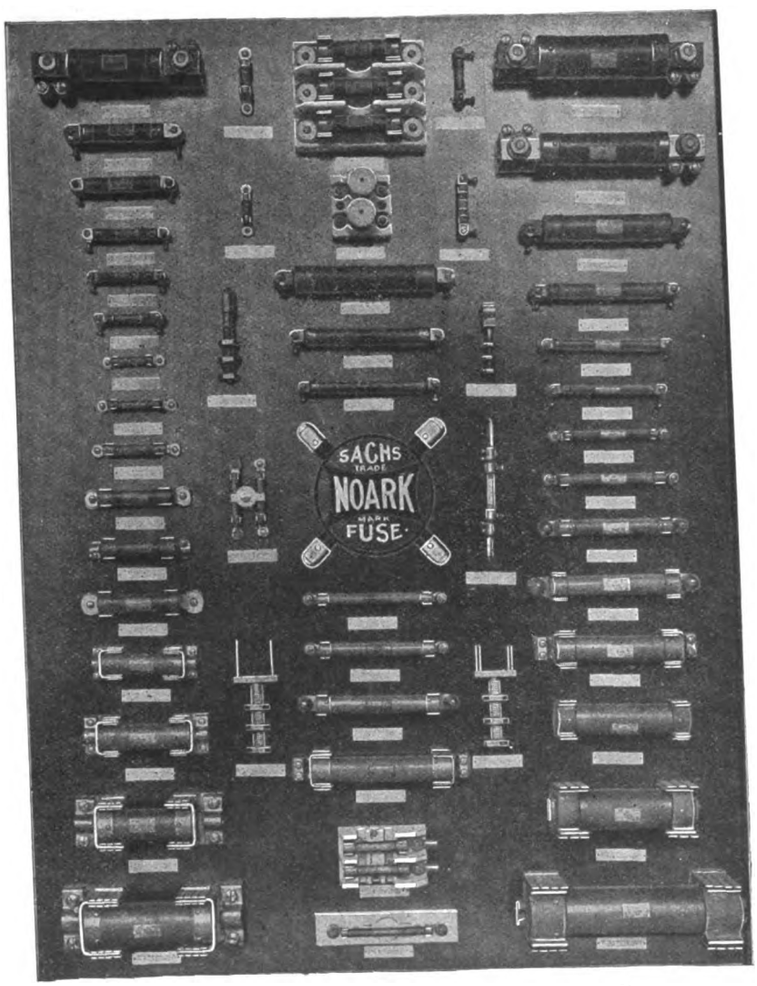

EXHIBIT SHOWING DEVELOPMENT OF FUSE PROTECTIVE DEVICES.

The variety of styles and types of enclosed fuse protective devices marketed by the above-mentioned concern is exceedingly extensive and covers almost every branch of electrical service. The illustration herewith shows some of the different types and styles of enclosed fuses and cutouts included in this line. It is also of interest to note the large ampere sizes to which these fuses have been developed on the various voltages in common use. Recent tests made of Sachs "Noark" fuses on a 4,000-ampere-hour storage battery at 250 volts have demonstrated the entire efficacy of fuses whose normal carrying capacity was 400 amperes at 250 volts (100,000 watts). These fuses were short-circuited dead on the terminals of the battery and operated absolutely without smoke, flash or any demonstration whatever, yet indicating upon the exterior of the tube their interior condition. Larger sizes are also being developed, and it is expected that they will be furnished up to 1,000 amperes in the near future. As a circuit-rupturing performance, the opening of an enclosed fuse capable of carrying 500 or 600 amperes at 250 volts absolutely without any external demonstration or explosion whatever, and without in any way affecting the integrity of the tube or external structure, is certainly noteworthy.

New Motor Cars of the Central London Railway.

The new electric motor cars which take the place of the separate electric locomotives formerly used in the operation of the line have a motor truck on one end only. The cab covers the entire length over this truck, behind which the steel underframe is dropped low to receive the body of the car. The cab is nine and one-half feet long and six and one-half feet wide over the frames, while the width over axle boxes is seven feet two and one-half inches. The wheels are thirty-four inches in diameter with a wheel-base of six feet. With a current of 200 amperes at 500 volts each motor is designed to give a tractive effort of 2,500 pounds at the rail, and a speed of not less than eighteen miles an hour. At eighty amperes and 500 volts the tractive effort is 650 pounds and the speed twenty-seven miles an hour. The gear ratio is one to four, with cut steel gears. There is a motor-driven air compressor, with a capacity of thirty-five cubic feet of free air per minute compressed to ninety pounds pressure in a main reservoir of eight cubic feet capacity. When the pressure reaches ninety pounds the motor is automatically cut out, but the circuit is closed again when the pressure has fallen to eighty pounds. The Westinghouse quick-acting brake is used, and a hand brake is also fitted.

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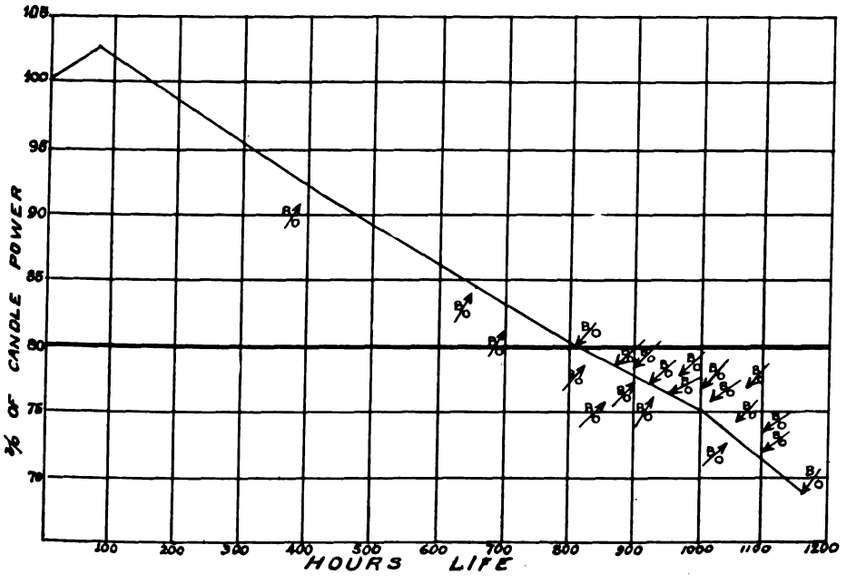
A New Departure in Incandescent Lamps.

The Bryan-Marsh Company, New York and Chicago, has developed a type of incandescent lamp which will no doubt prove a very attractive proposition to central station managers. One of the greatest obstacles in the way of satisfactory service by means of incandescent lamps lies in the fact that, no matter how well an incandescent lamp may be made, there comes a time when, in spite of the greatest care in regulating the voltage and in submitting the lamp to severe shop tests before packing, the lamp begins to grow dim, and it becomes a very inefficient piece of apparatus.

Realizing the dissatisfaction which arises from the poor illumination of a lamp which has outlived its useful life, to say nothing of the poor economy from an operating point of view, central station managers have often found it expedient to go out over their lines at certain periods and renew all lamps which have falled below a certain predetermined standard of candle-power.

The advantages, then, of a lamp that would always be bright and never grow dim throughout its useful life, provided this life were of sufficient length to justify its installation, are evident. This is just what the Bryan-Marsh Company is aiming at in the production of its new type of incandescent lamp. The accompanying drawing is a reproduction of an average curve sheet, and shows the results of a test on a number of lamps constructed upon this principle. When the lamps are originally installed, the illumination rises at once to a little above the original candle-power. In about 150 hours this has dropped to the original efficiency, and for the next 500 hours there is a gradual decline to eighty per cent of the original candle-power. Up to this point, as is well known, the illumination is very satisfactory, but when it drops down to something between seventy and sixty per cent, there is a point reached where the lamps are so dim that dissatisfaction is manifest.

The design and construction of the new type of Bryan-Marsh lamp are such that when the lamp crosses the eighty-per-cent line it will burn out. Of course, it is impossible to make an incandescent lamp that will automatically burn out when it reaches the exact eighty-per-cent line. The accompanying curve sheet, which shows the test made on twenty-one lamps, with an average efficiency of 3.41 watts per candle, points out how near to the eighty-per-cent line the lamps actually burn out. The rating of these lamps was 3.5 watts per candle. The average life to eighty per cent was 813 hours, and the actual average life, 914 hours.

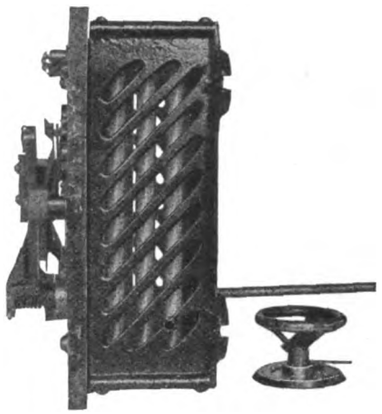


CURVE SHEET SHOWING TEST OF NEW INCANDESCENT LAMP.

If this condition can be maintained continually, there is no doubt that, in many quarters, a type of lamp having this characteristic will be very well received.

Motor-Starting Rheostats.

The accompanying illustration shows a motor-starting rheostat for rear-of-switchboard mounting, made by the Cutler-Hammer Manufacturing Company, Milwaukee, Wis. The apparatus consists of the usual front and resistance, the contacts, etc., on the front being reversed in arrangement to those on the front-of-board apparatus, so that when the starter is mounted on the rear of the switchboard, with the contact parts facing out from the board, the hand-wheel will be moved in the same direction to cut out resistance as is the case with the lever for the front-of-board apparatus.



MOTOR-STARTING RHEOSTAT.

In addition to this, the contact parts are insulated from the lever and the resistance is rearranged in order to allow space for the passage of the hand-wheel shaft through the resistance and switchboard. This results, in some instances, in a somewhat larger starter than is necessary in front-of-board arrangement, in so far as the external dimensions are concerned; but other than this, the rear-of-board apparatus is arranged for practically the same service and has the same capacity in both front and resistance as the front-of-board type.

The Interborough Rapid Transit Company has contracted for an escalator to be installed at the Thirty-third street station of the Sixth avenue elevated railroad. The escalator will be placed on Broadway just north of Thirty-third street and will carry passengers direct to the downtown station. A footbridge will extend over the tracks to the uptown station and it is anticipated that a majority of the uptown passengers will avail themselves of the escalator and footbridge thus avoiding the laborious climb of the stairway used at present. In connection with this installation, the commendable action of the owners of the department store on the corner in surrendering much of their sidewalk and part of their basement space should be noted.

With a pressure of 100 pounds at the nozzle, one and three-eighths inches diameter, a stream can be thrown vertically 103 feet, and horizontally ninety-six feet. The nozzle will discharge 574 gallons of water per minute. With a higher pressure, equivalent to a higher head, the amount discharged and the distance to which the water may be thrown will be increased.

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THE AMERICAN STREET RAILWAY ASSOCIATION.

PROGRAMME OF THE TWENTY-SECOND ANNUAL MEETING, HELD AT SARATOGA, N. Y., SEPTEMBER 2, 3 AND 4.

The twenty-second annual meeting of the American Street Railway Association convened at Saratoga, September 2, 3 and 4. The first session was held on Wednesday at 2 P. M. The following programme had been arranged:

Meeting called to order by W. Caryl Ely, first vice-president.

Address of welcome by Hon. A. P. Knapp, president of the village of Saratoga. Calling of the roll. Address of the president. Report of the executive committee. Report of the secretary and treasurer.

The following papers were scheduled for presentation:

"Steam Turbines." "Electric Welded Joints." "The Evils of Maintenance and Champerty in Personal Injury Cases." "Train Orders and Train Signals on Interurban Roads." Freight and Express on Electric Railways." "The Manufacture of Distribution of Alternating Currents for City Systems." "Comparative Merits of Single and Double-Truck Cars for City Service." "The Right of Way."

Appointment of committee on nomination of officers and selecting of next place of meeting.

THURSDAY, 10 A. M.

Discussion of papers presented to the association. Report of committee on standard rules for the government of employés.

FRIDAY.

Continued discussion on papers presented to the association. Report of committee on standards. Election of officers for the ensuing year.

The following entertainment was provided for the attendants at the convention, and, in addition, two daily concerts by Victor Herbert's orchestra. On Wednesday, at 8 P. M., there was an excursion to Saratoga Casino, the train being drawn by an electric locomotive. On Thursday, at 1 P. M., an excursion was made to Schenectady, to visit the works of the General Electric Company. Friday, at 1 P. M., an excursion was made to Lake George, the train drawn by an electric locomotive. Friday evening, annual banquet at the Grand Union Hotel.

The excursions to Saratoga Casino and Lake George were by courtesy of the Hudson Valley Railway Company. The excursion to Schenectady was by courtesy of the General Electric Company.

Among the exhibitors displaying apparatus at the convention were the following:

American Automatic Switch and Signal Company, Chicago.

American Automatic Switch Company, New York.

American Brake Shoe and Foundry Company, Mahwah, N. J.

American Car and Foundry Company, Chicago.

American Car Seat Company, Brooklyn, N. Y.

Benjamin Electric Manufacturing Company, New York.

Brady Brass Company, New York.

Harold P. Brown, New York.

Bullock Electric Manufacturing Company, Cincinnati, Ohio.

Cheatham Electric Switching Device Company, Louisville, Ky.

Chicago Mica Company, Valparaiso, Ind.

Climax Fence Post Company, Chicago.

Columbus Steel Rolling Shutter Company, Columbus, Ohio.

R. W. Conant, Cambridge.

Consolidated Car Fender Company, New York.

Consolidated Car Heating Company, Albany, N. Y.

Continuous Rail Joint Company, Chicago.

Crouse-Hinds Electric Company, New York.

Dearborn Drug and Chemical Works, Chicago.

Detroit Trolley and Manufacturing Company, Detroit, Mich.

O. M. Edwards Company, Syracuse, N. Y.

Electric Storage Battery Company, Philadelphia.

Electric Railway Equipment Company, Cincinnati, Ohio.

Federal Manufacturing Company, Cleveland, Ohio.

C. J. Field, New York.

General Electric Company, Schenectady, N. Y.

Gold Car Heating and Lighting Company, New York.

Gould Storage Battery Company, New York.

C. J. Harrington, New York.

F. M. Hawkins, New York.

H. W. Johns-Manville Company, New York.

Johnson Wrecking Frog Company, Cleveland, Ohio.

Le Valley Vitae Carbon Brush Company, New York.

National Carbon Company, Cleveland, Ohio.

National Electric Company, Milwaukee, Wis.

Ohio Brass Company, Mansfield, Ohio.

Peckham Manufacturing Company, New York.

Pittsburg Reduction Company, Chicago.

Pittsburg Switch and Signal Company, Pittsburg, Pa.

Robins Conveying Belt Company, New York.

Rossiter, MacGovern & Company, New York.

Speer Carbon Company, St. Mary's, Pa.

Standard Automatic Lubricator Company, Philadelphia.

Standard Paint Company, New York.

Standard Vitrified Conduit Company, New York.

Stanley Electric and Manufacturing Company, Pittsfield, Mass.

Sterling Meaker Company, Newark, N. J.

Sterling Varnish Company, Pittsburg, Pa.

Taylor Electric Truck Company, Troy.

Traction Equipment Company, Brooklyn, N. Y.

Trolley Supply Company, Canton.

Union Signal Company, Cambridge.

United States Electric Signal Company, West Newton, Mass.

United States Steel Company, West Everett, Mass.

Westinghouse Electric and Manufacturing Company, Pittsburg, Pa.

Westinghouse Traction Brake Company, Pittsburg, Pa.

Wheel Truing Brake Shoe Company, Detroit, Mich.

The Meeting of the British Association.

The annual meeting of the British Association will be held at Southport, England, beginning Wednesday, September 9. A large committee has been in charge of local arrangements for some time past, and every indication points that there will be an unusually large gathering and that the attractions provided will be of great value.

Three sections will meet in the Science and Art Schools as follows: Section A, which is in two departments, mathematics and astronomy; Section B, chemistry; and Section G, engineering. Section L, education, will meet in the Cambridge Hall, and Section H, anthropology, will meet in the Town Hall. Two of the corporation committee rooms in the Town Hall have been set aside for the deliberations of the International Meteorological Committee which will meet in Southport at the same time as the British Association. The laboratory of the Science and Art Schools will be used as a meteorological museum and for the reception of apparatus and specimens illustrative of papers communicated to the sections.

The first general meeting of the assembly will be held on Wednesday evening, September 9, at 8.30, in the Opera House, when the president, Sir Norman Lockyer, will deliver his inaugural address.

Excursions will be made to Manchester, visiting the works of the British Westinghouse Electrical and Manufacturing Company at Old Trafford. The new technical school, the John Rylands Library, and the Chetham Hospital will be inspected. A trip will be made to Stonyhurst College and Whalley.

On the concluding day of the meeting, Wednesday, September 16, an excursion will be made to the British Insulated Wire Company's works at Prescot, the Lancashire & Yorkshire Railway Company's works at Horwich and to two collieries at Wigan.

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CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

A POWER PLANT FOR DULUTH—The Great Northern Power Company, of Duluth, Minn., is about to install an electric power plant which it is expected will eventually deliver some 100,000 horse-power. A fall of more than 350 feet vertically is secured by bringing the water down a steep hill in a pipe. Energy is to be furnished for the industries of the city and probably for the mines of the Mesaba range. The first installation will cost about $3,500,000.

VIRGINIA POWER COMPANY TO INCREASE ITS CAPACITY—The Virginia Passenger and Power Company has purchased thirty-six miles of land lying on both sides of the Appomattox river, and will construct a lake thirty miles long and four miles wide, the object being to obtain a full supply of power for the cities of Richmond and Petersburg. It is also proposed to erect a clubhouse and to create a great pleasure resort at this point. It is said that the general plan contemplates the expenditure of several millions of dollars.

NEW CALIFORNIA POWER PLANT—The California Edison Electric Company has started preliminary work on another power plant to be situated on Bear creek. It will be located near the junction of Bear creek and the Santa Ana river, near the headworks of the present power-house in the Santa Ana Cañon. The water of both rivers will be used to furnish power, and by means of an extensive system of tunneling a long pipe line will be established. The power from this plant will be used by the Edison company to supplement the supply which goes to San Bernardino, Riverside, Redlands and Los Angeles.

A CONSOLIDATION SUGGESTED FOR THE CHICAGO TRACTION COMPANIES—A consolidation of all the Chicago street car lines is the solution of the traction problem favored by Judge Grosscup and planned by the Union Traction receivers, according to a statement which has been made by Marshall E. Sampsell, receiver. A basis of one-city-one-fare is considered by the receivers to be the best foundation upon which to ask franchises from the city. The Court favors this plan, and the details will probably be worked out by protective committees representing the Northwest and other companies, together with a voting trust with power to act for the Union Traction Company. The Chicago City Railway will be represented by New York stockholders who favor consolidation and by Chicago shareowners who hold the same views. It is not believed that the one-city-one-fare arrangement would be a heavy burden upon the consolidated company, as it is thought that through travel through the various parts of the city will be comparatively light.

THE COOPER HEWITT MERCURY VAPOR LAMP.

The Cooper Hewitt Electric Company has recently perfected a new method of starting some of the various types of mercury vapor lamps manufactured by it under the Hewitt patents.

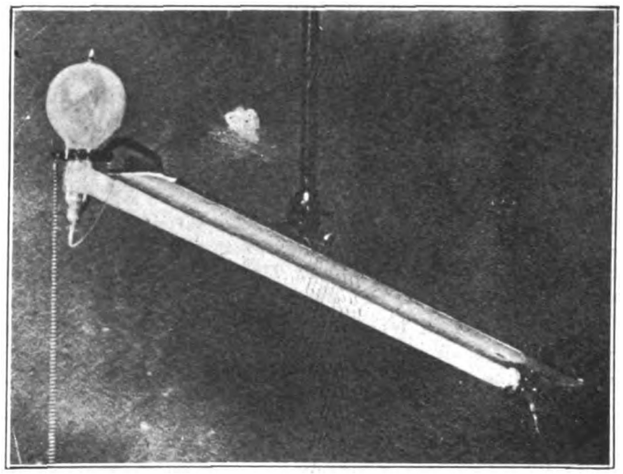
Up to now the lamps put into commercial use were started by a high-potential kick from an inductance coil. A special quick-break switch under oil was used to make and break a circuit across the coil, the discharge of which passed through the lamp, breaking down the initial reluctance to starting.

The new process of starting, which is called by the descriptive name, the "Tilting" method, is somewhat similar to that employed by Arons and other early investigators, in that an absolute connection is established between the two electrodes of the lamp by means of the fluid of the electrodes themselves.

These lamps had two mercury electrodes on the same plane and were started by being turned sideways so that the two pools of mercury came into contact. On being returned to the original position the contact was broken and the conduction through the vapor established.

In the Hewitt lamp, however, the electrodes are placed one above the other and a connection is established by first tipping the lamp so that there is an excess of mercury in the normal upper electrode and then allowing this mercury to flow, by gravity, in a stream down the length of the tube. This stream momentarily establishes a metallic connection between the electrodes and then breaks, usually at the bottom, where it ends in a spray. The lamp lights across the break, the luminous area rapidly extending up the tube as the stream falls away. The liquid mercury has the property of stringing out into a long, fine, continuous stream, and lamps over four feet long have been lit in this manner, using no more mercury than is required for their normal operation. It is usual, however, to use lamps about two feet long to operate on fifty-five or sixty volts. This is the type of lamp here illustrated.

At the upper end is the condensing and regulating chamber, which is one of the distinctive features of the Hewitt lamp. The lamp is supported by two asbestos-lined clamps to a metal tube, through which run the wires to the two terminals. The rod is pivoted in the centre and has a weight at the lower end so that the lamp normally hangs as shown. A chain is provided for pulling the upper electrode down and thus furnishing it with a surplus of mercury. On releasing the chain the lamp returns automatically to its normal position, the stream is formed and



NEW TYPE HEWITT MERCURY VAPOR LAMP.

the conduction through the vapor established. A spring and cushion at the pivot prevent any jar. An adjustable reflector is strapped to the supporting rod.

To operate 110 to 120 volts, the lamps are connected two in series. If it is intended to light both lamps simultaneously they are mounted in one frame and tilted together. With an apparatus of this kind, a simple rheostat and choke coil for steadying resistance are all that is required. When the lamps are to be lighted independently, each is furnished with a resistance having in shunt across the vapor lamp another resistance which is automatically cut out when the lamp is started. Two forty-volt, 1.5-ampere incandescent lamps are used as the shunt, so that being first turned on by an ordinary switch the operation of tilting the vapor lamp may be readily accomplished in an otherwise dark place. They also serve as pilot lamps to show when the switch is left closed and the vapor lamps unlit.

Besides the lamp illustrated, the company is manufacturing two other types of Tilting lamps. Both are mounted in double holders and are intended to be lit simultaneously. One set consumes but 1.3 amperes and is intended for retouching and lantern slide work, etc., while the others are the regular three-ampere lamps and are arranged for all sorts of photographic and printing work.

In spite of the distortion of colors produced by the light, the lamp is finding much favor as an illuminant for offices where close application is required.

The company has recently installed vapor lamps for lighting the composing-room of the New York *Evening Post* and the train despatcher's office of the Pennsylvania Railroad at Jersey City, N. J.

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PERSONAL MENTION.

MR. S. L. BARRIETT.

MR. S. L. BARRIETT is the designer of the well-known Cincinnati motor, and the inventor of the automatic-release rheostat and self-oiling bearing, two inventions which have been utilized with the greatest practical benefit in connection with the operation of electric motors. Mr. Barriett was general master mechanic of West Point foundry during the late Spanish American War, and is recognized as an authority on electrical and mechanical matters generally. While associated with the Sprague Electric Company, Mr. Barriett worked out various controlling devices for that company, leaving this connection in 1896, when he took charge of the tool-designing at the West Point foundry, shortly after being promoted to the position of general master mechanic. Shortly after the war Mr. Barriett resigned his position at the West Point foundry and came to Cincinnati, organizing the Cincinnati Electric Motor Company, designing special tools and machinery for the manufacture of electric motors ranging from one-half to ten horse-power. This institution has been very successful, and on July 1 it was decided to change the name to the Barriett Electric Company. The Barriett Electric Company will manufacture the Cincinnati motor and also a new type of motor which Mr. Barriett is designing, and which will be known as the Barriett motor.

MR. G. WILBUR HUBLEY, superintendent and electrical engineer of the Louisville Lighting Company, Louisville, Ky., made a brief visit in New York city last week on his return from Atlantic City.

MR. WILLIAM S. BARSTOW, the well-known consulting engineer, New York city, has moved his headquarters to the Bowling Green offices, 11 Broadway. Mr. Barstow makes a feature of giving periodical and special reports on electrical properties, prepares plans and specifications, and supervises installations.

MR. CHARLES H. WILLIAMS, of the Madison Gas and Electric Company, Madison, Wis., will be in charge of the wrinkle department of the National Electric Light Association. Mr. Williams was suggested by past-President Doherty, and will make this subject of value and interest to the members of the association.

MR. GEORGE C. EWING has been appointed the New England representative of the Cooper Hewitt Electric Company, of New York city, to handle the Hewitt mercury vapor lamp in his territory. This is not a change from his present business, but an addition to it. Mr. Ewing's headquarters are the Board of Trade Building, 131 State street, Boston, Mass.

MR. T. F. MANVILLE, president of the H. W. Johns-Manville Company, and family returned on August 20 from a two months' trip abroad, visiting London, Paris, Berlin and other places on the Continent. Mr. Manville was largely interested in numerous important tests of the efficiency of pipe-coverings conducted by the English Government, and feels confident of closing some large contracts as a result.

MR. LARUE VREDENBURGH has been appointed reporter on advertising methods, and will present a report on this subject at the twenty-seventh annual convention of the National Electric Light Association, to be held in Boston, May, 1904. Mr. Vredenburgh is in charge of the Edison Electric Illuminating Company's exhibition department in Boston, and this is one of the most complete of its kind in the country.

MR. FRANCK Z. MAGUIRE, of New York and London, has been elected vice-president of the DeForest Wireless Telegraph Company. Mr. Maguire was formerly associated with Thomas A. Edison and Alexander Graham Bell in electrical work and will be a valuable member of the DeForest company. Mr. Maguire has numerous electrical interests in this country and Great Britain and crosses the ocean several times every year.

MR. RUSSELL HOWLAND, for several years assistant advertising manager of the ELECTRICAL REVIEW, has recently resigned to open a business office at 150 Nassau street, New York city. It is Mr. Howland's intention to take charge of general advertising for his patrons and its systematization, this service to include the preparation of original copy and literature and a system of following up enquiries. His experience should win him pronounced success in this field. The ELECTRICAL REVIEW extends to Mr. Howland its best wishes for his success.

ELECTRIC RAILWAYS.

WATERTOWN, N. Y.—It is rumored here that the street car line into Dexter will next year be extended to Guffins Bay, to handle both a freight and a passenger business.

SOUTH BEND, IND.—The Northern Traction Company has been incorporated to build an electric railroad connecting the cities of South Bend, Laporte, Valparaiso and Hammond.

DOYLESTOWN, PA.—Rights of way for the extension of the Philadelphia & Easton Railway Company's line from Tohickon Park to Bedminster, three miles, have been secured, and work will commence shortly. The extension will cost about $50,000.

BURLINGTON, IOWA—Plans have been made for the construction of an interurban electric line from this city to Keosouqua. Corporate articles have been filed by the Burlington Interurban Company, with $200,000 capital stock. Carl Liepold is president and J. W. Topping, secretary.

DOYLESTOWN, PA.—It is said on good authority that a trolley road will be built between Newton and Willow Grove at an early date. The route between the two places has been decided on and considerable of the right of way secured. The line will take in the villages of Richboro, Southampton, Davisville and Hatboro.

MINEOLA, N. Y.—The board of supervisors has unanimously granted the Mineola, Roslyn & Port Washington Traction Company a franchise over the country roads included in the proposed trolley route from Mineola to Port Washington. Under the conditions of the franchise the company is required to begin work not later than January 1 next and complete the road on or before June 1, 1904.

LOUISVILLE, KY.—The Southern Kentucky Interurban Traction and Power Company has been incorporated in New Jersey for the purpose of building an electric railroad from Bowling Green to Hopkinsville, *via* Franklin, Russellville and Elkton. The company is now acquiring right of way between the terminals of the proposed line, most of it having been already secured. The company's capital is $125,000.

SHARON, PA.—The officials of the Cleveland & Sharon Electric Railway have awarded the contract for the construction of the line from Middlefield to Sharon, a distance of forty-five miles, to Joyce, Heasley & Fawcett, of Youngstown, for $200,000. The line is now in operation from Cleveland to Middlefield. In addition to the line from Middlefield to Sharon, another is to be built by the same company from Kinsman through to Warren, Ohio, and the line is also to be extended northeast from Kinsman to Greenville and Meadville.

LITTLE ROCK, ARK.—The state board of railway incorporators has granted a charter to the Little Rock & Monroe Railway Company, which will probably furnish the connecting link in a new line from Little Rock to New Orleans. The capital stock is $500,000. The proposed line is to be about fifty miles in length, extending from Felsenthal, Ark., to Monroe, La. It will probably cross the Ouachita River at Ouachita City, La. The directors of the company are: C. D. Johnson, president, St. Louis; E. A. Frost, Texarkana, Ark.; E. W. Frost, Texarkana, Ark.; J. F. Rutherford, Pine Bluff, Ark., and J. E. Cavanagh, Lapile, Ark.

PAWTUCKET, R. I.—If present plans are carried out, work will commence next year on the construction of a double-track electric railroad between Woonsocket and Providence, by the new Providence & Burrillville Street Railway Company. The line will start from a point south of Woonsocket and will run through North Smithfield, Lincoln and Smithfield to a point near Centredals, connecting there with the tracks of the Providence system. The distance between Providence and Woonsocket by steam road is sixteen miles, and the promoters of the plan hope to cut this down two or three miles. The company will handle both passengers and freight and will also do an express business.

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ELECTRICAL SECURITIES.

Contrary to expectations, the price changes during last week amounted to very little. The total dealings were lighter than in any week for some time, and it is stated that on Thursday the record was made for the smallest dealings in two years. While this was hardly expected, dulness at this time is the rule. The general prosperity of the country is admitted, and at this time it seems hard to reconcile the prevailing opinion that a decline in values is the forerunner of a decline in industrial activity.

The money market appears to be in a stronger position than the adverse speculative conditions of the past few months would seem to warrant. This, however, is due to the radical measures which government officials have taken to provide against a prot.acted stringency. The announcement has been made that Secretary Shaw has accumulated from internal revenue receipts a fund of $40,000,000, which will be thrown into the local money market in case of necessity. This, of course, relieves the banking community of any uneasiness, and it is also known that the greater number of banks are in a stronger position than they have been for several years.

Railroad earnings, which are taken more or less as the index of industrial conditions, show an unabated prosperity. Some companies which were not expected to do very well have shown, in balancing up their books, that the earnings have been beyond the most sanguine expectations.

ELECTRICAL SECURITIES FOR THE WEEK ENDING AUGUST 29.

New York:	*Closing.*
Brooklyn Rapid Transit	45¾
Consolidated Gas	178
General Electric	163
Kings County Electric	150
Manhattan Elevated	135½
Metropolitan Street Railway	114
New York & New Jersey Telephone	148
Westinghouse Manufacturing Company	175

The annual report of the Brooklyn Rapid Transit Company for the year ended June 30, 1903, shows the gross earnings to have been $12,357,041, and the expenses, $7,553,939, leaving net earnings of $4,803,102. The total income of the company amounted to $5,025,491, and the charges to $4,289,907, leaving a surplus for the year of $735,584, as compared with a deficit of $129,156 for the preceding year.

Boston:	*Closing.*
American Telephone and Telegraph	133
Edison Electric Illuminating	230
Massachusetts Electric	81
New England Telephone	125
Western Telephone & Telegraph preferred	80

It is estimated that the earnings of the American Telephone and Telegraph Company this year will be about 10 per cent on the stock eligible for dividends, and about 8 per cent on the total stock outstanding. The direct net earnings of the company from its long-distance service this year will probably be at least $2,000,000, against $1,800,000 last year.

Philadelphia:	*Closing.*
Electric Company of America	8⅝
Electric Storage Battery common	56
Electric Storage Battery preferred	56
Philadelphia Electric	6¼
Union Traction	43¾
United Gas Improvement	84

The stockholders of the Union Traction Company will hold their annual meeting on September 16.

Chicago:	*Closing.*
Chicago Telephone	122
Chicago Edison Light	140
Metropolitan Elevated preferred	60
National Carbon common	20
National Carbon preferred	88
Union Traction common	4¼
Union Traction preferred	32

The directors of the South Side Elevated Railroad have declared the regular quarterly dividend of 1 per cent, payable September 30. Books close September 19 and reopen October 1.

ELECTRIC LIGHTING.

SAUK CITY, WIS.—A contract has been made with a Madison firm for an electric lighting and power plant for this town, to cost $9,000. This does not include the building.

HUNTINGTON, W. VA.—Work on the new power station for the Camden Inter-State Railway at Kenova has been commenced and the new station will be completed as soon as possible. The building, when completed, will have cost $2,000,000.

NIAGARA FALLS, N. Y.—The common council has accepted the bid of the Buffalo & Niagara Falls Electric Light and Power Company to light the city streets. The city is to use not less than 400 arc lights, at $65 a light, and the contract is to run for a period of five years.

JANESVILLE, OHIO—The Acme Electric Light and Power Company has been incorporated with a capital of $10,000, to furnish Crooksville with light and power. The incorporators of the company are Ellwood Newberry, Lewis Springer, H. F. Kinnen, W. H. Dunn, A. E. Smith and J. J. Hill.

GRAND RAPIDS, MICH.—The Grand Rapids Edison Company's plant at Lowell is said to be nearing completion. The plant, which will cost $500,000, is located two miles north of Lowell in Vergennes township. The electricity will be used largely in Grand Rapids for lighting, heating and power.

APPLETON, WIS.—The United Gas and Electric Corporation, of which Thomas A. Rockwell, president of the Fox River Valley Gas and Electric Company, is chairman, has purchased the gas and electric interests at Ishpeming. The property includes the electric light and gas plants of Negaunee and Ishpeming and an interurban electric railway between them.

DUXBURY, MASS.—It is stated that a proposition is under way for the formation of a stock company of Boston capitalists to furnish light for Duxbury, Standish Shore, Duxbury Beach and Green Harbor village, possibly extending the system through Brant Rock, and that more than $50,000 has been subscribed for the purpose. The company, if present plans materialize, will probably furnish power for electric lines that may be built through the South Shore beaches.

TROY, N. Y.—Articles of incorporation for the Hoosic Electric Light and Power Company have been filed in the office of the county clerk. The capital stock of the company is $50,000, and the directors are Le Grand G. Tibbits, George A. Bovie and Sayre McLeod. The company will do business in Renssalaer, Washington, Albany and Saratoga counties, operating particularly in Schaghticoke, Pittstown, Hoosick and Hoosick Falls, White Creek, Cambridge, Jackson, Easton, Greenwich, Petersburgh, Valley Falls, Johnsonville, Eagle Bridge, Green Island, Waterford, Troy, Albany, Cohoes, Rensselaer and Watervliet. The field of operation may be extended to all parts of the state, and the company's equipment, it is said, will be sufficient to do municipal lighting and to furnish light and power to large industrial concerns.

LEGAL NOTES.

SUIT FOR INFRINGEMENT OF CLEANING AND COATING PROCESS—The Safety Armorite Conduit Company, Pittsburg, Pa., a large manufacturer of the enameled type of iron-armored electric conduits, has brought a suit in the United States Circuit Court for the Western District of Pennsylvania against the American Conduit Manufacturing Company, of New Kensington, Pa., alleging an infringement of a patent for a cleaning and coating process.

TIME LIMIT ON TRANSFERS—The Supreme Court of Maryland has held in the case of Garrison *vs.* United Railways and Electric Company (55 Atlantic Reporter 371) that a statute of the state requiring the street car company of Baltimore city to give on request to each passenger paying a cash fare for a "continuous" ride a transfer, does not prohibit the company from limiting the time within which a transfer can be used. It was further held that when the time limit of a transfer issued by the street railway has expired, the transfer is void on its face, and the conductor is justified in refusing to honor it and in demanding a fare. It was also decided that when a conductor has given a passenger a reasonable time and opportunity to pay his fare and the passenger has refused, and the conductor has commenced to eject the passenger, the ejection may be completed even though a fare be tendered, as the passenger has forfeited his rights as such.

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INDUSTRIAL ITEMS.

THE SPRAGUE ELECTRIC COMPANY, 524 West Thirty-fourth street, New York city, in its bulletin No. 206, describes a line of Lundell motors for direct current. This includes round-top motors, open and enclosed; medium-speed, six-pole, single-field-coil motors; and slow-speed, six-pole, single-field-coil motors.

THE BUREAU OF EXPERT INVESTIGATION AND CONSTRUCTION, 35 Nassau street, New York city, has issued an attractive folder setting forth the functions of the organization. This consists of specifications on electrical, mechanical, hydraulic, civil, mining and factory engineering problems, and research into chemical problems. There is also a law department, and a department of patents and patent law.

THE DOUBLEDAY-HILL ELECTRIC COMPANY, Pittsburg, Pa., is supplying the electrical apparatus for the new Grand Opera House, in Pittsburg, which is being entirely redecorated. The work is being done by the Fullman Company, which is installing its new floor box. This will be described later. The large dimmer for this installation is of the Wirt type, manufactured by the Wirt Electric Company, Philadelphia, Pa.

THE OTIS ELEVATOR COMPANY, 71 Broadway, New York city, has secured an order from the Navy Department for an electric dumb-waiter with push-button control, to be installed on the United States receiving ship Hancock. The car will run from the gallery on the lower deck to the messroom on the upper deck, with a third landing at the deck midway. The rated capacity of the dumb-waiter will be 250 pounds, at seventy-five feet per minute, and the car travel will be thirty feet.

THE VARLEY DUPLEX MAGNET COMPANY, Providence, R. I., has issued its catalogue No. 10B. This contains descriptions and illustrations of electromagnets and all kinds of coil windings of insulated and bare wire. A supplement to this work, which is a valuable contribution to the literature on this subject, has two curve sheets showing the relation between ampere-turns and pull in pounds for different air-gaps, and also showing the relation between pull in pounds and air-gap for various ampere-turns.

THE CROUSE-HINDS ELECTRIC COMPANY, Syracuse, N. Y., is marketing a fine line of "Norbitt" electric specialties. These "Norbitt" porcelains are well known to the electrical trade, and eastern visitors are invited to enquire at the New York office, 23 Dey street, where a full stock is carried. A new catalogue which has just been issued by the company will give a good idea of the extensive line covered by the "Norbitt" specialties, and this will be sent to any one interested upon request to the company.

THE PHOENIX GLASS COMPANY, New York, Pittsburg and Chicago, has just issued a handsome catalogue on electric and gas globes and shades. This catalogue, which is known as No. 15, is 14 by 12 inches in size, consists of 108 pages, fifty-four plates, with over 1,000 artistic designs of globes and shades for gas, electric or combination fixture and bound in heavy green cloth with handsome decorations and lettering in silver. Every color and period of design to harmonize, not only with the chandeliers but with the interior decorations as well, are shown.

THE WESTERN ELECTRIC COMPANY, Chicago, Ill., in its bulletin No. 6005 illustrates a new line of automatic circuit-breakers for direct currents. The company states that the current-carrying parts will not rise in temperature more than twenty degrees above the surrounding atmosphere. The breakers are tripped by a simple electromagnet device. There is ample copper in the laminated brushes and in the coils, and the endeavor has been made to construct a breaker which will possess reliability, simplicity and strength. This handsome bulletin will be sent on request.

THE H. T. PAISTE COMPANY, Philadelphia, Pa., manufacturer of electric light supplies, has recently purchased a pottery, and this, with the expansion of its electrical supply business, has necessitated the active services in its home office of its secretary, E. A. Jenkins. Mr. Jenkins has heretofore had charge of the western office of the company, with headquarters at 190 South Desplaines street, Chicago, Ill. The H. T. Paiste Company has secured the services of James Wolff, western sales manager of the New York Insulated Wire Company, who will conduct the former company's western business at the same address, in connection with his present well-known wire line.

THE KELLOGG SWITCHBOARD AND SUPPLY COMPANY, Chicago, Ill., has secured a contract from the New Home Company, of Linton, Ind., for an 800-line switchboard with an ultimate capacity of 3,000 instruments. The contract includes the telephones. The satisfactory results which the Kellogg company's apparatus has given in the plant of the Knox County Telephone Company, of Vincennes, Ind., have caused the directors of the New Home Company, of Linton, part of whom are on the board of directors of the Knox County Telephone Company, to purchase an exact duplicate of the Vincennes board.

THE AUTOMATIC ELECTRIC COMPANY, Chicago, Ill., reports that it is now installing the following plants with the Strowger automatic telephone apparatus: Citizens' Telephone Company, Grand Rapids, Mich., 5,000 stations; Northeastern Telephone Company, Portland, Me., 2,500 stations; St. Marys Telephone Company, St. Marys, Ohio, 500 stations; Cleburne Telephone Company, Cleburne, Tex., 640 stations; Southern Telephone Construction Company, Columbus, Ga., 700 stations; University of Illinois, Urbana, Ill., 50 stations; University of Chicago, 50 stations; Armour Packing Company, St. Louis, Mo., 45 stations; Union Telephone Company, Woodstock, New Brunswick, Canada, 110 stations. All of these equipments will be in operation within a few weeks.

THE EWING-MERKLE ELECTRIC COMPANY, St. Louis, Mo., is mailing an attractive folder which calls attention to its great facilities for promptly taking care of orders of any magnitude. The illustration is a clever drawing of a young woman in military costume, and impresses forcibly the foreword, "Military Promptness." The company states that its corps of able assistants is at headquarters for its patrons' command, and that each assistant is trained to fulfil his part with care and promptness. Every order will have immediate attention, so that not a moment will be lost. At the head of every department is a lieutenant capable of commanding his special post. All goods are carefully packed, and there is little danger of accident en route. The company will be pleased to send its green-book or special bulletins on request.

THE H. W. JOHNS-MANVILLE COMPANY, 100 William street, New York city, has secured an order from the Cincinnati & Columbus Traction Company, Cincinnati, Ohio, through its Cleveland branch, for sufficient overhead line material to build fifty-five miles of new road. The construction will consist of parallel trolley wires of 000 grooved type. The well-known Johns-Manville extra heavy galvanized round-top hangers with three-quarter-inch studs, provided with deep petticoats, will be used, ensuring high-class surface insulation. These insulators are attached to galvanized straight-line yokes having a centre dimension of six inches between trolley wires. The combination mechanical and solder clip, fifteen inches in length, being one piece only, which has proven very successful in the East in extra heavy construction, will also be used in conjunction with the extra heavy hangers and "Giant" type pullovers. "Giant" strain and "Philadelphia" section insulators will be used throughout.

THE AMERICAN ELECTRICAL HEATER COMPANY, 17-19 Spencer street, Detroit, Mich., has issued its new catalogue, which illustrates and describes a fine line of electrical heating apparatus. This takes in a great many devices which are of constant use in industrial and domestic service. The apparatus manufactured by the company has been in successful use for over nine years, and the sales to-day are larger than at any previous time. One of the devices of great practical value made by this company is its electric soldering iron for fine work. A special type of this device is known as the telephone iron for switchboard work. A tip can be used with this iron that will extend four or five inches beyond the end of the iron, and the tips can be removed and forged into any angle desired. This iron can be attached to a lamp socket and used with any length of cord, which will allow it to be carried to any part of the room. The company also makes a larger number of laundry and pressing irons and automatic cutouts and auxiliaries for this apparatus. Another feature is the electric disc heaters or portable stoves. These are also made in a great many shapes, along with griddles, toasters, plate warmers, curling-iron heaters, glue pots, foot warmers, rheostats, shoe-ironing tools, etc. The company's catalogue will be mailed to any one interested upon request.

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CHARLES W. PRICE . . . . . PRESIDENT AND EDITOR
STEPHEN H. GODDARD . . . . . SECRETARY AND MANAGER
WM. HAND BROWNE, JR. . . . . TECHNICAL EDITOR
AINSLIE A. GRAY . . . . . ASSISTANT EDITOR

PUBLISHING OFFICE . . . . . 13-21 Park Row, New York
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CONTENTS

EDITORIALS 337, 338, 339
The Electric Sleeper 337
The Street Railway Convention 338
Electricity as an Agent for Health 339
Languages and the Telephone 339
Electric Power for Mining Purposes, by George Scarfe 343
Development at Niagara Falls for the Utilization of Its Power 344
Regulation of Transmitted Power, by Alton D. Adams 349
The Production and Distribution of Alternating Current for Large City Systems, by Richard McCulloch 350
Remarkable Alternator, by E. Guarini 359
Effect of Electricity on Plant Growth 360
The Street Railway Association of the State of New York 360
Committee of American Institute of Electrical Engineers Appointed to Prepare an Exhibit for the Institute at the World's Fair 360
Twenty-second Annual Convention of the American Street Railway Association 361
American Railway Mechanical and Electrical Association 368
International Association of Municipal Electricians 373
Electric Lights on Railway Trains in Germany and Austria 373
INDUSTRIAL SECTION:
The "New American" Turbine 374
An Electrical Testing Laboratory 375
The Ohio Electric Light Association 375
Break Finder and Ground Locator 375
A New Type of Successful Oil Burning Engine 376
A New Automatic Volt-Ammeter 377
Reorganization of the Standard Vitrified Conduit Company 378
A Simple Form of Trolley Catcher 378
Automatic Fire Alarm System 379
New Telephone Apparatus 380
Tray Type Storage Battery 380
Exhibits and Exhibitors at the Street Railway Convention 381
CURRENT ELECTRICAL NEWS:
Export and Domestic 384
Automobile Notes 385
Electric Lighting 385
Personal Mention 386
Obituary 386
Telephone and Telegraph 386
Electrical Securities 387
Electric Railways 387
Industrial Items 388

The ELECTRICAL REVIEW appears this week with some typographical changes and a general enlargement of its various departments. It is the constant aim of the publishers and editors to increase the value and influence of this journal, and the strides made in the recent past may be taken as an indication of the future of the pioneer electrical weekly of the United States.

The Association of Edison Illuminating Companies in session this week at Thousand Islands is a pioneer electrical organization. Its influence, though quiet, has been important and progressive, and the tone of the papers and discussions on a high plane.

A Canadian inventor has come to the rescue of the baseball umpire. An electric plate is provided by which the baseman rings a bell if he touches it first, and which the runner can prevent from ringing if he arrives first. This seems easy, yet we doubt if it will succeed in practice. It would be of doubtful popularity, for the discussions over the decisions of umpires is one of the main features of the game to many patrons, and any interference by electrical science would likely meet with objection.

The electrical inventor is never idle. He is probably the most restless and discontented of all the various classes of inventors. This may be due to a certain mystery that surrounds the application of electricity's flexible power and its no-flame light—or perhaps our younger geniuses are fascinated by the fame that has so rapidly come to successful ones in this field, as instanced recently by the rise of Marconi. Anyhow, we do not find anything to object to in this earnest work. There is much yet to be accomplished.

A protest has already been made against wireless telephony. To have the voices of the air shouting you out of a nap in some secluded spot will have its drawbacks. Scientists, think this matter over.

THE ELECTRIC SLEEPER.

Although the trolley road has made great inroads into the suburban traffic of the steam roads, up to the present time the latter have had the monopoly of the sleeping-car service. Now a western system of electric roads is about to enter this field, and will operate sleeping cars on its trolley lines which will be as luxurious as the Pullman on the steam road, and will offer in addition other conveniences which will add materially to the comfort and pleasure of the patrons of the road. The construction of the sleepers, while following the general scheme of the older type, will embody a number of new features. The cars will be somewhat lighter than the steam road sleeper, and during the day will be converted into parlor cars.

Probable Success of the Electric Sleeper.

As this service is just being introduced, it is too early to predict its success. But since electrically operated cars are free from the great discomfort caused by the smoke and cinders of the steam locomotive, and since the motion of the car should be easier, as it is free from the jerks caused by the steam locomotive, it looks as though these cars will become popular and that an additional blow has been given to the electrical wedge which is entering steam railroad operation.

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THE STREET RAILWAY CONVENTION.

The twenty-second annual convention of the American Street Railway Association has passed into history, but it has left perhaps a stronger imprint upon the life of the association than has any one of the conventions of recent years.

"To be or not to be?" To stand as the foremost working association dealing with the problem of electric railroading, or not so to stand? To have a greater or a smaller number of delegates present in the convention hall during the transaction of business, than any other national electrical association? These and kindred questions, passed and repassed between earnest workers for the welfare and standing of the association, gave marked tone to the meetings.

The New President.

The newly elected president, Mr. W. Caryl Ely, has had the unusual opportunity of testing the fibre and temper of the association before entering upon the duties of the presidential office. He has had opportunity to view from the standpoint of a presiding officer the force of the various factors which contribute to the convention, and he will have opportunity to enhance or restrict their prominence at the next convention in the ratio of their usefulness.

The association is fortunate in having as president a man of firmness, directness and unusual tact to guide its destinies during the year of its majority, a year in which it is highly fitting new policies should be inaugurated, and, if anything, a more earnest and strenuous life entered upon.

The Proceedings.

The papers and the committee reports presented before the convention, and especially the discussions thereof, and the impromptu talks thereon, were strong and valuable, and it is to be regretted that they were not listened to by a greater number of the delegates. The sessions were full of good things—things that will never get into the printed reports—vigorous and timely things—the essence of knowledge that makes paying properties.

The President's Address.

Mr. Ely's address is full of hope for the future. The association should grow and wax very strong under the stimulation of an executive who has made for his term of service so good a platform. The president recognizes the great possibilities of the association. He has rightfully placed the fulfilment of a broad and comprehensive policy as a mark worthy of attainment, and the ELECTRICAL REVIEW wishes him deserved success.

The Right of Way.

This is a subject to which the public must be educated. Mr. Vreeland points out the winning way when he emphasizes this point. In so far as a public service corporation earnestly strives to meet its obligations to the public, the public should extend the weight of its influence in a responsive spirit of helpfulness to the corporation. The fact must be recognized by public service corporations that the education of the public, through the activity of opposing forces, has to no small extent been carried on along lines at once productive of injustice to themselves as well as to the public. With this fact in view, a tactful corporation can change the attitude of the public mind in such measure as to make it trace with clearer vision the equities of the problem of "the right of way"—and thereby much time may be saved and credited to increased prosperity instead of being lost. No one has calculated the aggregate of the life that is needlessly wasted in a great city by wanton interference with traffic—yet it totals the lives of many men each day.

General Rules.

The report of the committee on rules for the government of employés is comprehensive and has evidently been made with the intent of conserving in the highest measure the rights, comfort and safety of passengers. The passenger, by these rules, is in every case given the benefit of doubt, and the eccentricities of human nature will be dealt with very kindly by the conductor or motorman who follows the path which the rules mark out. When the report of the committee was presented before the convention the only changes suggested were such as will tend still further to accommodate patrons of electric railways, and the attitude of the men in charge of these great transportation properties was at all times so solicitous of the public welfare as to command admiration.

Standardization of Electrical Railway Apparatus.

Standardization in all things pertaining to industry promotes industry and perfection. Not long ago the standard rules of the underwriters were promulgated, and since, by general cooperation, have been brought to a high state of perfection and helpfulness. The American Institute of Electrical Engineers has been foremost in developing a code for the standardization of electrical machinery.

We all recognize the value of this new work, which is well done, and we commend to electric railway managers an active and vigorous "putting to the test" of this latest adjunct to the code of progress.

The Next Convention.

The matter of the next meeting place of the American Street Railway Association has been very wisely referred to the executive committee. Proposed changes in the conduct of the conventions make it particularly desirable that this matter should be left open so as to give the officers of the association the utmost freedom of action in developing their plans. Although there was no official discussion of the matter, there was nevertheless a well-defined sentiment expressed in favor of the acceptance by the American Street Railway Association of the invitation of the committee of organization of the International Electrical Congress of 1904 to meet with it in joint session in St. Louis.

The invitation carries with it the active conduct by the American Street Railway Association of the international gathering of electrical railway interests that will assemble at the St. Louis World's Fair next summer during the electrical week of September 12 to 17.

A participation in the International Congress as the sponsor for the electrical railway interests of the world is a fitting honor for the association, and it is to be hoped that the executive committee will see its way clear to cooperate in the fullest sense with the organization committee of the congress.

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ELECTRICITY AS AN AGENT FOR HEALTH.

As an agent for health, electricity has proven as good a servant as in the weightier and more spectacular engineering environments. As a by-product it serves as a means whereby profit may be made of the use of refuse destructors which otherwise would entail an almost prohibitive cost on a community.

Electric Vehicles and Clean Streets.

The ultimate use of the electric motor for all forms of vehicles will bring about a condition of city sanitation that would be impossible while the horse is used as a draft animal. The universal use of electrical energy as a means for producing illumination will bring about a clearer atmosphere, due to the elimination of gaseous odors and the products of incomplete combustion.

Ozonizing and Sterilizing Qualities.

Experiments which have been given recent publicity have established the value of the electric current as an ozonizing and sterilizing agent. Faradic currents as remedial agents in nervous diseases have been prescribed by physicians of high standing for some time. The electric fan is invaluable in the sick room and for ventilation of every description.

As an Anti-Microbic.

As an anti-microbic, various forms of light-wave phenomena, which are conceded to be the direct result of electrical conditions, are rapidly coming into favor. No one can read of either the iron spark or ultra-violet ray treatment, which Finsen has so elaborated on, without feeling that here alone in the treatment of parasitic diseases of the cuticle, a wonderful opportunity is given to electricity as a boon for the relief of human suffering.

Radium in the Treatment of Cancer.

The suggested use of radium for treating cancer is of interest to students of electrical science for several reasons. In the first place it shows what unexpected results may follow from investigation of what to the practical man seems to be far removed from useful application. Thus the study of discharges in vacuum tubes led to the discovery of Rœntgen rays. Experiments with this phenomenon soon showed that the rays acted strongly upon living tissues, and it was suggested to use these for treating malignant growths.

Value of the Radium for This Purpose.

The particular value of radium for this purpose lies in the fact that it may be used to bring about a localized treatment. When the Rœntgen rays are used the rays must, as far as possible, act upon the diseased spot without affecting the sound tissues. This is difficult to accomplish because the rays have the property of passing through opaque material. With radium, however, a small tube containing the active material could be introduced into the diseased tissues, thus bringing the active agent just where it is wanted. If the value of this treatment is proved it will be one of a large number of weapons against disease which has been discovered through the work of men who never for a moment imagined any such outcome of their studies.

LANGUAGES AND THE TELEPHONE.

An interesting statement was made recently in a cable message to the New York daily press to the effect that the telephone employés in Paris have found that French is more easily understood over the telephone than English. It is said that in telephoning between Paris and London during a storm conversation in English is impossible but French is easily understood.

The Conditions Which Affect Voice Reproduction.

This effect might be due either to the speaker or to the telephone line itself. The electrical constants of a long line or a cable tend to smooth out and destroy the electrical waves which are produced by the voice acting upon the transmitter and which by means of the receiver reproduce more or less exactly the original words. On the other hand, while the effect just mentioned must be present in all cases to some extent, it need hardly be recalled how surprisingly will the telephone reproduce not only spoken words but even that peculiar quality of each voice which enables another to recognize it.

The Characteristics of French and English.

If it be the fact that the French language lends itself to transmission by telephone better than the English—distinctness of articulation and acuteness of hearing being alike in both cases—the difference must then be inherent in the language itself. Now a spoken language consists of sounds (phonetic elements), intonation and stress.

The greater part of the sounds (vowels and consonants) employed are common to both languages; but a few are peculiar, for example the hard and soft *th* and the flat *a* (as in *hat*) do not exist in French; while the nasal *n* (as in *mon, pain*), the narrow final *u* and the palatal *r* do not exist in English. There seems no reason to suppose that these sounds are more difficult of transmission than others.

There is a difference in intonation, or *timbre* of voice, no doubt, and it is possible that this might be the cause. This could be tested by having an Englishman and a Frenchman to repeat each the same sentences in both languages. If the Frenchman's English was transmitted better than the Englishman's French, the difference would seem to be in the *timbre* of voice.

But it seems more probable that the difference, if there be a difference, is in the stress. All English words above monosyllables have a well-marked primary stress, and polysyllables also a secondary stress, and sometimes two. French, on the other hand, has properly no syllabic stress, except that on the final syllable, approximating in this respect to a monosyllabic language. The result of which is that the strong stress in English causes the unstressed syllables to be slurred over, while in French they have equal enunciation. Compare the English "university" with the French "université" (u-ni-ver-si-té, as if it were "one-two-three-four-five"). It seems at least probable that words thus pronounced would be more distinctly transmitted.

What Might Result from Investigation.

Should further investigation confirm the statement that various languages are transmittable with different degrees of distinctness it would be well for those who attempt to introduce a common language to bear this in mind and construct one which is suitable for telephoning. A commercial language which can not be used easily over a telephone starts with a very serious handicap.

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REGULATION OF TRANSMITTED POWER.

BY ALTON D. ADAMS.

Regulation of the voltage at incandescent lamps is the most serious problem in the distribution of electrically transmitted energy. First-class regulation should not allow the pressure at incandescent lamps rated for 110 to 120 volts to vary more than one volt above or below the normal. Even fairly good regulation, such as every electrical supply system ought to provide, should not permit a variation of more than two volts either above or below the rating of such lamps.

As to arc lamps the bearable conditions are less exacting and a variation of as much as five volts either way from the standard at the terminals of each lamp would not seriously impair the quality of the service. Electric motor service is even less exacting as to constancy of voltage, and the pressure at motor terminals may generally be varied as much as ten per cent without material objection on the part of users. A mixed service to these three classes of apparatus must generally be provided where transmitted energy is used, and the limitations as to variations at incandescent lamps are thus the ones that must control the regulation of pressure.

Transmission systems may be broadly divided into those that have no substations and must therefore do all regulation at the generating plant, and those that do have one or more substations so that regulation of voltage may be carried out at both ends of the transmission line.

As a rule a substation with an operator in attendance is highly desirable between transmission and distribution lines, and this is the plan generally followed at important centres of electrical supply, even though the transmission is a short one. One example of this sort may be noted at Springfield, Mass., where energy for electrical supply is transmitted from two water power plants on the Chicopee river only about 4.5 and six miles, respectively, from the substation in the business centre of the city. The voltage of transmission for two-phase current in this case is 6,000 and this is reduced to about 2,400 volts at the substation for the general distribution of light and power. A similar instance may be seen at Concord, N. H., where electrical energy at both 2,500 and 10,000 volts is delivered to a substation in the business section from a water power plant at Sewall's Falls, on the Merrimac river, 4.5 miles distant. From this substation the current is distributed at about 2,500 volts for the supply of lamps and motors. A substation was found desirable at Concord for purposes of regulation before the voltage of transmission was raised above that of distribution. Subsequently, when the load increased, the voltage of 10,000 was adopted on a part of the transmission circuits in order to avoid an increase in the size of their conductors.

In some instances, however, transmission and distribution lines are joined without the intervention of a substation, where regulation of voltage can be accomplished, though this practice has little to recommend it aside from the savings in first cost of installation and subsequent cost of operation. These savings are more apparent than real if fairly constant pressure is to be maintained at the lamps, because what is gained by the omission of substations will be offset, in part at least, by additional outlays on the lines. This fact may be illustrated by reference to Figs. 1, 2 and 3, in each of which D represents a generating station and A, B and C towns or cities where energy from the station is to be distributed. In the case of each figure it is assumed that the distance between the generating station and each of the cities or towns is such that distributing lines with a loss of, say, not more than two per cent in voltage at full load can not be provided between the generating station and each city or town because of the cost of conductors. This being so, one or more centres of distribution must be located in each town and the transmission lines must join the distribution lines at these centres either on poles or in substations. If several of these towns are in the same general direction from the generating plant so as to be reached by the same transmission line, as A, B and C in Fig. 1, this one line will be all that is necessary with a substation in each town. Where substations are not employed a separate transmission circuit must be provided between the generating plant and each town for reasons that will appear presently. The percentage of voltage variation in a transmission line under changing loads will frequently be from ten to twenty, and is thus far beyond the allowable variations at incandescent lamps. To give good lighting service the centre of distribution, where the transmission line joins the distribution circuits, must be maintained at very nearly constant voltage if no substation is located there. Regulation at a generating station will compensate for the changing loss of pressure in a line under varying loads so as to maintain a nearly constant voltage at any one point thereon. No plan of station regulation, however, can maintain constant voltages at several points on the same transmission line when there is a varying load at each. The result is that even though the several towns served are in the same general direction from the generating station as in Fig. 2, yet each town should have its separate transmission line where no substations in the towns are provided. In the case illustrated by Fig. 3, where the towns served are in very different directions from the generating station, there should be a separate transmission line to each, regardless of whether there is a substation or only a centre of distribution there.

Even in the case illustrated by Fig. 3, as in each of the others, there is a large saving effected in the cost of distribution lines by the employment of a substation at the point where these lines join the transmission circuit, provided that the variation of pressure at lamp terminals is to be kept within one or two volts either way from the standard. With the variations of loads the loss of pressure in the distribution lines will range from zero to its maximum amount and the connected lamps will be subjected to the change of voltage represented by this total loss, unless the distribution start from a substation where the loss in distribution lines can be compensated for by regulation. To give fairly good service the distribution lines should be limited to a loss of between one and two per cent at full load if there is no substation where they join transmission lines. With opportunity for regulation at a substation the maximum loss in distribution lines may easily be doubled, thus reducing their weight by one-half in comparison with that required where there is no substation.

Another advantage of connecting transmission and distribution lines in a substation where regulation of voltage can be had lies in the fact that it is practically impossible to maintain an absolutely constant pressure miles from a generating plant on a transmission line that is carrying a mixed and varying load. A result is that without the intervention of regulation at a substation it is almost impossible to give good lighting service over a long transmission line. Furthermore, the labor of regulation at a generating station is much increased where there are no substations, because it must be much more frequent and accurate. The absence of substations from a transmission system thus implies more transmis-

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sion circuits, heavier distribution circuits, more labor at the generating plant, and a poor quality of lighting service.

Where stationary motors form the great bulk of the load on a transmission system and good lighting service is of small importance it may be well to omit substations at some centres of distribution. This is a condition that sometimes exists in the Rocky mountain region where the main consumers of power along a transmission line may be mines or works for the reduction of ores. An example of this sort exists in the system of the Telluride Power Transmission Company, in Utah, which extends from Provo Cañon, on the river of the same name, entirely around Utah lake by way of Mercur, Eureka and Provo, and back to the powerhouse in Provo Cañon, a continuous circuit of 105 miles.

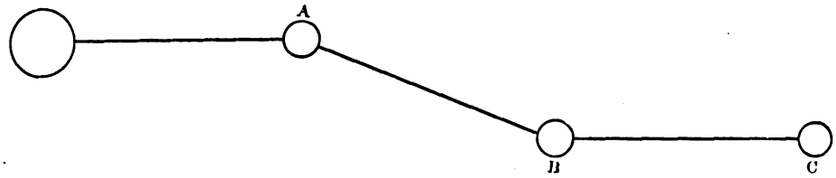

FIG. 1.—THE REGULATION OF TRANSMITTED POWER.

The transmission voltage on this line is 40,000 and at intervals where there are distributing points the voltage is reduced to about 5,000 by transformers on poles, and without the aid of regulation at substations in some cases. The power thus transmitted is largely used in mines and smelters for the operation of motors, but also for some commercial lighting.

Regulation at generating stations of the voltage on transmission lines may be accomplished by the same methods whether there are substations at centres of distribution or not. In any such regulation the aim is to maintain a certain voltage at some particular point on the transmission line, usually its end, where the distribution circuits are connected. If more than one point of distribution exists on the same transmission line the regulation at the generating plant must be designed to maintain the desired pressure at only one of these points, leaving regulation at the others to be accomplished by local means. One method of regulation consists in the over compounding of each generator so that the voltage at its terminals will rise at a certain rate as its load increases. If a generator and a transmission line are so designed that the rise of voltage at the generator terminals just corresponds with the loss of voltage on the line when the output of that generator alone passes over it to some particular point, then the pressure at that point may be held nearly constant for all loads if no energy is drawn from the line elsewhere. These several conditions necessary to make regulation by the compounding of generators effective can seldom be met in practice. If a varying number of generators must work on the same transmission line, or if varying loads must be supplied at different points along the line, no compound winding of generators will suffice to maintain a constant voltage at any point on the line that is distant from the power station. For these reasons the compound winding of generators is of minor importance so far as the regulation of voltage on transmission lines is concerned, and on large alternators is not generally attempted. An example may be noted on the 3,750-kilowatt generators at Niagara Falls, where the single magnet winding receives current from the exciters only.

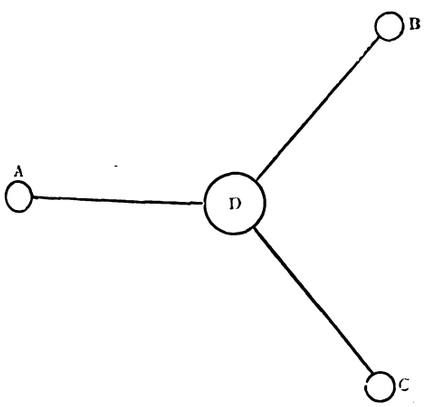

FIG. 3.—THE REGULATION OF TRANSMITTED POWER.

A much more effective and generally adopted method of regulation of voltage at the generating plants of transmission systems is based on the action of an attendant who varies the current in the magnet coils of each generator so as to raise or lower its voltage as desired. The regulation must be for some one point on the transmission line, and the attendant at the generating plant may know the voltage at that point either by means of a pair of pressure wires run back from that point to a voltmeter at the generating plant, by a meter that indicates the voltage at the point in question according to the current on the line, or by telephone connection with a substation at the point where the constant voltage is to be maintained. Pressure wires are a reliable means of indicating in the generating station the voltage at a point of distribution on the line, but the erection of these wires is quite an expense in a long transmission, and in such cases they are only occasionally used. Owing to inductive effects and to variable power-factors the amperes indicated on a line carrying alternating current is far from a certain guide as to the drop in voltage between the generating station and a distant point. In long transmissions, telephone communication between the generating plant and the substations is by far the most general way in which necessary changes to maintain constant voltage at substations are brought to the attention of the attendant in the generating plant. Few, if any, extensive transmission systems now operate without telephone connection between a generating plant and all of its substations, or between a single substation and the several generating plants that may feed into it. Thus, the generating plant at Spier's Falls, on the Hudson river, will be connected by telephone with substations at Schenectady, Albany, Troy and some half dozen smaller places. On the other hand, the single substation in Manchester, N. H., that receives the energy from four water power plants has a direct telephone line to each.

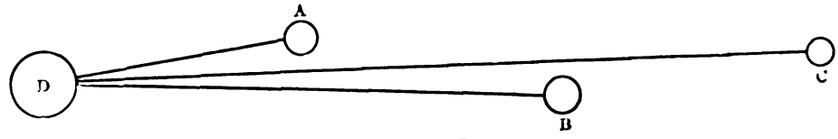

FIG. 2.—THE REGULATION OF TRANSMITTED POWER.

Where two or more transmission lines from the same power station are operated from the same set of bus-bars the voltage at a distant point on each line can not be held constant by changes of pressure on these bus-bars. One generator only may be connected to each transmission line and be regulated for the loss on that line, but this loses the advantages of multiple operation. Another plan is to connect a regulator in each transmission line before it goes from the generating plant. One type of regulator for this purpose consists of a transformer with its secondary coil divided into a number of sections and the ends of these sections brought out to a series of contact segments. The primary coil of this transformer may be supplied with current

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from the bus-bars and the secondary coil is then connected in series with the line to be regulated, so that the secondary voltage is added to or subtracted from that of the main circuit. A movable contact arm on the segments to which the sections of the secondary coil are connected makes it possible to vary the secondary voltage by changing the number of these sections in circuit. In another transformer used for regulating purposes the primary coil is connected to the bus-bars as before and the movable secondary coil is put in series with the line to be regulated. The regulation is accomplished in this case by changing the position of the secondary relative to that of the primary coil and thus raising or lowering the secondary voltage. Both of these regulators require hand adjustment and the attendant may employ the telephone, pressure wires or the compensating voltmeter above mentioned, to determine the voltage at the centre of distribution. The voltage indicated by this so-called "compensator" is that at the generating station minus a certain amount which varies with the current flowing in the line to be regulated. The voltmeter coil of the compensator is connected in series with the secondary coils of two transformers, which coils work against each other. One transformer has its secondary coil arranged to indicate the full station voltage, and the other secondary coil is actuated by a primary coil that carries the full current of the regulated line. By a series of contacts the effect of this last named coil can be varied to correspond with the number of volts that are to be lost at full load between the generating station and the point on the transmission line at which the voltage is to be held constant. If there is no inductive drop on the transmission line, or if this drop is of known and constant amount, the compensator may give the actual voltage at the point for which the regulation is designed.

Automatic regulators are used in some generating stations to maintain a constant voltage either at the generator terminals or at some distant distributing point on a line operated by a single generator. These regulators operate rheostats that are in series with the magnet windings of the generators to be regulated, and raise or lower the generator voltage by varying the exciting current in these windings. These regulators are much more effective to maintain constant voltage at generating stations than at the distributing ends of long transmission lines with variable power-factors. In spite of the compound winding of generators, of automatic regulators for the exciting currents in their magnet coils, and of regulating transformers in the transmission circuits, hand adjustment of rheostats in series with the magnet coils of generators remains the most generally used and probably the most reliable method of voltage control at the generating stations of long transmission systems.

The more exacting and final work of regulation in transmission systems is usually done at the substations. After a nearly constant voltage is delivered at the high-pressure coils of step-down transformers in a substation, there remains the varying losses in these transformers, in motor-generators or converters, in distribution lines and in service transformers, to be compensated for. In general, three or four sorts of loads must be provided for, namely, arc or incandescent lamps for street lighting on series circuits, usually of 4,000 to 10,000 volts. Arc and incandescent lamps on constant-pressure circuits of 2,000 to 2,500 volts for commercial lighting, direct-current stationary motors on constant-pressure circuits of about 500 volts, and alternating motors which may be served at either 2,500 or 500 volts according to their sizes and locations. To these loads may be added that of street car motors of 500 volts, direct current, in some cases. Both the stationary and the street car motors, but more especially the latter, by their changes of load give rise to large and rapid fluctuations of voltage on the distribution lines to which they are connected. The problem of regulation with combined lamp and motor loads is not therefore so much to maintain a nearly constant voltage at the motors as to protect the lamps from the fluctuations of voltage which the motors set up.

For street car motors using direct current at about 500 volts the substation equipment includes either step-down transformers and converters, or motor-generators with or without transformers. It is the practice in some cases where both lighting and street railway service are drawn from the same transmission system to keep these two kinds of service entirely separate, devoting independent generators and transmission lines, as well as independent transformers and converters or motor-generators, to the street car work. This is done in the transmission system centering at Manchester, N. H., in which each one of the four water power plants, as well as the substation, has a double set of bus-bars on the switchboard; and from each water power to the substation there are two transmission lines. In operation one set of generators, bus-bars, transmission lines and transformers supply converters and motor-generators for the street car motors; and another set of generators, bus-bars, transmission lines and transformers are devoted to lighting and stationary motors, in this system. Where street car motors draw their energy from the same generators and transmission lines that supply commercial incandescent lamps, some means must be adopted to protect the lighting circuits from the fluctuations of voltage set up by the varying street car loads. One way to accomplish this purpose is to operate the lighting circuits with generators driven by synchronous motors in the substations. These generators may of course be of either direct or alternating type and of any desired voltage. The synchronous motors driving these generators take their current from the transmission line either with or without the intervention of step-down transformers. By this use of synchronous motors the lighting circuits escape fluctuations of voltage corresponding to those on the transmission line, because synchronous motors maintain constant speeds independently of the voltage of the circuits to which they are connected. This plan was followed at Buffalo where the street car system and the lighting service are operated with energy from the Niagara Falls stations over the same transmission line. In one of the substations at Buffalo both 2,200-volt, two-phase alternators and 150-volt continuous-current generators for lighting service are driven by synchronous motors connected to the Niagara transmission lines through transformers. At other substations in Buffalo the 500-volt continuous current for street car motors is obtained from the same transmission system through transformers and converters. Another solution of the problem of voltage regulation where street railway and commercial lighting service are to be drawn from the same transmission line is found in the operation of 500-volt continuous-current generators in the substations by synchronous motors fed from the line either directly or through transformers. This plan has been adopted for the transmission system of the Boston Edison Company, which extends to a number of cities and towns within a radius of twenty-five miles. The substations at Natick and Woburn in this system, where there are street railways as well as lighting loads, will contain 500-volt continuous-current generators driven by synchronous motors connected directly to

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the 7,000-volt, three-phase transmission lines. In a case like this the synchronous motors maintain their speed irrespective of the voltage on the line and thus tend to hold that voltage steady in spite of the variable losses due to fluctuating loads.

Stationary motors should not as a rule be operated from the same distribution lines that supply incandescent lamps, especially in sizes above two or three horse-power, and this is the better practice. Motor circuits of about 2,400 volts and two or three-phase, alternating, or 500 volts, direct current, may be supplied at a substation either by transformers alone in the first case or by transformers and converters in the second. In either case no especial provision is usually necessary for the regulation of constant pressure on the motor circuits.

In some transmission systems the distribution circuits for stationary motors are not fed by the same transmission lines that carry the lighting load, but draw their energy from lines that do no other work. This practice is certainly desirable as it frees the lighting circuits from all fluctuations of voltage due to line losses with changing motor loads. Examples of this sort may be seen at Springfield, Mass., and Portland and Lewiston, Me., in each of which the load of stationary motors is operated over independent transmission as well as distribution lines.

In transmission systems series arc and incandescent lamps for street lighting are commonly operated either by direct-current arc dynamos or by constant-current transformers or constant-pressure transformers with automatic regulators at the substations. The arc dynamos are driven by either induction or synchronous motors supplied directly from the transmission line or through transformers. As the arc dynamos regulate automatically for constant current no further regulation is required. If the series arc and incandescent lamps are to be supplied with alternating current the constant-current transformer or the constant-current regulator come into use. This type of transformer and regulator alike depend for their regulating effect on the movement of a secondary coil on a transformer core in such a way that the current in this coil, which is in series with the lamps, is held nearly constant. Such constant-current transformers and regulators are usually supplied from the transmission line through regular constant-pressure transformers, and they hold their currents sufficiently constant for the purposes of their use.

The main problem of regulation thus comes back to the 2,000 to 2,500-volt, constant-pressure circuits for incandescent lighting, supplied from transmission lines through simple transformers at the substation. For this regulation the most reliable instrument is the hand of a skilful attendant, guided by voltmeters connected with pressure wires from minor centres of distribution, and adjusting the regulating transformers, above mentioned, with either divided or movable secondary coils in series with the various distributing circuits.

ELECTRIC POWER FOR MINING PURPOSES.[1]

BY GEORGE SCARFE.

When electric power was first introduced in the Nevada County mining district, it found the field well supplied with a fine system of water ditches and pipe lines, supplying power to a great many mines and other industries; in fact, it is an ideal water system, and is still furnishing a first-class power, and the success of electricity in this district does not in any way mean that there is less water used than before; but it shows that electric power has, by its flexible nature, created a field for itself. The reason for this is, perhaps, to be explained by the fact that many mines have been opened up above what may be called the water line, that is, they are above the ditches, or so little below them that water power is out of the question; also many that previous to the event of electric power were operated by steam, but had to close down owing to the excessive cost, are now again opened up and are being successfully operated with the new power. To mines situated as above, electricity has solved the problem to the satisfaction of all.

The location of mines at different levels below the source of water supply calls to mind a curious condition in regard to water power, which is this—water is sold at a fixed price per miner's inch, regardless of the head. A man, for instance, buys an inch of water at the ditch and irrigates his garden with it; his neighbor, who is 100 feet below the ditch, buys an inch, and is able by the use of a small wheel to generate about one-fifth horse-power with the inch, and water his garden as well, and at the same cost as his friend above pays for irrigation alone. Now this is a condition we find, for suppose that a mine should be developed at, say 100 feet below the ditch, and water power is used, they will get about 0.19 of a horse-power for each inch bought, assuming that the wheels used have an efficiency of seventy per cent. At the same time another party has a mine 600 feet below the ditch, and for each inch he will get 1.19 horse-power at the same efficiency. The first party gets his power for 64.2 cents per twenty-four-hour day, and the second party gets his for thirteen cents per twenty-four-hour day, or $25.26 as against $3.90 per horse-power-month of thirty days. This explains in part why the two powers have separate fields, as there is a point where the two are equal, for if you are getting, say one cent per kilowatt-hour for electricity, and the motors have an efficiency of ninety per cent, then a water-wheel with an efficiency of seventy per cent at a head of 402 feet will cost the same per horse-power-month on continuous power, such as driving an air compressor or pump, but when it comes to intermittent work, such as hoisting, the head of water would have to be still higher to meet electric-driven machines at the prices in mind—one cent per kilowatt-hour and sixteen cents per inch for water—and any mine with less than 402 feet head can not afford to use it in place of electricity.

For driving a quartz mill there is nothing to be compared to the synchronous motor, as it gives a steady speed, which can only be changed at the power-house. The returns from a mill driven by a motor of this type above the same mill driven by water is often enough to pay the monthly power bill. We have in Grass Valley one mill of forty stamps and sixteen concentrators driven by an eighty-horse-power synchronous motor that bears out this statement. The electricity is brought to the mine by the power company, where it is metered, while in the case of water it is measured at the ditch, and, again, the convenience of cutting off the power by simply opening a switch is in favor of the last named.

There was another condition which had to be met on introducing the power into this district. Many of the mines were all equipped with steam power, and to get the business started it was necessary to make the change as cheaply as possible, and many interesting outfits are to be seen. We have also the synchronous motor driving a direct-current machine, which, in its turn, operates motors of the railroad type for hoisting, which has been very successful; but most of the large units are used to drive air compressors, for a good deal of pumping is done with air, the steam pumps using it in place of steam, as they did before, and the mines being deep it is a great help in the matter of ventilation, especially in the headings, where the exhaust from the drills furnishes plenty of good air. For this reason I do not expect to see electric drilling to any extent. In the matter of pumping, I think the electrically driven pump is coming to stay with us. We are now installing two in one of the mines; one at the 700-foot level, and one at the 1,000-foot. These, we have no doubt, will be the means of many more going in. For the success of these pumps I have no fear, and it will open a new field for electricity which will result in a profit both for the power company and the mine owner.

There is one more application of the power I wish to see, that is, the hoist driven direct by motors of the induction type.

We have in this district about 2,640 horse-power in 133-cycle motors, and 700 horse-power of sixty-cycle. The power-house on the South Yuba, is, as you no doubt know, the oldest in the Bay Counties' system, and the first machines, two 330-kilowatt S. K. C. are still as busy as ever. These were originally driven by Tuttel wheels on 190 feet head, but one of them now has in addition, one 600-horse-power Doble working on 800 feet head. In the new addition, we have two 330-kilowatt, 133-cycle, 5,500-volt machines, operating with wheels, working under 190 feet head, also each has one 600-horse-power Doble on the same shaft, under 800 feet head.

[1] Abstract of a paper read before the seventh annual convention of the Pacific Coast Transmission Association, San Rafael, Cal., June 16.

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Developments at Niagara Falls for the Utilization of Its Power.

Progress Being Made on Both Sides of the Niagara River.

THE year 1903 will long be remembered for the activity it brought in the development of the power of the falls of Niagara. On October 4 next it will be thirteen years since the first sod of the development of the Niagara Falls Power Company was turned at the corner of Falls and Third streets in the American village of Niagara Falls, N. Y., and since that memorable day, when the silver spade actuated the soil of the Niagara locality, there have been many truly wonderful results obtained and a marvelous spirit of enterprise displayed. Not alone to the New York side has the progress been confined, but the industrial vigor has extended into the Dominion of Canada, so that to-day the flags of two countries give protection to the development created to rob one waterfall of a portion of its energy, but this single downpour of water is the greatest fall the world knows, and there is small prospect that its magnificent beauty will ever be lessened by the works of man. This being accepted as fact, one can look upon the wonderful power works at Niagara as something destined to enlarge the world's facilities of manufacture; while not being surrounded or accompanied by a destructive tendency. For this reason there is a double pleasure in reviewing the industrial creations of Niagara, knowing that man's construction will not mar Nature's gift.

POWER-HOUSE NO. 2.—SHOWING THE "TERRACE" DECORATED FOR A RECEPTION NEW YORK SIDE. FOREBAY OF POWER-HOUSE NO. 2, NIAGARA FALLS POWER COMPANY.

On the New York side, the Niagara Falls Power Company is completing the

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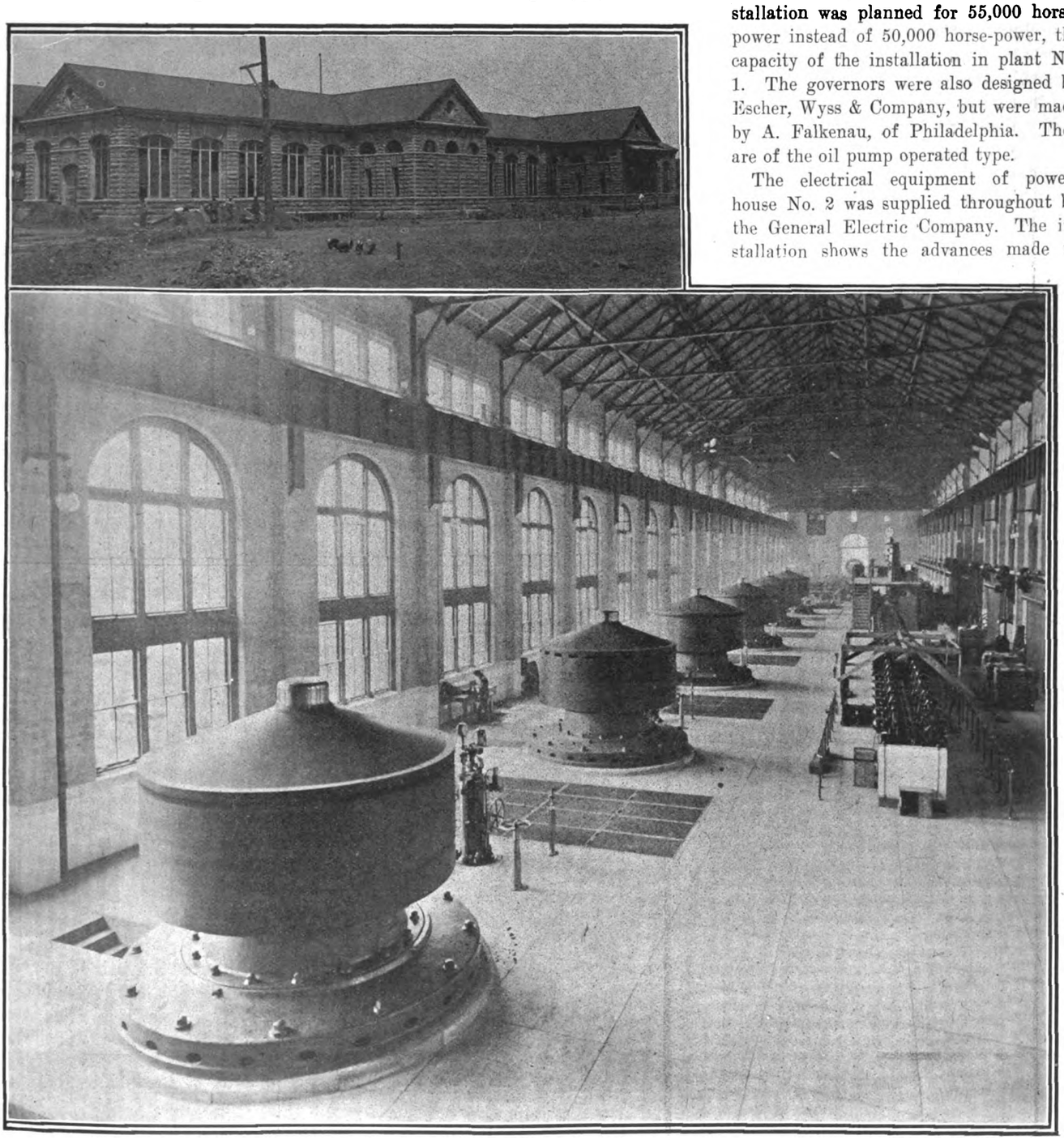
installation in its second great power station. This power-house stands on the opposite side of the inlet canal to power-house No. 1, and it is closer to the river. Its general style of architecture is quite similar to the beautiful lines that have won so much admiration for power-house No. 1, but its long stretch of roof is broken by gables at the ends and centre. Its length is about 560 feet, and its width about seventy feet. On the canal side there is a forebay structure about 420 feet long and seventy feet wide. The wheel-pit beneath power-house No. 2 is 463 feet long, eighteen and one-half feet wide and 178½ feet deep. Its capacity is 55,000 horse-power. The unit of development is 5,000 horse-power, which provides for eleven turbines and the same number of generators. The turbines in the pit are of the Francis or inward discharge type, and work under a head of 145 feet. The turbines were designed by Escher, Wyss & Company, of Zurich, Switzerland, and built by the I. P. Morris Company, of Philadelphia, Pa. The turbines in wheel-pit No. 1 are double wheels with outward discharge. The turbines in the new pit being of the internal discharge have the discharge water carried off through draft tubes, which add about ten per cent to the effective head. This increased efficiency makes it possible to get ten per cent more power for the same amount of water used, and therefore the new installation was planned for 55,000 horse-power instead of 50,000 horse-power, the capacity of the installation in plant No. 1. The governors were also designed by Escher, Wyss & Company, but were made by A. Falkenau, of Philadelphia. They are of the oil pump operated type.

The electrical equipment of power-house No. 2 was supplied throughout by the General Electric Company. The installation shows the advances made in the art after power-house No. 1 was completed. The total of eleven generators is made up of six of one type and five of another, each differing in some feature from the generators in power-house No. 1, so that the Niagara Falls Power Com-



ENLARGED TRANSFORMER STATION OF THE NIAGARA FALLS POWER COMPANY—INTERIOR VIEW NIAGARA POWER-HOUSE NO. 2, NEW YORK SIDE.

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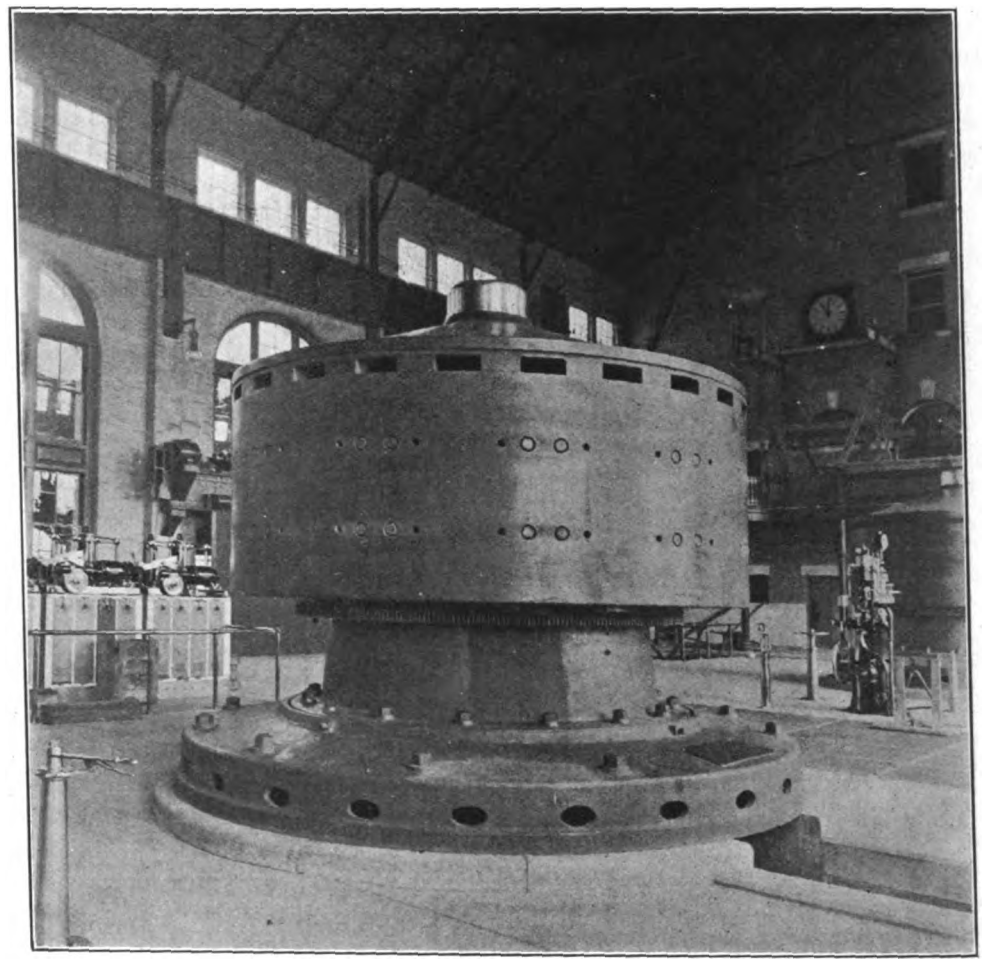
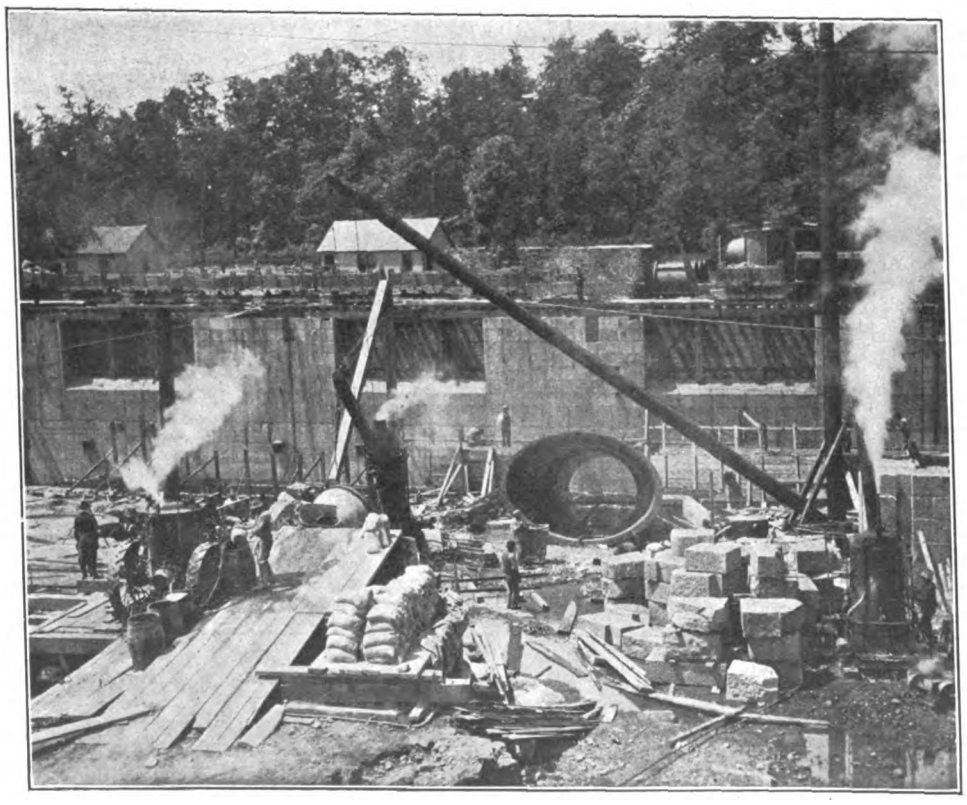
pany has now three types of generators in its plants. The six generators first installed are of the external field type with the nickel-steel revolving magnet ring. Each is of 5,000 horse-power, or 3,750 kilowatts, wound for 2,300 volts, two-phase, 25 cycles, at 250 revolutions per minute. As compared with the generators in power-house No. 1 the appearance of these new machines in power-house No. 2 is changed by the fact that the iron bridge over the machines has been omitted, the change being brought about by placing the collector rings at the bottom of the dynamo shaft instead of at the top. The regulation of the new generators is nearly three times as close as those of power-house No. 1, and the system of ventilation is radically different.

The other five generators to have place in power-house No. 2 will be of the internal revolving field type, each of 5,000 horse-power, wound for 2,300 volts, twenty-five cycles, two-phase, and will make 250 revolutions per minute. These machines are now being installed. They will be of the same regulation as the six machines above referred to, but will cost less to build and will be more simple to handle. For all there are three types of generators in the two stations no trouble will be experienced in operating them in parallel. The ten generators in power-house No. 1 are operated from two



THE NEW STYLE POWER GENERATOR IN POWER-HOUSE NO. 2—NEW YORK SIDE.

switchboards, while in power-house No. 2 there is but one switchboard. It is a gallery structure running through the centre of the floor. On it thirty-six controlling panels are mounted; eleven being generator, twenty-two feeder, two interconnecting and one exciter. All switching is done by relay switches. Each panel is a complete unit, having all the switches and instruments necessary for any operation which may be made upon it. Under normal conditions, it is expected to operate the total of twenty-one generators in the two stations in four groups, but any generator may be thrown into any group desired.



WHEEL-PIT, CANADIAN NIAGARA POWER COMPANY.

The exciter plant in connection with the new installation in power-house No. 2 has been placed in a chamber excavated in the side of the wheel-pit. The plant consists of four 150-kilowatt compound-wound vertical shaft, 220-volt exciters, each of which has its independent turbine placed directly underneath it. Each exciter turbine has its individual governor, the speed being 750 revolutions per minute. The power-house lights and auxiliary motors are operated from this plant. Interconnection may be made with the exciter plant in power-house No. 1. The main generator switchboard is connected by telephone with the exciter chamber.

Extending under the inlet canal, at a depth of 130 feet from the surface, there is a connecting tunnel between wheel-pit No. 1 and wheel-pit No. 2, for the convenience of the company's employés.

The water from the inlet canal flows through arches, the tops of which are

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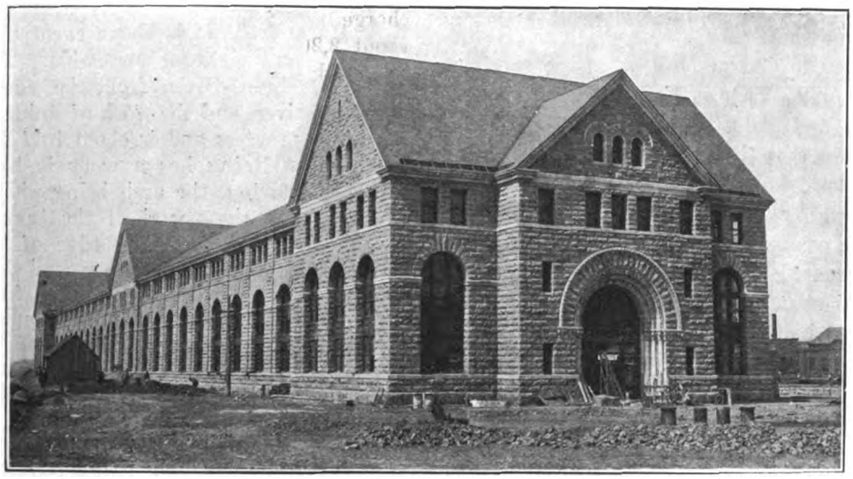
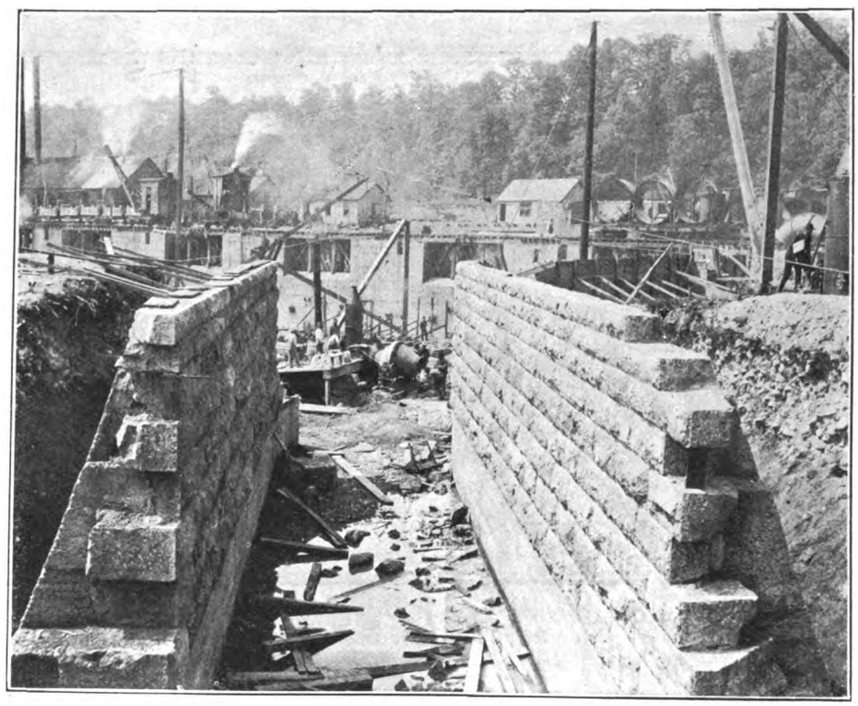


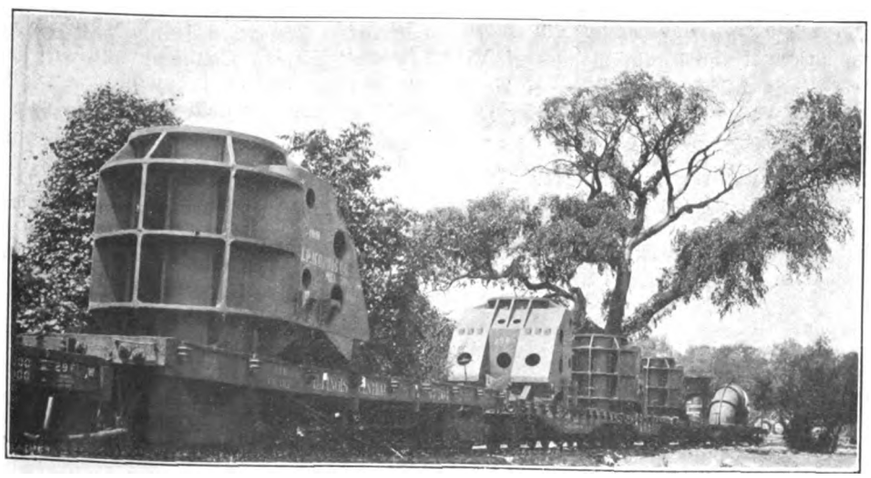
EXTERIOR OF POWER-HOUSE NO. 2—NEW YORK SIDE.

below the surface, into the forebay, where it reaches the racks under cover of that structure. This construction is expected to be an aid in removing the ice difficulties of winter. The roof of the forebay structure has been nicely finished, and has been given the name of "The Terrace." It is a delightful spot from which the upper river, the inlet canal and general surroundings of these great power plants can be viewed. As a point of interest and entertainment, it was first opened to the public on the occasion of the recent convention of the American Institute of Electrical Engineers at Niagara; the scene that pleasant afternoon being faithfully portrayed in one of the accompanying illustrations.

During the present year the Niagara Falls Power Company has made notable changes in the method of running its cables for distribution. In February it built a conduit from the south end of power-house No. 1 around the west side to the Forbes subway, a distance of about 800 feet. In this new conduit twenty-four ducts were placed for carrying cables of 1,000,000 circular mils. Now the company has just finished tearing down the stone bridge that extended over the inlet canal between power-house No. 1 and the transformer station. It will be recalled by those familiar with the Niagara installation that at one time practically all the cables from power-house No. 1 passed through this bridge, but under the new method the cables not placed in the conduit mentioned above have been placed in a new conduit built directly under the bridge site, so that now the cables from the original generating station pass underground to the transformer station. This new conduit built to replace the bridge, has sixty ducts, each about three and one-quarter inches in diameter. They are arranged in groups of twelve and a feature is that no concrete was placed about them except sufficient to hold them in place. In this manner free ventilation is provded, and ventilators have been placed in a walk extending along the former bridge site over the conduit. There now passes through this new conduit all power from station No. 1 that is to be transformed and also some that is sent direct to consumers. An additional fact is that the end of the inlet canal beyond power-house No. 1 had been filled in, and was no longer



SLUICEWAY OF CANADIAN NIAGARA POWER COMPANY.



ARRIVAL OF DRAFT TUBE FOR THE CANADIAN NIAGARA POWER COMPANY'S INSTALLATION.

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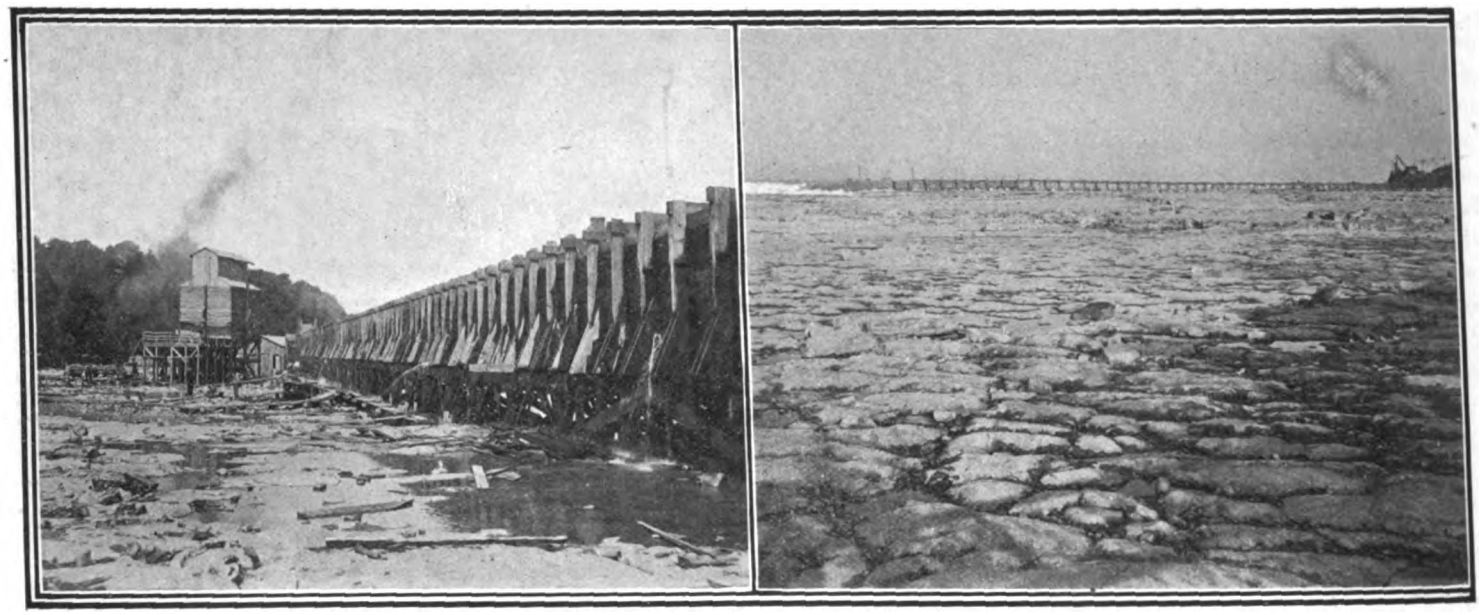
used for water purposes, so that the bridge was no longer a necessity. The spot has been graded and seeded, and a driveway is to be built across it from power-house No. 1 to power-house No. 2. Running along the walk from power-house No. 1 to the transformer station there is a parapet wall with ornamental lamps. The change opens up a fine new view of power-house No. 1, the canal and river. William A. Brackenridge is the resident engineer of the Niagara Falls Power Company, H. W. Buck is the electrical director, and P. P. Barton, electrical superintendent.

NIAGARA FALLS HYDRAULIC POWER AND MANUFACTURING COMPANY.

This company owns and operates the surface canal power development on the New York state side of the Niagara river. For years it has been making important additions to its power-house and installation, while it has constantly been at work enlarging its canal capacity. The canal is 4,400 feet long, and the company has a right of way 100 feet wide. When the company acquired the property the canal had a width of about thirty feet, but it has extended it until for the entire length it is 100 feet wide. The waterway has also been materially deepened, a work that is not as yet completed. New wheels and generators are being installed in its power-house in the gorge, and a new power station is being built in the gorge a short distance below the present station. The development of this company is one of the most important at Niagara.

ON THE CANADIAN SIDE.

The tourist visitor to the Canadian side at Niagara might easily acquire the impression that scenic Niagara is destined to destruction, for in the precincts of pretty Victoria Park the hand of capital and industry has laid such a firm grasp that the average visitor might find it hard to believe that it will be possible to throw it off. However this may be, the commissioners of Victoria Park have promised the public that the beauty of Canadian Niagara shall remain unimpaired when the general clearing up takes place, a few years hence; for the power works now in progress there will take several years to complete. Three companies are actively at work rushing their different projects toward completion. They are the Canadian Power Company, the Ontario Power Company, and the Toronto & Niagara Power Company.



TEMPORARY POWER PLANT, ONTARIO POWER COMPANY, CANADIAN SIDE. EFFECT OF THE WING-DAM CONSTRUCTION. VAST AREA OF RIVER-BED LEFT DRY. ONTARIO POWER COMPANY'S WORKS, CANADIAN SIDE.

WORKS OF THE CANADIAN NIAGARA POWER COMPANY.

The Canadian Niagara Power Company was first to be granted a franchise by the Ontario Government on recommendation of the commissioners of Victoria Park. This franchise grants the right to an original development of 100,000 horse-power by means of a wheel-pit and tunnel tail-race. The plans of this company are furthest advanced, and it will be the first to have power ready for sale and transmission. It is controlled by practically the same capital as the Niagara Falls Power Company. The full length of the wheel-pit of the Canadian Niagara Power Company will be about 480 feet. It will be twenty-one feet wide and about 170 feet deep. The first section, having a length of about 265 feet, has been sunk to the required depth, and the extension is now being excavated. The tunnel that will carry off the discharge of the turbines has a length of about 2,200 feet. It is about twenty-five feet high and eighteen feet wide. The tunnel has been driven from the wheel-pit to the river, and the work of lining it is now in progress and is about half finished. The lining has a concrete back with brick facing, the arch being wholly of brick. At the portal of the tunnel, which is very close to the edge of the Horseshoe Fall, all the second-class masonry is in. Owing to the spray from the fall, it will be impossible to complete the masonry at this point until next summer, for cold weather will cause immense quantities of ice to form all about the portal.

The Canadian Niagara Power Company is also having built a forebay, inlet canal and sluiceway, work on all of which is progressing nicely.

The installation of this company will be notable because the unit of development will be 10,000 horse-power, the generators to be wound for 12,000 volts, three-phase. These machines will be of the internal revolving field, vertical shaft type, and will make 250 revolutions per minute. They are being built by the General Electric Company, and will have a diameter of about nineteen feet. The high voltage at which the current will be generated on the Canadian side is significant of long-distance transmission, and it is understood that for long-distance transmission step-up transformers will be used to raise the voltage to 22,000, 40,000 or 60,000 volts. Cecil B. Smith is the resident engineer of the Canadian Niagara Power Company, while William A. Brackenridge is the consulting engineer.

ONTARIO POWER COMPANY.

The plan of the Ontario Power Company is somewhat similar to that employed by the Niagara Falls Hydraulic Power and Manufacturing Company on the New York side, in that its power-

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house will be located at the water's edge in the gorge only a short distance from the Horseshoe Fall. The site for the power-house has been partially cleared, and a roadway has been built along the water from the Maid of the Mist landing to where the station will stand. The water supply of this company will be conducted through Victoria Park in a steel flume or tube about eighteen feet in diameter, laid in a trench and covered from view in order that its presence will not intrude upon the scenic features of the park. This flume will run through the park at the base of the bluff back from the river. The flume will receive its water from a forebay now being built above the Dufferin Islands. In order to divert the waters of the river during construction of the forebay a huge wing dam was built extending about 800 feet out into the river. This had the effect of laying bare a large section of the river-bed, and to-day it is not the least interesting feature of Niagara. To aid in its work the Ontario Power Company has erected a temporary power plant operated by water carried through a long flume, as shown in the illustration. At the head of the flume of the company a gatehouse will be located. At the lower end of the big pipe the water will pass into penstocks that will carry it down the high bank to the wheels to be located in the power-house. The company's franchise allows of the development of 150,000 horse-power, it having practically two rights.

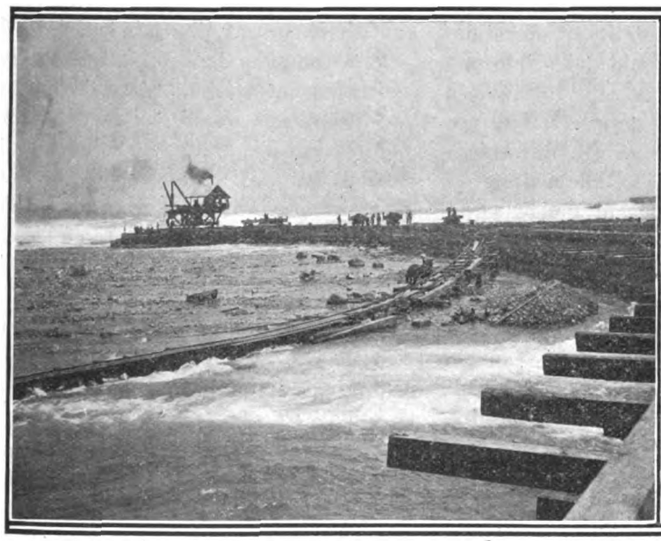
THE TORONTO & NIAGARA POWER COMPANY.

For its proposed development the Toronto & Niagara Power Company has also adopted the wheel-pit and tunnel plan of construction. The power-house of this company will be located a short distance up the river from the station of the Canadian Niagara Power Company. At present a large cofferdam is being built about the wheel-pit site to shut off the water of the river, and another dam will be built inside of this big dam. The company's franchise will permit a development of 125,000 horse-power. M. P. Davis, of Cornwall and Ottawa, has the contract for the construction of the wheel-pit of this company, while Anthony C. Douglass, who is building the tunnel of the Canadian Niagara Power Company, will also build the tunnel of the Toronto & Niagara Power Company. Contractor Davis is now getting his plant on the ground.

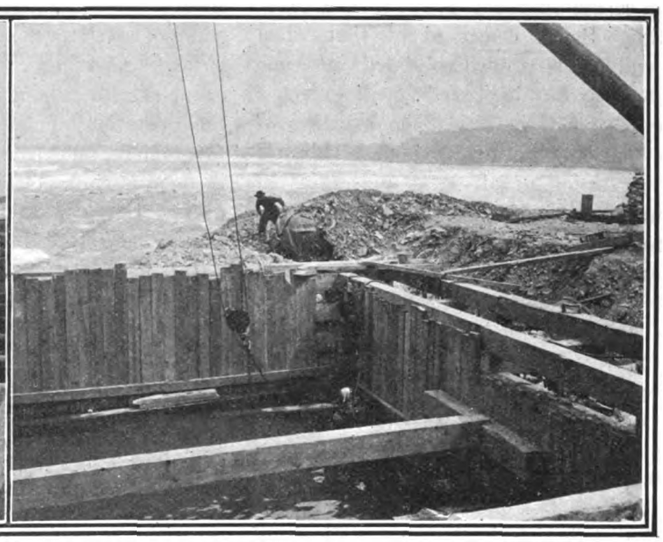
Contractor Douglass has commenced work on his big contract, and is at present engaged in sinking a shaft seven by fifteen feet on the shore at a point about 375 feet back from the fall. This shaft will be carried to a depth of 160 feet, and from its bottom there will be built a lateral tunnel eight by fifteen feet extending out under the river-bed about 650 feet to the line of the main tunnel. From this junction point headings will be driven up and down stream in the construction of the main tunnel, which will have a slightly larger area than the tunnel of the Canadian Niagara Power Company. The route of the tunnel from the wheel-pit to the gorge extends right under the river-bed, and the excavated material will be raised to the surface up the shaft now being sunk. The present depth of the shaft is about ninety feet. The point where the lateral tunnel will strike the line of the main tunnel will be but a short distance back of the falling water of the Horseshoe Fall, behind which the discharge of the tunnel will flow into the lower river.

Combined, the franchises of the three companies now working on the Canadian side permit of a development of 375,000 horse-power, a stupendous amount of force. Under the provisions of their franchises they will pay the park commissioners at the rate of one dollar per annum for each electrical horse-power generated and used and sold or disposed of over 10,000 electrical horse-power up to 20,000 electrical horse-power, and the further payment of the sum of seventy-five cents for each electrical horse-power generated and used and sold or disposed of over 20,000 electrical horse-power up to 30,000 electrical horse-power, and the further payment of the sum of fifty cents for each electrical horse-power generated and used and sold or disposed of over 30,000 electrical horse-power; that is to say, by way of example, that on generation and use and sale or disposal of 30,000 electrical horse-power the gross rental shall be $32,500 per annum, payable half yearly, and so on in case of further development as provided, and that such rate shall apply to power supplied or used either in Canada or the United States.

This gives the management of Victoria Free Park a very handsome annual income, which is being expended for the betterment of the park; each company having made a deposit of advance rental as a guarantee of good faith. While the developments are having the effect of making many changes within the park boundaries, there is much filling going on, which, when finished, is expected to add materially to the beauty of the pleasure ground.



BUILDING THE BIG COFFERDAM OF THE TORONTO & NIAGARA POWER COMPANY, CANADIAN SIDE.



SINKING THE SHAFT FOR THE TUNNEL OF THE TORONTO & NIAGARA POWER COMPANY, CANADIAN SIDE.

OFFICE OF THE TORONTO & NIAGARA POWER COMPANY, CANADIAN SIDE.

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THE PRODUCTION AND DISTRIBUTION OF ALTERNATING CURRENT FOR LARGE CITY SYSTEMS.[1]

BY RICHARD McCULLOCH.

The large city street railway system of to-day is due to a process of evolution. In most cities twenty years ago the business of transporting passengers through the streets on rails was divided up among several companies operated with more or less skill, each independent of the other, and each striving after the other's business and paralleling its tracks. When the electric era came on, motive power was changed, and a new equipment selected according to the judgment of the manager, with no particular regard for standardization of apparatus, and without any thought toward a unity of purpose in the operation of the several properties. So it comes about that when several roads are consolidated into one system, as has happened in all except a few of our large cities, the manager of the consolidated property finds himself in possession of all sorts and styles of equipment, chosen with a greater or less amount of wisdom, and an aggregation of power plants and feeder systems which, however suitable they might have been for the individual roads, do not lend themselves readily to an economical operation of the property as a whole. The weeding out and the standardization of apparatus, and the adjustment of generation and transmission systems is the task of to-day. The question of power plants and distribution is the most difficult of solution, and in taking it up several plans suggest themselves.

1. To keep the best of the present plants, add to them as necessary, and adjust the distribution systems from them.

2. To abandon the present plants, constructing an entirely new plant with a new distribution system leading from it, using the old plants as substations if they are suitably located.

3. A combination of these two systems, which consists in the beginning of a new plant, the plans of which contemplate the operation of the entire system from it at some future date; at the present time, however, only putting enough apparatus in the station to take care of the growth of the system and adding to it from year to year as other stations are abandoned.

Either of the latter schemes would lead us to consider the generation of alternating current and its transmission to substations, and any change in the power plant system involves a discussion of the relative advantages of power generation in one or several power plants. This question has lately received a great deal of attention in the engineering world, and has been thoroughly discussed from an engineering standpoint.

The great and all-important question which confronts the manager and which the engineer should assist him in solving, is how to transport passengers with the greatest degree of safety, reliability and economy. The power plant and transmission system constitute only two links in the chain of many devices necessary to accomplish this task, and should not be given undue importance in the laying out of the general scheme. Economy of generation or transmission of power should never be sought after at the expense of safety or reliability of operation. True engineering should take into account the financial questions involved in the operation of the property, but unfortunately there are fads and fashions in engineering, just as in matters of dress. Large questions of policy which should be solved by sound engineering have sometimes been settled from a desire to be in the prevailing fashion or to have a power plant which will eclipse in daring the last one built. This can not always be laid at the door of the engineer, who is sometimes called into consultation only after the great questions have been disposed of, leaving him only the details. All this, perhaps, has little to do with the subject of this paper, but it is given as a preface, because, after all, more important than the question of how to generate and transmit alternating current is whether or not to generate it at all.

In this paper the alternating current will be considered to be made by steam power at a central power station, transmitted at a high voltage to substations located in different parts of the territory to be served, there converted into 575-volt direct current and distributed by means of feeders to the trolley sections in the usual way.

The use of alternating-current motors for street cars, although the subject of a great deal of experimenting, has not yet been successful. In Switzerland on an interurban road and in northern Italy on a steam road which has been converted to electric traction, alternating-current motors are used, and their use was seriously considered in the electric equipment of one of the London underground roads formerly operated by steam locomotives. Where the stops are frequent, however, as is the case in city service, in the present state of the art the use of alternating-current motors is impracticable.

For railway and power transmission work, the advantage of transmission by alternating current is that small high-tension feeders from the central station and short direct-current feeders from the substations are substituted for the long, heavy lines of feeders leading from the central direct-current station. The problem is more one of current transmission than of current production.

The discussion will be taken up under the following headings:

The production of alternating current.

The transmission of alternating current.

The relative advantages of alternating and direct-current transmission.

As a complete description of an alternating-current station, transmission line and substation would be very lengthy, and of no great novelty, the following discussion will call attention only to those general points which are most remarkable in present practice and those which should be especially looked after in the design.

THE PRODUCTION OF ALTERNATING CURRENT.

Site of Station—The central station should be located where coal may be obtained by rail or water, or both, and where large quantities of water may be obtained for condensing purposes. If a location fulfilling these requirements may be obtained in any large city near the centre of gravity of the load, well and good; if not, it is not so serious as it would be if the plant were designed to furnish direct current. The location should not be in a residence district where the plant is apt to become a nuisance, and physical obstacles to the laying of feeder mains, such as rivers, bridges, etc., should be avoided if possible in the selection of the site.

In the general principles of its construction, the alternating-current plant does not differ from the direct-current plant, except that the amount of power installed and the size of units usually warrant a magnitude of construction rarely attempted in direct-current plants. We have the same boiler plant, the same engines, similar generators, and a switchboard which transmits alternating current to feeders instead of direct current.

Coal Supply—There is no point more important to the continuous operation of a power plant than regularity and in-

[1] A paper presented at the twenty-second annual meeting of the American Street Railway Association, Saratoga Springs, N. Y., September 2, 3 and 4, 1903.

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fallibility in the delivery of coal. The amount of coal coming to one of our large power plants is such that extraordinary means must be taken for quickly unloading and handling it. If the coal is delivered by rail, a large switchyard must be provided for handling the cars, and if bottom dumping cars can not be depended upon, some form of a car tipple for quick unloading should be installed. The tipple used on the ore docks suggests itself for this purpose. If coal is delivered by water, clam-shell drop buckets are used for unloading the barges. Those of us in the West learned by last winter's experience that we must expect at times to be obliged to burn all sorts of coal in all sorts of condition. It is, of course, preferable that the coal should be delivered crushed ready for the automatic stokers, but provision should be made in the layout of the station for a coal crushing plant to handle lump and mine run coal. The quantity of coal burned in the large stations is such that if an attempt is made to furnish storage capacity within the plant for even a modest period of time, the size and cost of the building are enormously increased by the large coal tank perched high in the air above the boilers. It is perhaps a better plan if the location of the power plant permits it, to carry only a few days' supply in the tank in the boiler room, and provide a separate building for the coal reserve, connected by conveyors to the boiler room, where the coal may be kept nearer the ground, and the cost of the ironwork for its storage diminished.

The large power plants in the eastern cities burn buckwheat anthracite, while those in the West burn bituminous screenings, which term includes all that will pass through the one and one-quarter inch screen at the mine, including the dust and fine coal made by the cutters. The plant should be laid out for the kind of coal it is intended to burn, and in cases where the cities are located so far from the mines that the cost of transportation becomes a large factor in the cost of the coal, it would pay to devote a great deal of attention to a determination of what is really the most economical coal to burn, and not assume as is often done, that that coal is the best which can be had for the lowest price per ton.

Building—The power plant building should be substantial and fireproof and just as ornate as the directors of the company wish to authorize, it being remembered that although it is creditable to a railroad company to have a handsome power plant, the gross receipts are not increased nor the operating expenses decreased thereby. The plant should be entirely closed and should be constructed with the idea that all employés and visitors should enter by one door and be checked in and out, just as in a well-managed factory. When this door is closed the plant should be impregnable, and conveniences should be arranged so that if necessary the entire operating force can be lodged and fed in the building.

Coal and Ash-handling Machinery—The apparatus to handle the coal and ashes of a large power station constitutes a formidable plant in itself. It is, perhaps, better in a large installation to keep the coal and ash-handling apparatus independent, as ashes are much more abrasive than coal, and it is better to leave either set of apparatus free so that it can be used at any time. Some form of the self-dumping bucket conveyor is in general use for coal, while various apparatus has been installed for handling ashes.

Mechanical Stokers—The use of mechanical stokers in the large plants of to-day is universal. They are more efficient on low-grade fuel, and by their use and that of coal and ash-handling machinery, the employment of a large number of laborers in the boiler room is dispensed with, and the likelihood of labor troubles diminished. In fact, if it were necessary to handle the coal and ashes, and fire the boilers by hand, it would be difficult to get men enough into some of our large plants to keep them going, and these men would be a constant source of annoyance.

Boilers—Some form of water-tube boiler is usually chosen for large plants because it may be made in large sizes without danger of explosion, and occupies less ground space per horse-power than the fire-tube boiler. There is nothing remarkable about the boiler installation for an alternating-current plant except that the size of the plant and the size of the units is such that a two-story boiler room is usually required. This feature, however, has already been introduced in some of our large direct-current plants. The question of pressure and superheated steam, while naturally belonging to boilers, will be taken up in the discussion of steam engines.

Engines—Until quite recently the only prime mover for driving generators of large size in railway steam plants was the compound, condensing steam engine. The triple expansion engine has been used in no large installation. In one recent installation a duplex compound engine, with the two low-pressure cylinders horizontal and the two high-pressure cylinders vertical, drives the generator. This is a mammoth unit of 5,000 kilowatts and is the largest which has been built.

Steam Turbines—Of late years, however, improvements in manufacturing facilities and our increased knowledge of the properties of steam have made possible the utilization of the steam turbine, which, remarkable to state, makes use of the principle upon which the first steps toward the application of steam as a prime mover was based. It seems as if we are on the verge of a radical change in the application of steam, as the introduction of the turbine makes an entire change in the usual layout of the power station. And, as in the case of all great inventions, necessity was the mother of this one. The steam engine has reached such a size that for large units it is heavy, clumsy, delicate of adjustment and requires constant skilled attention. On account of the inertia of the valves and reciprocating parts, the speed of the steam engine must be kept so low that the cost of the electric generator is greatly increased. In fact, it would seem that the limit in the size of steam engines for driving electric generators is about reached. If the claims of its advocates are only partly realized, the steam turbine is the ideal machine for driving alternating-current generators. The efficiency of the steam turbine is claimed to be fully equal to that of the best steam engine; the turbine being a rotary machine, the thrusts caused by the reciprocating motion of the steam engine are avoided, thus relieving the foundation and frame of that strain, and facilitating the operation in parallel of alternating-current generators; foundations and buildings for turbines are cheaper than for engines; as the electric generator is driven by the turbine at a much higher speed than by the engine, its cost is less; there being no valve gear and reciprocating parts in connection with the turbine, its maintenance is less, and there is no need of the skilled attendance during operation, so necessary with the engine; as no oil is needed for the lubrication of the turbines, the steam may be condensed in surface condensers and used over again in the boilers, thus affording practically distilled water for boiler use. All of these claims are being made for the turbine, and although all of them may not be fully realized, it is likely that there will be such advantages in the use of steam turbines that no large alternating-current plant will be built in the future containing any other prime mover. One of the most important advantages of the

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steam turbine for electric work is that between half load and fifty per cent overload its efficiency is nearly constant, and that even at less than half load its efficiency is good.

Superheated Steam—The amount which steam may be superheated when used for driving steam engines is limited on account of the carbonizing action of the steam on the cylinder and valve lubricants. With a special valve gear constructed for use with superheated steam, steam superheated 150 degrees Fahrenheit above the temperature corresponding to its pressure may be used. With steam turbines any superheat which it is practicable to obtain may be used, and great economy is effected by its use. Some of the makers of water-tube boilers now make an attachment to be placed in the path of the heated gases within the brickwork of the boiler for superheating the steam. The amount of superheat which can be obtained by this device depends upon its heating surface, but enough heating surface may be placed within the brickwork of a boiler to obtain about 200 degrees of superheat. If it is desired to obtain a greater degree of superheat than this, it is advisable to use an external superheater.

Condensers—In order to obtain the maximum economy by the use of steam turbines, as rare a vacuum as possible should be maintained by the condenser, the usual specification calling for twenty-eight inches. This necessitates a larger and more expensive condenser than is usually installed with the same capacity in steam engines. The economy of the steam turbine increases very rapidly, both with the quantity of superheat and the rareness of the vacuum, and the limit of twenty-eight inches has only been set because it is the limiting vacuum which it is practicable to maintain.

Steam Pressure—Economy in the use of steam also increases with the steam pressure. With compound condensing engines the common pressure in use is 175 pounds, while with steam turbines the economical point seems to be about 200 pounds.

Piping—The design and installation of the piping in a large, higher-pressure plant necessitate the greatest degree of skill. The old fads of double-headers, auxiliary headers and loop systems have expired, and now the best practice is to make the piping as short and simple as possible, and make up in excellence of construction the security which it was once sought to obtain by doubling the installation. In some of the large plants recently installed, the condensers have been set directly over tunnels connected with the water supply and the heavy piping necessary for the condensing water has been entirely done away with.

Auxiliaries—The auxiliary apparatus, such as coal-crushers, coal and ash-handling machinery, stoker machinery, boiler feed pumps, condenser pumps, air pumps, cranes, exciters, elevators, etc., require a large amount of power for their operation, and the piping for the engines furnishing this power is expensive of installation and maintenance. It is recommended that these auxiliaries, as far as possible, be driven by motors, preferably induction motors. There will be a gain in economy over steam operation, and a large amount of high-pressure steam piping will be done away with. Any machine which should run at a reasonably constant speed can be operated by means of an induction motor, and one which requires a variable speed can be run with a direct-current motor.

For one large alternating-current plant, the construction of which is now pending, it is proposed to furnish current for the auxiliaries and for the excitation of the generators as follows: Small alternating-current generators, driven by turbines, are to be installed to furnish current of a voltage suitable for driving all the induction motors in the plant. Rotary converters, driven by this current, furnish the direct current, probably at 250 volts, for exciting the main generators, and for lighting the plant. A storage battery installed on this 250-volt circuit steadies any fluctuations and furnishes a reserve in case of a breakdown. In this way the running of the auxiliaries, the excitation of the generators and the lighting of the plant are made entirely independent of the main current supply.

Division into Units—Large alternating-current city plants as at present installed represent a vast quantity of power under one roof. Any accident which might cripple the plant would have very serious results, and affect a large number of people and industries. The greatest care should be taken to avoid such a possibility. In order to prevent, as far as possible, the crippling of the entire plant by an accident to any part of it, some of the more recent installations have been divided into units, each unit consisting of a generator, engine and condenser, together with the necessary number of boilers to furnish steam for the engines and the auxiliaries in connection with the boilers. It is intended that each unit shall be independent of any other; in fact, there will be as many separate power plants as there are units. An emergency steam connection is made between the steam headers, but for emergency use alone. The unit method minimizes the danger of a complete shutdown of the plant, but the price paid for it is the greater amount of reserve apparatus necessary, and also a somewhat poorer economy if the unit idea is carried out in detail as to feeders and substations.

Frequency—By common consent a periodicity of twenty-five cycles per second has been adopted in the United States for alternating-current power work. In Europe there seems to be no fixed standard, each installation following the ideas of its designer. Rotary converters work better at low frequency, and in a combined railway and lighting plant where alternating-current lighting is to be done it is best to generate at twenty-five cycles, use rotary converters at this periodicity for the railway and direct-current lighting, and install motor generators to give a frequency of sixty cycles for any alternating-current lighting.

Phase—Where the generator voltage is used in transmission, it is the accepted practice to generate three-phase current. Where the generator current is stepped up for transmission, it is the custom with some manufacturers to generate two-phase current and in stepping up the current for transmission to change it to three-phase. In most city installations the desired transmission voltage is less than 15,000, and as this voltage can be obtained with modern insulation in well designed generators, unquestionably the best practice is to generate at the transmission voltage, because this obviates the use of step-up transformers. Where the desired transmission voltage is above that which can be obtained in the generator, it is common to generate at a low voltage and raise to the transmission voltage by means of step-up transformers.

Operation of Generators—For railway and power purposes there is no great difference between the running of alternating and direct-current generators. If there is any difference it should be in favor of the alternating-current machine, owing to the substitution of rings for the commutator, and the slightly greater efficiency owing to the absence of brush friction and losses. The large modern machines are made of the revolving field type, the revolving parts carrying low-voltage current and the high-voltage confined to the stationary parts with little risk of accidental contact with persons. With engines of good regulation

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and similar types of valve gear there is no difficulty in running engine-driven alternating-current generators in parallel, and with generators driven by turbines which have a constant impulse throughout the entire revolution, operation in parallel becomes a simple matter.

Switches—The handling of high-voltage current in large quantities is quite a serious question, and the switches and switching devices of a large alternating-current station have become one of the most important parts of the plant. In the more recent installations, the switch contacts are broken in oil and each switch is built in a brick fireproof compartment. The bus-bars are divided into several sections, so that in case of a short-circuit any section may be isolated. All switches are opened and closed by means of a motor running on an auxiliary circuit controlled by the switchboard attendant. No high-voltage current is brought to the switchboard.

Central Station Plans—In order to indicate the general trend of modern practice in central station design, there are published with this article the following power station plans:

Figures 1 and 2—Plan and cross-section of the Manhattan power station, New York city. This installation is the latest large American installation and represents the highest development of an engine-driven station. It contains 40,000 kilowatts, divided into eight 5,000-kilowatt units, and covers about 82,400 square feet, or 2.06 square feet per kilowatt. The cubical contents of the building are about 8,580,000 cubic feet, or 215 cubic feet per kilowatt capacity.

Figures 2A and 2B (not published in this reprint) show the plan and cross-section of the Chelsea station, London, now under construction. This station is to be equipped with ten 5,500-kilowatt turbine-driven units and one smaller unit, making a total of 57,000 kilowatts. These turbines are of the horizontal shaft type, and this is the first large station to be entirely equipped with steam turbines. From a published report the ground area is 1.36 square feet per kilowatt, and the cubical contents of the building 139 cubic feet per kilowatt. These measurements include an office building adjoining the station.

Figures 3 and 4 are sketches showing the proposed arrangement of a station to contain eight 5,000-kilowatt steam turbines of the vertical shaft type. This has the same capacity as the Manhattan and it would be interesting to compare

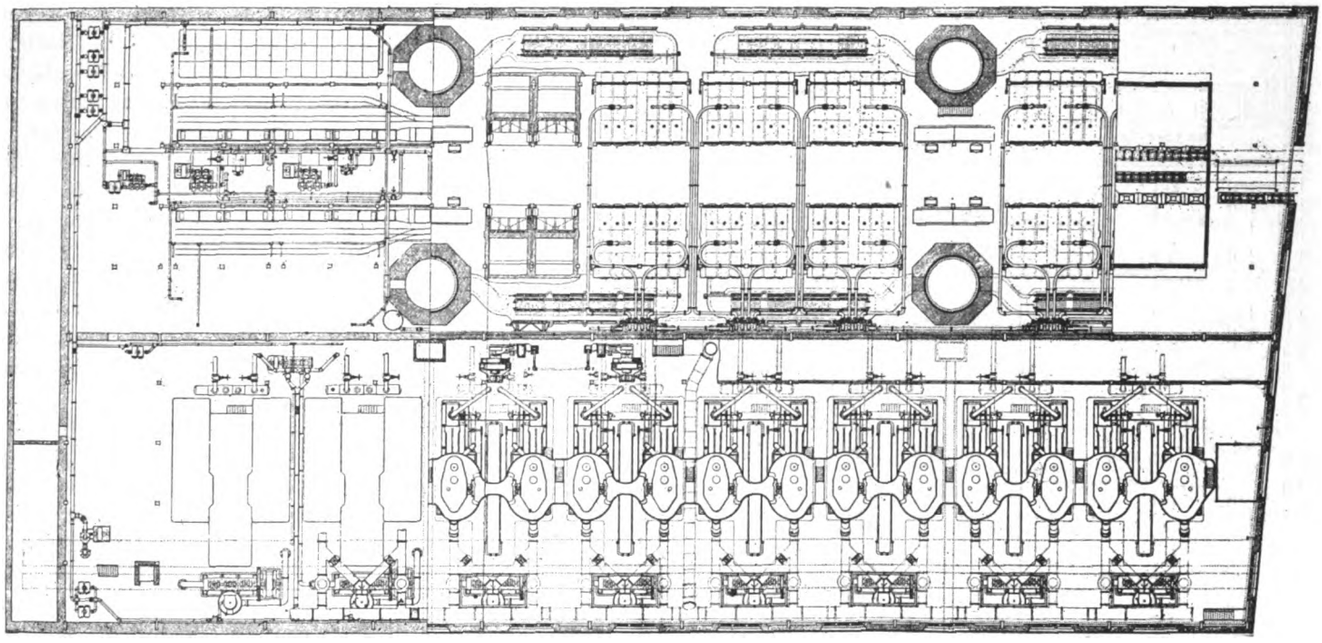

FIG. 1.—PLAN OF MANHATTAN POWER STATION—CAPACITY, 40,000 KILOWATTS.

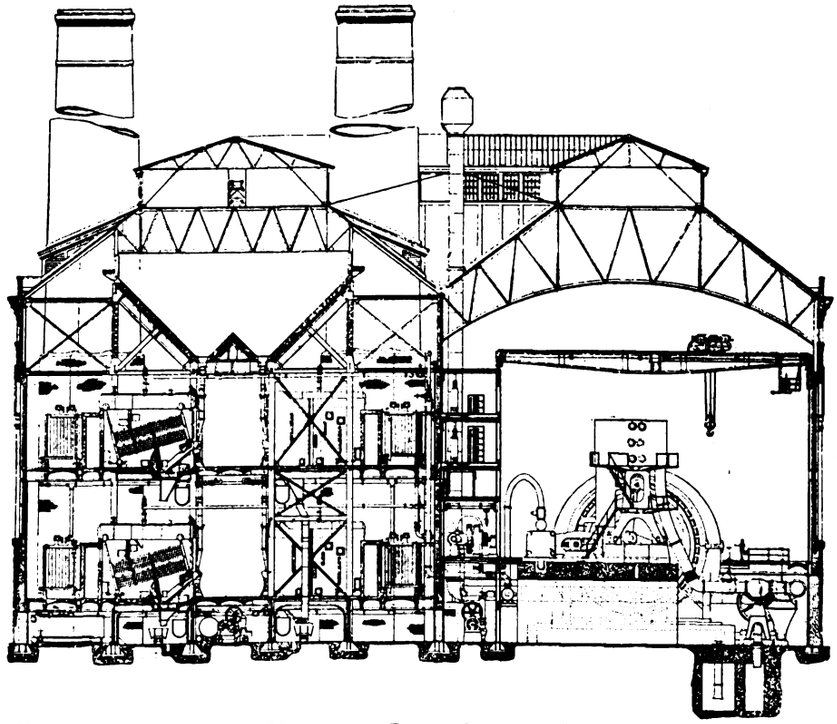

FIG. 2.—CROSS-SECTION OF MANHATTAN POWER STATION—CAPACITY, 40,000 KILOWATTS.

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the relative sizes of the two buildings. The turbine station covers an area of 58,860 square feet, or 1.47 square feet per kilowatt. The cubical contents of the building are 5,403,000 cubic feet, or 135 cubic feet per kilowatt. This station also contains space for 12,000-kilowatt substation capacity.

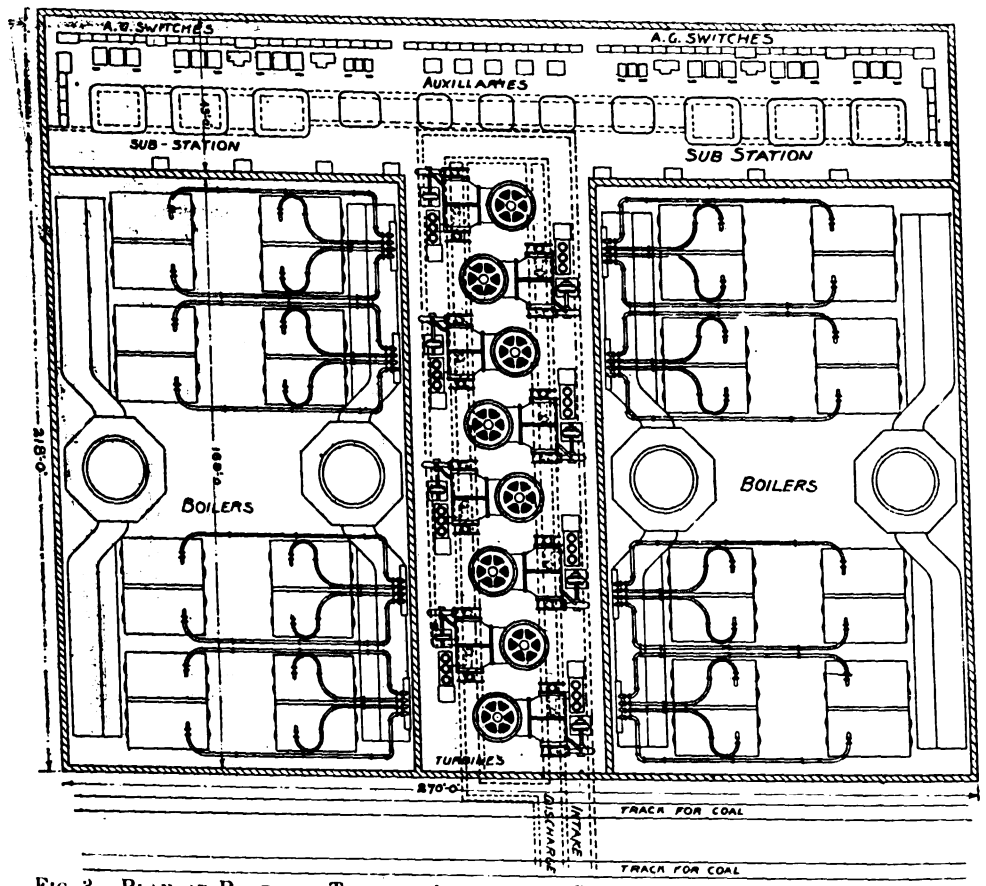

FIG. 3.—PLAN OF PROPOSED TURBINE STATION AND SUBSTATION—CAPACITY, 40,000-KILOWATT GENERATORS AND 12,000-KILOWATT ROTARIES.

of power over long distances with comparatively small wire. Since the size of the wire necessary decreases as the transmission voltage increases, there seems to be no reason why for city use, where heavy loads must be transmitted, the limiting transmission voltage should not be the limiting voltage at which current can be produced in the generator, except that voltages above 15,000 require cables of high cost. It is unquestionably the best practice to carry the high-tension cables underground in conduits. There are some large cities where alternating current at a pressure of 5,000 volts or higher is carried on overhead wires strung along city streets, but although quite a sum of money is saved in the initial cost of feeders, the true economy of such an installation is doubtful. Serious interruption to traffic and perhaps injury to the central station and substation machinery are invited by short-circuits and grounds from fires, storms, lightning and accidental crosses with other wires, while the danger to human life is such that the railway company is liable at any time on account of some fatality to be ordered to place the high-tension wires underground at a greater expense than if it had been done in the first installation.

Transmission Cables—As by three-phase transmission a minimum of copper transmits a given amount of power with a given loss, this is the system which has been generally adopted for transmission. Where the feeders are placed underground, three-conductor cables are used, the three conductors being separately insulated and then surrounded by a lead sheath. Formerly rubber was the insulation used for this purpose, but paper has come rapidly to the front and at present paper insulation is preferred by many to rubber. Paper does not soften under heat like rubber, and the cable has the advantage of being cheaper than rubber and of having a somewhat greater overhead capacity. The weak part of any cable is the joint, and great care should be taken in splicing to exclude all moisture. This is especially true of paper-insulated cables.

In estimating the sizes of cables for

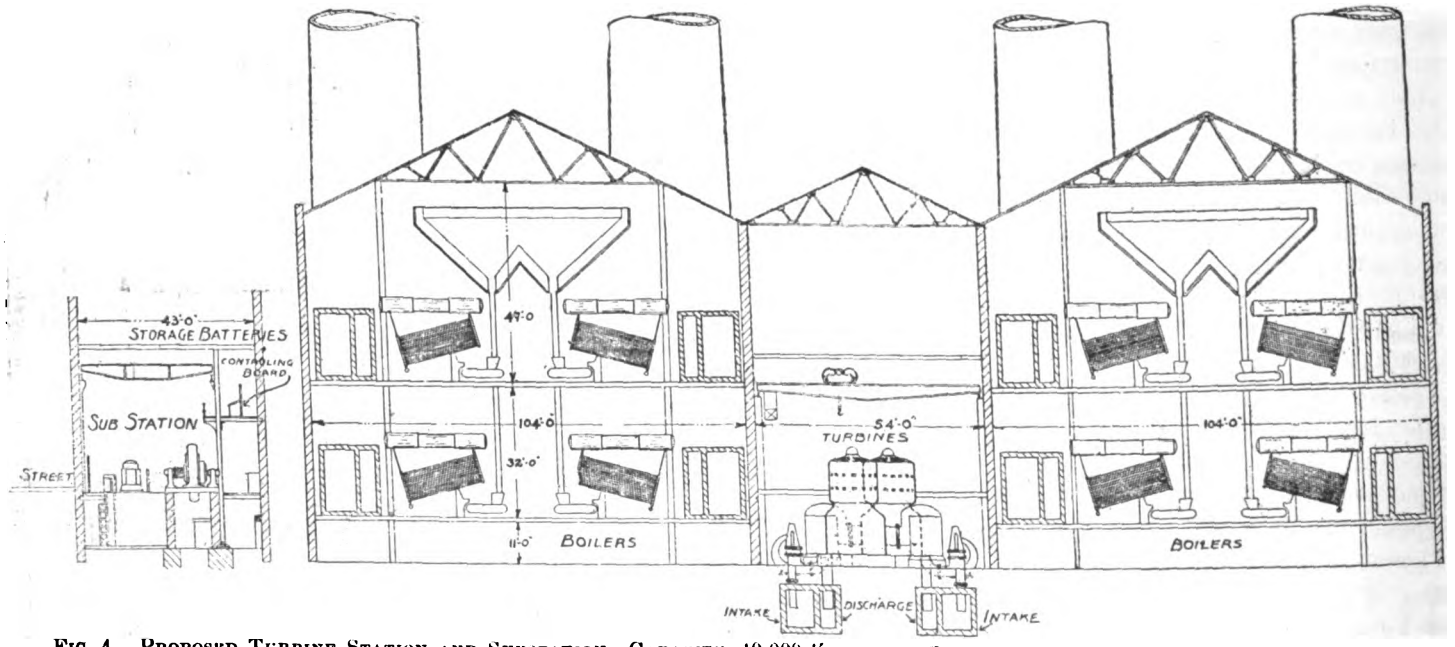

FIG. 4.—PROPOSED TURBINE STATION AND SUBSTATION—CAPACITY, 40,000 KILOWATT GENERATORS AND 12,000-KILOWATT ROTARIES. SECTION THROUGH BOILER, TURBINE AND ROTARY ROOM.

THE TRANSMISSION.

Transmission Voltage—In a few words, the advantages which alternating-current transmission offers lie in the possibility of transmitting large amounts

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carrying the high-tension current it is usually necessary to figure the cable for ampere carrying capacity instead of for drop in voltage, as is customary in long-distance transmission. This is on account of the short transmission distances as compared with the high transmission voltage. The amperes per phase for three-phase transmission may be determined very simply by dividing the watts to be transmitted by the transmission voltage multiplied by the square root of three.

The cross-sections of the copper may be taken very conservatively at 1,000 circular mils per ampere for rubber-insulated cables and 900 circular mils per ampere for paper-insulated cables. The copper cross-section should be checked by estimating the drop in voltage at maximum load, but for the comparatively short distances of city work it will usually be found that the drop in voltage is very small in a cable properly proportioned for the current it is to carry. The largest size three-conductor cable which it is advisable to install in an ordinary duct, is one in which each conductor has a four naught section.

Tables Nos. 1 and 2 give data and cost of rubber and paper-insulated, three-conductor, lead-covered cables with two naught conductors, for voltages ranging from 5,000 to 20,000. It will be observed that above 10,000 volts for rubber and above 15,000 volts for paper-insulated cables, the cost increases so rapidly as almost to make these the limiting voltages for underground distribution.

In some installations one cable for each rotary has been run between the power plant and the substation. In other instances a standard size of cable has been adopted for the system, and a number of cables run to each substation corresponding to the estimated load. An extra cable should always be provided, so that the maximum load of the substation may be carried with one cable out of service.

Conduit—Various forms of duct have been used for underground conduits. The old wooden pump-log ducts have been abandoned because the wood rots and the juices in the wood act chemically on the lead covering of the cable. The ducts at present laid are usually of cement-lined iron pipe, tile in either single or multiple duct, and concrete tubes. It pays to imbed the ducts well in concrete, so that an excavation under the conduit line will not cause settling. The spacing of the brick manholes is usually determined by the obstructions met with in the street, but may be put down as averaging about 400 feet apart. In some recent installations great precautions have been taken to avoid the danger of fire and damage to other cables, arising from a short-circuit in one of the high-tension cables. The high-tension cables have been kept to themselves and at the manholes they have been wrapped with asbestos cloth. The destructiveness of a short-circuit on underground high-tension cables has not proven as great as was anticipated. In one instance a laborer drove a pick through a 6,600-volt three-conductor cable without experiencing any shock, or producing any great amount of pyrotechnics. It was fortunate for the laborer that the pick had a long wooden handle. The lack of destructiveness in the arc is probably due to the quick action of the automatic circuit-breakers at each end of the cable, and also to the fact that although the pressure is of great intensity, the current flow is small.

Substations—The location and number of substations might form the subject of an interesting discussion as to the relative costs of interest on feeder investment, substation equipment and maintenance and operation of substation, were it not for the fact that for city use the location of the substations is pretty closely determined by a study of the density of the traffic. The congested points are closely marked, but where doubt exists as to the wisdom of several locations, an estimate of the costs in either case, together with

TABLE 1.

RUBBER-INSULATED, LEAD-COVERED, THREE NO. 00 CONDUCTOR CABLES.

For three-phase, alternating-current, underground distribution. Cables to be carried in tile or concrete ducts, one cable in each duct.

Working Voltage.	Outside Diameter of Cable. Inches.	Thickness of Envelope of Each Conductor. Inch.	Thickness of Envelope Around Conductors. Inch.	Thickness of Lead Covering. Inch.	Weight per Foot. Lbs.	Cost per Foot.	Test Voltage for 1 Minute.	Minimum Radius of Bending. Inches.	Working Capacity Each Conductor. Amperes per Square Inch of Cross-section, Temperature Rise 30 Degrees Centigrade.
5000	1 1/16	3/32	3/32	3/32	4.86	$0.64	15000	10 7/8	1150
7500	2	4/32	4/32	3/32	5.50	0.91	22500	12	1150
10000	2 9/32	5/32	5/32	1/8	7.24	1.16	30000	13 5/8	1150
12500	2 15/32	6/32	6/32	1/8	8.27	1.37	35000	14 1/4	1150
15000	2 3/4	7/32	7/32	1/8	9.29	1.62	40000	16 5/8	1050
17500	2 31/32	8/32	8/32	1/8	10.22	1.79	45000	17 3/4	1050
20000	3 5/32	9/32	9/32	1/8	11.15	2.08	50000	19	1050

TABLE 2.

PAPER-INSULATED, LEAD-COVERED, THREE NO. 00 CONDUCTOR CABLES.

For three-phase, alternating-current, underground distribution. Cables to be carried in tile or concrete ducts, one cable in each duct.

Working Voltage.	Outside Diameter of Cable. Inches.	Thickness of Envelope of Each Conductor. Inch.	Thickness of Envelope Around Conductors. Inch.	Thickness of Lead Covering. Inch.	Weight per Foot. Lbs.	Cost per Foot. Cts.	Test Voltage for 1 Minute.	Minimum Radius of Bending. Inches.	Working Capacity Each Conductor. Amperes per Square Inch of Cross-section, Temperature Rise 35 Degrees Centigrade.
5000	1 7/16	7/64	7/64	1/8	5.5	54.8	15000	15	1150
7500	2 5/32	5/32	5/32	1/8	6.52	61.6	22500	17 1/4	1150
10000	2 3/8	6/32	6/32	1/8	7.26	66.4	30000	19 1/8	1150
12500	2 9/16	7/32	7/32	1/8	8.04	72.9	35000	20 1/2	1150
15000	2 3/4	8/32	8/32	1/8	8.84	78.5	40000	22	1050
17500	2 31/32	9/32	9/32	9/64	10.60	88.5	45000	23 3/4	1050
20000	3 1/16	10/32	10/32	9/64	11.28	93.2	50000	25 1/2	1050

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the expense of maintaining and operating the substations, will quickly determine which is the better plan.

In interurban construction there are two different opinions maintained regarding substations. One is that substations should be miniature power stations, contain a large quantity of apparatus, in charge of skilled attendants, and be spaced at rather long intervals along the road; the other idea is that substations should be frequent, contain little reserve, and should be taken care of by the station agent or some other employé whose principal duties are not the caretaking of the substation. In city practice, however, there is no question but that the substation should be designed and built with as much care as that used in the power plant construction, that it should contain reserve apparatus enough to tide over any ordinary breakdown, and that it should be constantly in charge of skilled attendants.

The high-voltage current entering the substations is handled by brick-enclosed, oil-break, motor-operated switches, just as in the power station. From the switches it passes to transformers, where its voltage is decreased to that suitable for driving the converters. This current, fed in at the alternating-current end of the rotary converters, produces the 575 or 600-volt direct current which is sent to the direct-current bus-bar for transmission to the trolley wire. The transformers are cooled either by water circulating around the shell or by air blown through the windings.

Rotary Converters—A size of rotary converter which has been largely adopted for city work is 1,000 kilowatts, although one large installation has 1,500-kilowatt rotaries. There seems to be no reason why rotary converters should not be built in as large sizes as direct-current generators, which have been successfully built in sizes of 2,500 kilowatts. The rotary converter is just as reliable a machine as the direct-current generator, and there should be about the same reserve capacity in a substation as is allowed in a direct-current station; that is, one reserve machine to every three or four units. Where the load is subject to sudden fluctuations, it is customary to place a reactive coil in the transformers and provide the rotaries with series windings on the pole-pieces, in addition to the shunt windings. For city use rotaries have simple shunt fields, and if they are kept well loaded at all times, their direct-current voltage is uniform. The substation of a large city system has such a large output that the momentary fluctuations noticeable in a small system are lacking. The load varies with the time of day; the attendants usually have plenty of time to prepare for any change in load, and there is no reason why they should not keep the rotaries well loaded.

Storage Batteries for Substations—Storage batteries have been installed in many of the large substations for the purpose of steadying the load on the rotary converters, taking care of the peaks of the load and creating a reserve capacity in the substation in case of a breakdown of the machinery. If it is possible, with any reasonable degree of accuracy, to draw the load curve for a proposed substation, the question of whether it is more economical to install rotary converters or storage batteries to take care of the peaks may be determined in advance. Most railway load curves show peaks in the morning and evening, some portions of which may be taken by batteries working up to their one-hour rate, provided the duration of the peaks is not too long. In case the shape of the peak is such that no portion of it is of shorter duration than three or four hours, the cost of a battery for handling it would probably be excessive. It should be taken into account that a substation battery carrying the peak of the load not only takes the place of a certain amount of rotary capacity, but exercises a valuable smoothing-out effect on the load, replacing an equivalent amount of station capacity at the central power plant; so that the investment in battery should be compared with the investment in rotaries, high-tension feeders and in generators and steam plant capacity thus dispensed with at the power plant. Figured at the one-hour discharge rate, the relative first cost of storage battery as compared with rotary converter, feeder and steam plant is approximately $90 per kilowatt for the storage battery and $130 per kilowatt for the converter plant, steam plant and transmission line, the latter figure being $30 for the rotary plant and $100 for the steam plant and transmission line. This estimate for rotary and steam plant is based on the nominal ratings of the machines and does not take into account their overload capacities. A battery worked on the peak at its one-hour rate is likely to cost about the same or somewhat less than the apparatus which it displaces.

The value of the storage battery as a reserve in heavy substation work depends upon the comparative amount of storage battery and rotaries which has been installed. If the substation contains a small amount of battery and a large amount of rotary, the reserve value of the battery is likely to be small; if, however, the short duration and sharp nature of the peaks has warranted a comparatively large battery installation, the battery may be of sufficient size to handle the entire load of the substation during the lighter hours of the day for a period long enough to tide over a breakdown, provided that this period is not longer than half to three-quarters of an hour. While the battery may replace those rotaries which would be operated for an hour or two on the peak, it can not be depended upon to take the place of those machines which run throughout the entire day. The reserve feature of a storage battery is especially valuable because it may be put into service immediately and in this it has the advantage of the steam plant, where time is required to get boilers ready for steaming.

In laying out a substation, it would be well to design the building with reference to the future installation of storage batteries, even if it is not intended to install them at once. No general statement can be made in regard to the advisability of their installation, as that should be figured out for each special case.

Low-Tension Switchboard—The feeder board for the substation and the 500-volt feeders leading from it to the trolley sections are practically the same as those used in connection with a direct-current station, and all of the devices installed in the best direct-current stations for the detection and isolation of trouble on the trolley sections should also be placed in the substation.

THE RELATIVE ADVANTAGES OF ALTERNATING AND DIRECT-CURRENT GENERATION AND TRANSMISSION.

With a desire of learning exactly what are the conditions in the cities of the United States, a circular letter was mailed to roads in all cities of more than 100,000 inhabitants. The information is tabulated in table 3 for those railways from which answers were received. It will be observed that the use of alternating current for city work is at present largely confined to the operation of suburban roads from city power stations. With the exception of New York, most of the other cities have a mixed system, direct current being used for city work and alternating current for suburban work. Brooklyn and Philadelphia are now building alternating-current stations and Chicago will probably soon begin the change to alternating-current dis-

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tribution. With the single exception of New York, all cities of more than 200,000 inhabitants have from three to eight power stations. Whether this condition is more economical or more desirable than distribution from a single power station is a problem which must be solved for each special case. The number of American roads using alternating current for purely city work is at present very small, but it is likely that within the next few years many city roads will change partially, at least, to the alternating-current system.

In table 4 is tabulated general data regarding the alternating-current installations in the large cities. It is difficult to tabulate such data because

	Per Cent.
High-tension feeders	3
Transformers	2½
Rotary converters	5
Low-tension feeders	7 to 10

making a total transmission loss between the generator and the trolley wire of seventeen and one-half to twenty and one-half per cent, which is about the same as that estimated for the direct-current

current switches, the high-tension feeders, the step-down transformers and the rotary converters. A failure of any piece of apparatus in this chain, or a mistake of any operator, is likely to cripple the system. With equal standards of workmanship and with an equal quality of operating skill in the two cases, the direct-current system would be more reliable.

The real problem which confronts most railroad companies in large cities is the question of the substitution of an alternating-current plant equipped with modern machinery in large economical units to replace several direct-current plants badly located with reference to the load and containing more or less

City.	Name of Railway Company.	Population of City.	Square Miles of Territory.	Mileage in City Limits.	Mileage Outside City Limits.	Number of D.C. Power Stations.	Capacity of D.C. Stations. Kilowatts.	Number of A.C. Power Stations.	Capacity of A.C. Stations. Kilowatts.	Remarks.
New York	Metropolitan Street Ry. Co.	1,850,093	40	230	.....	.....	.....	1	38500	Another A. C. station soon to be put in operation.
	Manhattan Ry. Co.		40	84	.....	.....	.....	1	40000	
Chicago	Chicago City Ry. Co.	1,698,575	40	175	.....	3	11580	.....	.....	A. C. station proposed to replace present stations
	Union Traction Co.		110	80	50	5	17250	.....	.....	
Philadelphia	Philadelphia Rapid Transit Co.	1,293,697	.....	445	30	7	31500	2	17000	A. C. station under construction.
Brooklyn	Brooklyn Rapid Transit Co.	1,166,582	200	520	.....	6	28160	1	16200	
St. Louis	St. Louis Transit Co.	575,238	65	315	44	4	26800	1	2500	
	St. Louis and Suburban Ry. Co.		125	41	52	2	3075	1	2400	
Boston	Boston Elevated Ry. Co.	560,892	116	.....	.....	8	36844	.....	.....	
Baltimore	United Railways and Electric Co.	508,957	.....	.....	.....	.....	.....	.....	.....	
Pittsburg and Allegheny	Pittsburg Railways Co.	451,512	375	224	179	6	19200	2	13050	
Cleveland	Cleveland Electric Ry. Co.	381,768	.....	.....	.....	3	16150	.....	.....	
St. Paul and Minneapolis	Twin City Rapid Transit Co.	366,350	150	232	20	6	6500	1	5600	
Buffalo	International Railway Co.	352,219	.....	202	156	2	3900	1	3000	Also rents power from Niagara Falls.
San Francisco	United Railroads of San Francisco.	342,782	63	249	27	5	7695	1	4800	
Cincinnati	The Cincinnati Traction Co.	325,902	75	181	35	5	15000	.....	.....	
New Orleans	New Orleans City R. R. Co.	287,104	.....	.....	.....	.....	.....	.....	.....	
Detroit	Detroit United Ry. Co.	285,704	.....	189	311	6	12060	2	2000	
Milwaukee	Milwaukee Electric Ry. and Light Co.	285,315	.....	.....	.....	.....	.....	.....	.....	
Washington	Washington Ry. and Light Co.	278,718	.....	107	38	4	4750	1	600	
Newark	Public Service Corporation	246,070	.....	.....	.....	.....	.....	.....	.....	
Kansas City, Mo. and Kan.	Metropolitan Street Ry. Co.	215,170	.....	167	15	5	8950	1	9000	A. C. station under construction.
Jersey City	Public Service Corporation	206,433	.....	.....	.....	.....	.....	.....	.....	
Louisville	Louisville Railway Co.	204,731	20	122	18	1	6000	.....	.....	Combined A. C. and D. C. station under construction.
Providence	The Rhode Island Co.	175,597	.. ..	163	101	1	7500	1	3500	A. C. for use on suburban roads.
Indianapolis	Indianapolis Street Ry. Co.	169,104	.....	.....	.....	.....	.....	.....	.....	
Rochester	Rochester Railway Co.	162,435	68	93	59	2	2620	1	600	
Denver	Denver City Tramway Co.	133,859	67	145	3	3	5000	1	1500	
Toledo	Toledo Railway and Light Co.	131,822	29	100	2	1	4000	.....	.....	
Columbus	Columbus Railway Co.	125,560	.....	82	25	2	.....	.....	.....	A. C. station proposed.
Worcester	Worcester Consolidated St. Ry. Co.	118,421	.....	60	80	4	7475	.....	.....	Change to A. C. for suburban lines under consideration.
Syracuse	Syracuse Rapid Transit Ry. Co.	108,374	25	56	.....	1	4000	.....	.....	
New Haven	Fair Haven and Westville R. R. Co.	108,027	25	47	53	2	2975	.....	.....	
Paterson	Public Service Corporation	105,171	.....	.....	.....	.....	.....	.....	.....	
Fall River	Massachusetts Electric Companies.	104,863	650	123	207	10	13317	2	14000	Largely an interurban system.
St. Joseph	St. Joseph Ry., Lt., Heat & Power Co.	102,979	.....	.....	.....	.....	.....	.....	.....	
Omaha	Omaha Street Railway Co.	102,555	50	120	10	2	3500	.....	.....	
Los Angeles	Los Angeles Railway Co.	102,479	25	100	.....	1	5000	.....	.....	Suburban system run independently.
Memphis	Memphis Street Railway Co.	102,320	50	58	14	1	3000	.....	.....	
Scranton	Scranton Railway Co.	102,026	140	32	45	2	2660	..	.....	

TABLE 3.—GENERAL DATA CONCERNING POWER STATIONS IN THE LARGE CITIES OF THE UNITED STATES.

special conditions exist in nearly every case. It will be noted that three-phase distribution and a periodicity of twenty-five cycles per second are nearly universal.

A discussion of the relative advantages of alternating and direct-current generation and transmission involves a discussion of:

1. The relative economy and reliability of generation and transmission, and

2. The relative advantages of one and several power stations.

The transmission losses in the feeders and return circuit from a direct-current station depend entirely upon the quantity of copper which it is deemed advisable to put into the feeders. For a city transmission where the feeders are long, and transmission. From these figures it will be seen that if the generating plant in the direct-current station is as economical as that in the alternating-current station, alternating-current generation and transmission should be no more economical than that by direct current.

As to the relative reliability of alternating and direct-current transmission, the latter has many advantages, owing to its greater simplicity. In the direct-current transmission the current is sent straight from the direct-current switchboard to the trolley feeders, while in the case of alternating-current transmission, there are interposed in the circuit, in addition to everything required in direct-current transmission, the alternating-

antiquated apparatus. It may be argued in favor of the operation of several power plants, as against one, that the power plants being located in different parts of the city, there is little likelihood of the same fire, flood, cyclone or other calamity destroying all of them, and thus entirely crippling the road. This, and the fact that the direct-current system is the simpler and the more easily comprehended by ordinary power plant men, are about the only arguments which may be advanced for the several power plant plan.

In a large city convenient locations for water, coal and railroad facilities are not easy to obtain near the centre of load, and it is obviously much easier to

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obtain one good location for a central power plant than several good locations to supply different parts of the system. A central power station should be absolutely fireproof, and if the plant is constructed on the unit system, it would be a very great calamity which would cripple more than one unit. An accident throwing out of service one unit would not be so serious as an accident incapacitating one power station, and thereby crippling the service in one part of the city. It is likely, however, that the greatest advantages of the one central plant is the fact that better supervision may be obtained, as it is much easier to get one good set of operators than several, and in times of trouble it is much easier to keep one plant in operation than several. The economy of generation where the load, alternating-current distribution from a central station will probably be found the more economical; but if a location for an economical power plant may be obtained near the centre of load, and the total city load is comprised within a radius of five miles from this point, as is the case in most cities of less than 250,000 inhabitants, it is probable that direct-current generation and distribution from this central station will prove the more desirable. Where doubt exists, preference should be given to the direct-current system on account of its greater simplicity, unless there is likelihood of a great expansion of the system in the near future, when direct-current transmission might prove burdensome. In case the direct-current system is adopted, suburban lines too long or too heavy for 500-volt transmission may be supplied by alternating current generated in the power plant for their use, or by means of boosters. If the suburban lines are of moderate length or if they require normally only a small amount of power, and make unusual demands upon the power plant only at intervals, such as on holidays and pleasant Sundays, which is the condition on many suburban roads, these lines can best be taken care of by means of boosters, and the same boosting system may be useful in operating some of the city lines. A company which installs an alternating-current transmission system on its heavy city lines merely to furnish power for a few light straggling suburban lines more economically, would place itself in the illogical position of allowing the tail to wag the dog.

It is difficult to make any recommendations as to the choice between alternating and direct-current distribution in merely an abstract discussion. All that can be done is to give the arguments pro and con, with the advice that each case of generation should be figured out for itself, and no plan adopted until its advantages had been thoroughly demonstrated. The discussion in this paper has been on current generation and distribution for use in large cities. The question of long-distance transmission has not been taken up, and no attempt has been made to discuss the question of the supply of current for interurban roads, or for cities where the principal part of the load comes from interurban or long suburban roads. For these cases, alternating-current transmission unquestionably offers great advantages.

Name of Company.	Location.	No. of alternating current generating stations.	Capacity of A. C. stations. K. W.	Generating Voltage.	Periodicity.	Generation 1, 2 or 3 phase.	Transmission Voltage.	Transmission 1, 2 or 3 phase.	No. of Sub-stations.	Capacity of Sub-stations. K. W.	Remarks.
Metroplitan Street Railway Co.	New York	1	38500	6600	25	3 phase	6600	3 phase	8	41000	Second A. C. station under erection.
Manhattan Railway Co.	New York	1	46000	11000	25	3 phase	11000	3 phase	8	63900	
Philadelphia Rapid Transit Co.	Philadelphia	2	17000	13200	25	3 phase	13200	3 phase	Undetermined	Undetermined	Change to A. C. transmission contemplated.
Brooklyn Rapid Transit Co.	Brooklyn	1	16200	6600	25	3 phase	6600	3 phase	6	22500	Intended to use both A. C. and D. C.
St. Louis Transit Co.	St. Louis	1	2500	6600	25	3 phase	6600	3 phase	1	2400	
St. Louis and Suburban Ry. Co.	St. Louis	1	2400	6600	25	3 phase	6600	3 phase	2	2400	
Pittsburg Railways Co.	Pittsburg	2	.....	1100 / 2200	60	2 phase	5000 / 10000	3 phase	8	3200	
Twin City Rapid Transit Co.	Minneapolis	1	5000	3590	34	3 phase	3500 / 12000	3 phase	4	4800	
International Railway Co.	Buffalo	1	3000	11000	25	3 phase	11000 / 22000	3 phase	8	10200	A. C. also rented from Niagara Falls Co.
United Railways of San Francisco.	San Francisco	1	9600	13200	25	3 phase	13200	3 phase	3	7000	
Detroit United Railway Co.	Detroit	2	2000	400	25	3 phase	16000	3 phase	7	3550	
Washington Railway and Light Co.	Washington	1	600	6600	60	2 phase	6600	2 phase	3	1200	
Metropolitan Street Railway Co.	Kansas City	1	9000	6600	25	3 phase	6600	3 phase	4	8000	Ultimately one D. C. and one A. C. Station.
Rochester Railway Co.	Rochester	1	600	375	25	3 phase	11300	3 phase	2	500	
Denver City Tramway Co.	Denver	1	1500	2300	25	3 phase	2300 / 26000	3 phase	3	2000	A. C. for use on suburban roads.
Massachusetts Electric Companies.	Boston	2	14000	13200	25	3 phase	13200	3 phase	10	12750	Change to A. C. transmission in progress.
Rhode Island Company	Providence	1	3500	11000	25	3 phase	11000	3 phase	5	4000	A. C. for use on suburban roads.
Louisville Railway Co.	Louisville	1	3300	13200	25	3 phase	13200	3 phase	3	2900	A. C. station under construction.

TABLE 4.—DATA CONCERNING USE OF ALTERNATING CURRENT IN VARIOUS LARGE CITIES IN THE UNITED STATES.

same quality of apparatus is installed, would not vary greatly, as the cost per kilowatt for the generation of power decreases very slightly after a large output has been reached, and it is assumed that in either case the plants would be of large size. To choose between the direct and alternating-current systems of generation, very careful estimates of the cost of installation and operation should be made in each case, and decision should be reserved until after these estimates are compared.

In some of our largest cities, where heavy loads must be taken care of at long distances from the central station, or where the central station can not be located near the centre of the load, or where reasons exist, such as cheap coal, water transportations, etc., for locating the central station away from the centre

A Correction.

In the article by Dr. Edwin F. Northrup, on "Two Simple Methods of Locating Faults in Cables," published in the issue of the ELECTRICAL REVIEW for August 29, a slight error was made in the drawing of the diagrams, Figs. 2, 3 and 4. In these figures the line *n* should not be joined to the other three lines at station *b*, as shown. The line *n* should not connect with any of the other three lines, except at the cross *j*.

What Is the Matter with Electricity, Mr. Daggett?

[*From the N. Y. Sun.*]

TO THE EDITOR OF THE SUN—*Sir:* The sooner the Federal Government orders the use of electricity to be discontinued in all the public departments, the better for this country. Let there be an investigation, summoning scientists from all quarters. JOHN S. DAGGETT.

BOSTON, Sept. 2.

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A REMARKABLE ALTERNATOR.

BY E. GUARINI.

A new tendency to the advantage of industry is manifest to-day: This is the construction of very large mechanical units. This tendency has been justified, among other things, by the fact that large machines permit a very high efficiency to be obtained, at least in certain conditions of operation. This latter restriction is indispensable, for there are cases, even many cases, where several machines of small or moderate output would be more advantageous to use than machines having a large output. This case is illustrated, for example, when the consumption of energy is not constant at all hours of the day. From the point of view of efficiency, it is then more advantageous to have recourse to several small or moderate sized machines operating at full load than to have a single large machine operating at less than normal load or even at half load.

It has not been long since steam engines of some thousands of horse-power formed remarkable exceptions; now it will be but a short time before engines of 7,000, 8,000 and even 10,000 horse-power are the rule.

After the steam engines, the dynamos have had their turn. What progress there has been since the inventions of Pacinotti and of Gramme! The dynamos are always more perfect, always larger, the electric motor has revolutionized industrial operations!

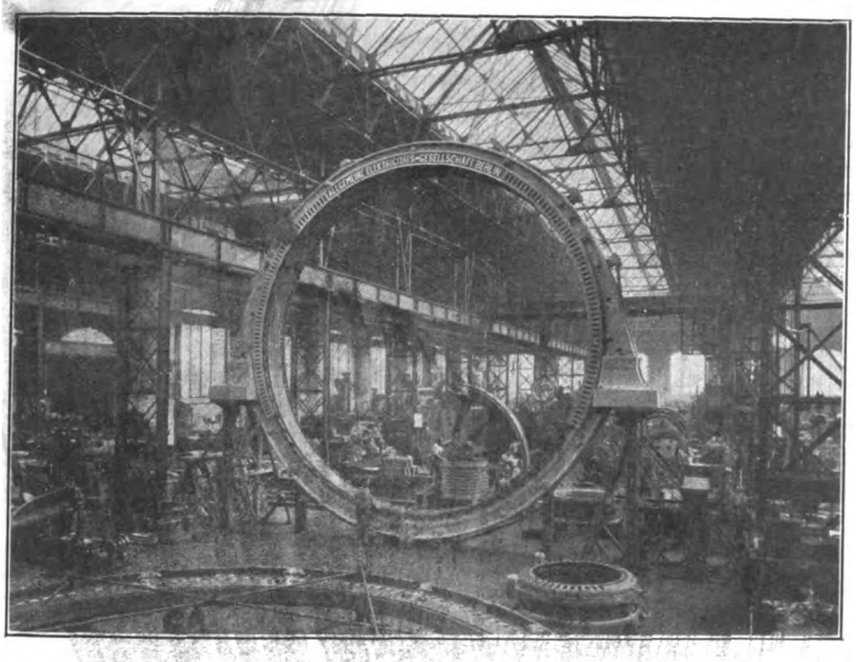

FIG. 1.—LARGE ALTERNATOR ERECTED AND BRACES IN PLACE.

The direct-current dynamos were first to be put to practical use. Although created first the alternators are their juniors from the industrial viewpoint, but it is these juniors which are now preferred by electricians whenever the necessity of transmitting energy to great distances arises. Now, these transmissions of energy are the most interesting for electrotechnics, because it is there that electricity triumphs, there alone that it can not be replaced.

There is one exception to this preference of electricians for alternating currents; this is Thury, who proclaims the superiority of direct currents for long-distance transmission and who cites, to the support of his opinion, the remarkable transmission from Saint Maurice to Lausanne, where energy is carried fifty-six kilometres at a tension of 22,000 volts, and where one of the conductors is replaced by the earth.

The three-phase system has been the most used of the alternating-current systems. This is produced by alternators of gigantic dimensions; certain of which are designed to supply current for traction, lighting, mining machinery, etc. The one which has just been built for the city of Manchester is destined to shine as the mastodon of its class. The following data will give an idea of it.

This is a three-phase alternator of 6,000 horse-power. It was constructed by the Allgemeine Elektricitäts-Gesellschaft, of Berlin, Germany, which company exhibited at the universal exposition of Paris in 1900, a dynamo of 3,000 horse-power. The two lower portions of the carcass of the new machine, which is in three sections, were set up on the foundation of the older machine.

The supports were sufficient as the dynamos of 1900 weighed eighty tons, while the present machine weighs but sixty tons. No special foundations were constructed. To obtain a satisfactory distribution of the pressure, it was only necessary to let the supports lightly into the foundation which covers the whole factory to the depth of one-half metre. The feet were provisionally united by braces. As a precaution against possible weakness, an additional support was constructed of large wooden beams, which were removed after erection. Fig. 1 shows

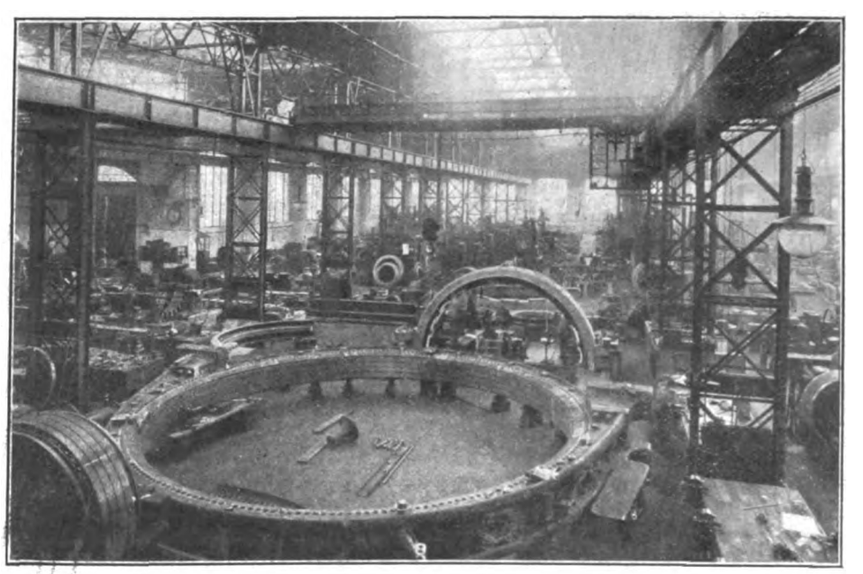

FIG. 2.—ARMATURE IN PLACE, BUT NOT SET UP.

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the carcass and its braces completely erected. In Fig. 2, on the contrary, it is seen finished and provided with its armature, but not yet set up. Fig. 3 shows one of the stages of construction.

To erect the machine a particular arrangement, in addition to that mentioned, was necessitated by the fact that the machine had a diameter of ten metres and the rails of the cranes were only at a height of eight metres. Further, the maximum height the crane hook could attain was seven and one-half metres. It was then necessary to have recourse to a special arrangement of cranes. It consists of two long axles four inches in diameter, furnished with nuts. Each of the threads of the screws was connected to a three-phase motor of five horse-power by gearing. The helicoided screws and nuts transmitted their pressure to the supports by means of balls. A bridge of iron I-beams and of wood rested on the cranes and supported the upper section of the alternator. This bridge could be moved easily, with the third section of the dynamos, between the two cranes which had been coupled. The carriages of the cranes were provided with a construction of iron I-beams supporting a pair of T-rails passing from one crane to the other. The axles were suspended freely from these two rails by means of solid T connecting rods. By means of this arrangement it is possible to move longitudinally by means of the cranes and at right angles by means of the carriages. By this system the erection did not take more than three hours. One man looked out for the regularity of the traction and stopped now one and now the other of the two motors as the regulation demanded. In this way the work was accomplished with safety and facility.

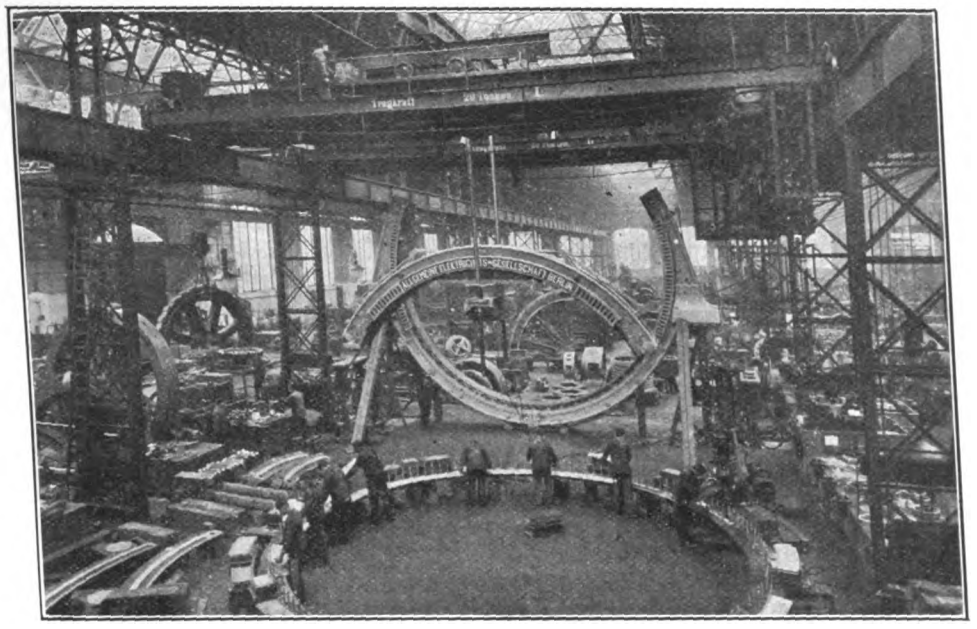

FIG. 3.—ONE OF THE STAGES OF CONSTRUCTION OF LARGE ALTERNATOR.

Effect of Electricity on Plant Growth.

One of the methods of testing the effect of electricity on the growth of plants, and which seems to be most readily accomplished, consists in burying plates of zinc and copper on either side of the plant to be experimented upon, and connecting these plates by means of wires placed above ground. The current generated passes through the earth and roots and thus, it is alleged, promotes a more healthy growth.

Static electricity has been utilized for the same results. Professor Lemström, a Russian, has carefully experimented for the purpose of finding the exact nature of the action of electricity in producing these results, and assumes that electricity "produces an augmentation of the energy to which is due the circulation of the sap," and that the "more fertile the soil and the more vigorous the growth, the more satisfactory are the results obtained from electrical treatment."

For example, he cites results obtained by the treatment of beets and potatoes, which showed an increase in harvest of 107.2 per cent in the former and 76.2 per cent in the latter case.

The Street Railway Association of the State of New York.

The twenty-first annual meeting of the Street Railway Association of the State of New York will be held at Syracuse, N. Y., Tuesday and Wednesday, October 6 and 7. The headquarters of the meeting will be at the Yates Hotel.

A number of papers upon important street railway subjects will be presented, and topics of general interest to street railway men will be discussed. An unusually interesting meeting is anticipated, and arrangements are being made to entertain a representative gathering of street railway men of the state of New York.

In addition to the interesting and profitable features of the meeting in the way of the presentation of papers and discussion, a fine programme of entertainment, including the annual dinner on Tuesday evening, October 6, has been arranged by the local committee.

The Street Railway Association of the State of New York at its next annual meeting will afford an opportunity for operating street railway men to get together and discuss conditions which will be of great mutual benefit. The committee in charge earnestly urges the necessity of all street railway representatives in the state coming prepared to participate in the discussion, as no effort will be spared to make this part of the meeting of greater utility than any convention which has been held heretofore.

Committee of the American Institute of Electrical Engineers Appointed to Prepare an Exhibit for the Institute at the St. Louis World's Fair.

The board of directors of the American Institute of Electrical Engineers has appointed a committee to arrange an exhibit showing the evolution of the prominent elements which are the basis of electrical engineering. Any person possessing or knowing of the whereabouts of interesting historical electrical machines or appliances, will render the committee a great service by communicating with the chairman at once. The exhibit will be given a prominent place in the Electricity Building, where the Institute will also maintain headquarters.

The members of the committee are: T. C. Martin, chairman, 114 Liberty street, New York city; W. J. Hammer, New York; J. S. Anthony, New York; Henry Noel Potter, New York; Cloyd Marshall, St. Louis, Mo.

The Four-Track News, published by George H. Daniels, general passenger agent New York Central & Hudson River Railroad, 7 West Forty-second street, New York city, for September, is resplendent in a new cover design in colors. An interesting innovation is a half-tone reproduction in color of "Mount Hood, Oregon, from Lost Lake." The contents are well varied and present sketches by well-known popular authors. *The Four-Track News* improves with every issue.

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American Street Railway Association.

The Twenty-second Annual Convention of the American Street Railway Association, Saratoga Springs, N. Y., September 2, 3, 4, 1903.

IN THE absence of President J. C. Hutchins, of Detroit, first Vice-President W. Caryl Ely called the opening meeting of the twenty-second annual convention of the American Street Railway Association to order Wednesday, September 2, saying, in part:

By reason of the absence in Europe of President Hutchins, the pleasant duty now devolves upon me of calling to order the twenty-second annual convention of this association. During a recent visit to Europe, from which I have but just returned, it was my pleasure on the outward voyage to be a fellow passenger of President Hutchins, whom I afterward saw at several different points and on different occasions. I bear to you his personal greetings, coupled with the highest expressions of regard and of regret at his inability to be present at this meeting. I am glad to be able to confirm the statement concerning his health contained in his letter which you will hear read, and to say that it has continued to improve, and that he now confidently expects to return within the month and resume the active duties of his business position. The duties thus devolving so unexpectedly upon me, pleasant and agreeable though they may be, are not without embarrassments, but I shall enter upon them confidently relying upon your forbearance and asking your assistance and coopertion at every stage of the proceedings.

Mr. Ely introduced the Hon. Edgar T. Brackett, of Saratoga Springs, who welcomed the visiting delegates.

The registration at the door took the place of the roll call, and the minutes of the last meeting were read and approved.

Secretary T. C. Pennington read a resolution from Mr. H. H. Vreeland, as follows:

WHEREAS, The executive committee of this association at its meeting held in Saratoga Springs, February 23, 1903, owing to its inability to secure hotel accommodations for the annual meeting of the association at any other time, issued its call for the meeting of the association to be held in Saratoga Springs, September 2, 3 and 4, 1903.

Resolved, That the action of the executive committee be and the same is hereby approved, ratified and confirmed, and that this meeting is hereby declared to be the regular annual meeting of the association for the year 1903.

Resolved, That all of the business of this association be proceeded with at this meeting in accordance with the by-laws of the association applicable to regular meetings called and held within the date provided by Article VII of said by-laws.

This resolution, on motion, was adopted.

The secretary read a letter from President Hutchins:

ZURICH, August 3, 1903.

MR. T. C. PENNINGTON,
Secretary American Street Railway Association, Chicago.

My dear Mr. Pennington: I have delayed writing you until now because my plans were not quite certain; but it is now finally settled that I will not be able to return in time for the Saratoga convention. I am much disappointed that this is the case. My health is very much improved—in fact I feel as well as I have ever been—but it is thought I should not risk a relapse by hastening back, and consequently I have concluded to remain in Europe until the middle of September.

I am sure, remembering our trip to Saratoga, that you have everything in good shape for the convention. Mr. Ely will doubtless be back in time to preside, and I am confident everything will pass off all right—better, in fact, under his skilled handling than would be the case were I present. My duty, however, is there, and it pains me that I have to write that I can not discharge it.

Hoping that I may make amends by such work as I may be able to do for the association in the future, I remain

Sincerely yours,
J. C. HUTCHINS.

Mr. Ely delivered the annual address to the convention, as Mr. Hutchins had been unable, because of ill-health, to prepare this according to the usual custom. An abstract from Mr. Ely's address follows:

Statistical information of any great length concerning the magnitude of the interests represented in this association would be wearisome and perhaps confusing. It is sufficient to say that from the recent United States Census report upon the street railway industry it appears that there were on June 30, 1902, in the United States 987 companies, owning and operating 22,589 miles of single track, upon which were transported in that year more than four and one-half billion passengers, by the use of more than one and one-quarter million of horse-power. The aggregate mileage run by the cars used in these operations exceeded one billion miles. In these stupendous operations capital is employed as represented by capital stock and funded debt in the aggregate amount of $2,400,000,000. These figures represent the investments of many thousands of people and relate to the intimate concerns and the daily life of millions of people. They are therefore the legitimate subjects alike of popular and government interest and enquiry, and correct data and information concerning them are matters of the very highest importance.

I am glad to be able to state that the methods of keeping the records and accounts of this class of transportation companies are improving from year to year, and that it is rare to find an instance where the fullest and freest information is withheld from the most casual enquiry Service of great value has been rendered in this department of street railroad work by the Street Railway Accountants' Association of America. The classification of construction accounts and operating expense accounts which has finally been settled upon by this association was adopted by the United States Census Bureau in gathering statistics for its census of electric railways, and a representative of the Census Bureau has prepared a paper on the subject, which is to be read in the Accountants' convention now being held here. This classification has been officially adopted by the state railroad commissions of New York, Massachusetts, Connecticut and Maine, and is about to be adopted by the commission of the state of Pennsylvania. The association's form of monthly and annual report has also been approved and adopted by the National Association of Railroad Commissioners. The standard classification and forms of report have been approved by the leading bankers and financiers of the country. It is quite common, I am informed, at the present time for a banking firm examining properties with a view of purchasing to require the accounts to be changed in accordance with the forms of the Accountants' Association. It has already been adopted by many of the most progressive electric railways and by a larger number of companies than any other one system of accounting. Exact and precise uniformity in forms of classification and report is highly desirable, and the sooner it is attained the better it will be for the stability and value of electric railway investments; and it will seem that the system which has been worked out by our Accountants' Association and adopted by such high governmental authorities, and which has received the approval of the financial and banking community, ought to be speedily adopted by all. The members of the executive committee of your association join me in urging upon members the desirability of immediate affiliation with the Accountants' Association, and the speedy adoption of its forms of classification and report.

The greatest activity displayed during

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the year has been in the development of the suburban and interurban properties as distinguished from the purely local service of city companies. This development has been notable not only in the increased mileage equipment and volume of business transacted by the interurban and suburban properties, but also in the extent of the field occupied and the scope of the service given.

The discussion of the possibilities of interurban electric railroading can not fail to be of interest to any gathering in the Hudson valley, where some of the most notable pioneer work in this branch has been done. The operating companies of this section have not only set a good example in indicating the possibilities of this class of service, but have gone on developing it and have maintained their commanding position as leaders in this field. It is estimated that there are now nearly one hundred companies throughout the country engaged in the handling of freight and express business, and there are possibly many more which are contemplating engaging in this work. All of these will be interested in the Mohawk valleys, and by the city systems of Albany, Schenectady, Troy and other large communities which serve as distributing points. The organization which has been perfected in these places and the experience gained by the management will, of course, be placed at the disposal of the visiting managers, who will need no assurance of the value of this opportunity for the examination of the practice adopted. At the present time the water power development in this region is one of the largest and most important in the country, and the street railway properties are taking advantage of it in securing their current at a low rate and ensuring reliable and constant service. The engineering features that have been developed in this connection appeal to those who are directly in touch with this branch of the service. Preparations are now being made for greatly increasing the available power from this source, and it is anticipated that within a few years the entire electrical service of this region will be operated by current produced by water power.

Another striking development of the year has been the tendency displayed toward consolidation of the street railway properties in the smaller cities, together with the electric and gas lighting service; in fact, this tendency has been so marked during the last year that in spite of the large number of new street railway corporations that have been formed in the last twelve months the actual number of operating systems has been only slightly increased. The value of the properties, however, has been growing constantly and the general average increase in gross receipts for 1902 over 1901 was nine per cent. The largest individual consolidation was that of the properties of the North Jersey Street Railway Companies and allied lines in the Public Service corporation of New Jersey. Other notable consolidations were those at Augusta, Mobile, New Orleans, Kingston, Oakland and Norfolk and Newport News.

From a financial point, probably the most important development of this character was the acquirement by the Interborough Rapid Transit Company, of New York, through lease, of the lines of the Manhattan Railway Company, thus assuring the operation of the elevated and subway properties of New York under a single management. The physical union of the two properties had already been recommended by the Rapid Transit Commission, and it had been suggested that the trains pass between the subway and the present elevated structure at several different points. This is hardly practicable at present, although it is within the possibilities that an exchange of traffic may be effected. The rolling stock of the elevated system would not be suitable for operation through the subway, and the great weight of the cars that are being built for the latter would prohibit their operation in long trains upon the present elevated structure. This feature of the change in methods of construction and equipment is, of course, suggestive of the general advancement that has been made in the rolling stock of all branches of the service with a view of increasing the comfort and convenience of passengers, as well as the safety and reliability of operation.

The growing importance of mechanical and engineering departments in electric railroad operation has resulted in the formation of a new association, the American Railway Mechanical and Electrical Association, which is meeting for the first time this year in connection with this convention. It is the purpose of this new organization to discuss mechanical and electrical subjects; exchange ideas on construction and equipment, and raise the standard of operation wherever improvement is possible. The necessity for better shop methods, and the advantages of correct and comprehensive records in the mechanical department are now generally recognized, and it will be the duty of the men forming the new organization to determine the best practice to be followed and see that it is adopted. It will be recognized, therefore, that the new association has an important mission and is entitled to the support and cooperation of this the parent organization.

A number of individual instances have been afforded during the year showing the progress that has been made in electric railway engineering. In Pennsylvania two very important interurban properties operated by third-rail systems have been opened. One of these employs a protected third rail, and is the first attempt to commercial operation of such a system. The line extends from Hazleton to Wilkesbarre, through a district that is visited by severe sleet and snow-storms, and this feature of the equipment will receive a severe practical test of its efficiency. The other third-rail system mentioned is that recently opened through the Wyoming valley and intended for freight and express service, as well as the transportation of passengers, in competition with several well-established steam lines. This property is particularly noteworthy because of the terminal facilities that have been provided and the organization effected for the collection and distribution of freight and express, as well as its transportation over the electric lines. It is really the first instance of the organization and establishment of an electric property intended for this class of service in which provision was made for handling a large volume of business from the opening of the road.

In station equipment and distributing systems, as well as in the character of the rolling stock, appreciable advancement has been made. At the last annual meeting, it will be remembered, a very interesting paper was read upon the steam turbine. The investigation of this important subject has been continued during the last twelve months, and a further contribution is promised for this meeting, which it is hoped will embody the record of the advancement during the last year. Already plans have been prepared and actual work has been begun upon the installation of several large power stations in which this class of apparatus is to be installed. The most important of this character for street railway service, thus far announced, is that of the new station of the Union Traction Company, of Philadelphia, where an installation of ten 5,000-kilowatt engines is contemplated.

A year ago considerable interest was awakened among street railway men, particularly those interested in interurban electric railroading, in the possibility of developing a single-phase motor for railway service. It was, of course, understood that such a motor would not be adaptable for city service, but many promises were held out to those who were interested in the development of long interurban lines. During the last twelve months assurances have been given that progress was being made, but up to the present time no reliable information has been available, and the electric railway engineers are still dependent upon the direct-current motor for interurban as well as city work.

This brings us in a somewhat crude manner to the close of the year. If you will bear with me yet a few minutes, I wish to speak very briefly upon several points of the highest importance, and as I have run out of manuscript, I feel that you will pardon me if I go ahead without any.

First, I wish to refer to the work that has been done by the Committee on Rules, and I ask and earnestly urge every member here present to read the report of that committee with great care between now and to-morrow morning. I feel also that the members of the association are greatly indebted to the Committee on Rules, because I know of my own personal knowledge that that committee has done a great deal of hard work, and has done it in the same painstaking, thorough and continuous manner in which the men who

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compose the committee perform the duties for which they are paid large salaries. This class of work when deputed to committees is sometimes not so well done as the work this committee has performed.

I wish to refer to the papers to be presented here. The subjects were chosen with great care at the meeting of your executive committee held in this place last February and which meeting was very fully attended. A businesslike and intelligent method in the printing and distribution of the papers upon the subjects so chosen has been heretofore adopted, and it is earnestly to be hoped that the same method will hereafter be pursued. It is right and proper that the subjects should be chosen in advance, and the papers written and distributed in advance of the meeting of the convention so that those who come here for actual benefit may read the papers, have them carefully digested and be ready to exchange views with each other upon the subject of the papers. The old method of presenting papers and reading them in the convention, and at that place first making the members aware of their contents was of but little value.

I wish also to speak of the admirable exhibit which has been prepared and installed here by the supply men. I think that a good, fair share of each delegate's time should be given, not only to a careful examination of the exhibits, but to a pleasant greeting and extension of thanks to the representatives of the companies who have expended so much money and so much effort in getting these exhibits here and installing them in perhaps a somewhat difficult and expensive place.

A most important subject is that of general standardization. We have now arrived at a point in electric railway practice where it would seem that it would be possible to very shortly reach a general standardization which should extend, not only to road construction, equipment and other features of the system, but also to every branch of accounting, and every branch of the operating, mechanical and engineering departments.

On motion by Mr. E. G. Connette, Syracuse, N. Y., the thanks of this association were tendered to Mr. Ely for the very able address which he presented to the convention.

The secretary announced that the Hudson Valley Railway, the United Railway, of Albany, and the Schenectady Railway extended the courtesy of their roads to the delegates and their friends. Free transportation to be given on the badges of the association.

The secretary also announced that the American Telephone and Telegraph Company and the Hudson River Telephone Company extended the courtesies of their long-distance telephone system to the delegates; the service to be given between 5 P. M. and 8 A. M. on presentation of the badge of the association.

The report of the executive committee included the business transacted at two meetings of the executive committee during the present year, at which arrangements for the convention were made, including the selection of topics for papers, the assignment of the topics to the writers of the papers, and the various details of the convention.

On motion of Mr. C. D. Wyman the report of the executive committee was adopted.

Secretary Pennington read the report of the secretary and treasurer, which showed that twenty companies had joined the association since the last meeting; that five members had withdrawn, mainly on account of consolidation; membership on August 24 was 206 companies.

The financial transactions during the year were as follows:

Balance in bank October 1, 1902, $9,948.03; receipts, $7,677.28; total, $17,625.31. Expenditures during the year $7,286.62, leaving a balance on August 22 of $10,338.69.

The chair announced the following gentlemen as the members of the committee on nominations to nominate officers and select a place for the next meeting: Messrs. Laffin, of Worcester; Goodrich, of Hartford; Sloan, of Chicago; Stanley, of Detroit; Henry, of St. Louis. This completed the preliminary business laid out for this session.

A question was brought up as to mail car service in cities. Some time ago a representative of the government stated that if some concerted action was taken by this association he thought it would be possible for us to get an increase in the compensation now paid. A resolution that a committee be appointed to confer with the government officials on the subject of increasing the compensation paid to street railway companies for carrying the mails, was offered to this effect by Mr. Grant.

After a lengthy discussion the chair suggested that the resolution be committed to writing, and so amended that it will provide that, as soon as the committee has finished its work, it shall file a report with the secretary of the association, who shall forthwith communicate it to all the members of the association for their guidance. The chair requested Mr. Grant to frame such a resolution and present it at his convenience, after which the meeting adjourned until ten o'clock Thursday morning.

THURSDAY SESSION.

Vice-President Ely called the meeting to order at 10.15 A. M. After a brief discussion relative to the carrying of United States mail, Mr. W. L. R. Emmett presented his paper on "Steam Turbines."

Mr. John I. Beggs, of Milwaukee, was called upon to open the discussion.

Mr. Beggs: Mr. Chairman and gentlemen, I did not expect to be called upon to discuss this question of steam turbines—the request to do so is a surprise; yet it is a subject I am deeply interested in, as I believe every other member of this association is, who is required to spend such a large amount of money as we are called upon to do in producing steam. I believe that engineering circles generally are waiting with a great deal of interest the results of the tests now being made in the power plant of the Commonwealth Electric Company, of Chicago, upon the first 5,000-kilowatt turbine unit that has been installed. In this connection I desire to throw out a suggestion as to whether or not, about the time that the steam turbine has reached the stage of perfection suggested by Mr. Emmett and the manufacturers of it, there is not a new power now looming up which may as far surpass the steam turbine as the steam turbine surpasses the reciprocating engine, at least so far as the matter of economy goes. I refer to the gas engine. We have given considerable thought to it for the last two years. If the predictions made for the gas engine, in using gas now produced as by-products, or in using the ordinary illuminating gas, or producer gas from plants installed in connection with our own steam plants, are carried out, we can cut the cost of a kilowatt of current no matter how high the economy of the plant may be—it can be cut in half and possibly reduced two-thirds in cost. I think this is an important question. There is one large engine building concern in this country which has recently acquired the right to build in this country the Nurenburg gas engine. It proposes to have one of these engines installed in St. Louis, twelve months hence. There is also a 3,000-horse-power gas engine to be direct-connected to a 2,000-kilowatt generator which it is likewise proposed to install in the St. Louis Exposition. In the Northwest, where coal is such a factor that we are paying $3.50 for 2,000 pounds for screenings, where four years ago it cost us only $1.70, you can appreciate that any device which will bring down the cost of producing steam is of great moment. The element of power going to operate a car-mile to-day becomes a very serious question, and if the cost of generating the power can be cut in half and that without the use of a steam power plant, anything which will tend to that end becomes a very important factor.

The Vice-President: This is an interesting subject and Mr. Beggs's remarks are of much value, and I hope that others will take part in this discussion. Referring to the very interesting subject of gas engines of which Mr. Beggs spoke, I might merely allude to the fact that in the new plant of the Lackawanna Steel

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Company, at Buffalo, by apparatus quite simple in its nature, the escaping gases from stacks of the blast furnace and the ovens are recovered, washed and conducted to the engine room, where they are used as fuel, costing nothing to the plant, yet supplying fuel for an installation of 40,000 horse-power of gas engines, power to move the machinery is supplied by the gas engines in that way. I have seen the plant several times. The engineer in charge is a Russian—of course, you all know that in the matter of gas engines, their manufacture and use, we are far behind Europe. I think the units are 2,000 horse-power each, perhaps there are some of 5,000 horse-power, but my impression is that most of them are 2,000-horse-power units.

There was a discussion on the question as to what extent the proceedings of the convention should be given to the technical press for publication before the remarks were revised by the various speakers. The enterprise of the technical press in publishing the discussions was commended. Some of the members thought there might be a freer expression of opinion if the report of the proceedings was not printed before revision by the speakers, and some members expressed the opinion that a member should have the privilege of having expunged from the record any remarks he did not wish to have printed. The discussion was participated in by W. Worth Bean, St. Joseph, Mich.; L. E. Myers, Peoria, Ill.; H. H. Vreeland, New York; C. C. Mailloux, New York; G. Tracy Rogers, Binghamton, N. Y.; John I. Beggs, Milwaukee, and J. G. White, New York.

The vice-president appointed the following committee to consider the matter and report to the convention: Messrs. Mailloux, White and Beggs.

The following named gentlemen were appointed as a committee on resolutions to report at this convention: W. Worth Bean, St. Joseph, Mich.; C. Loomis Allen, Utica, N. Y.; Thomas Hawken, Rockand, Me.

The following named gentlemen were appointed a committee on rules to report at the next convention: E. G. Connette, Syracuse, N. Y.; T. E. Mitten, Buffalo, N. Y.; W. E. Harrington, Camden, N. J.; Richard McCulloch, Chicago, and John J. Stanley, Cleveland.

Mr. Beggs offered the following resolution:

Resolved, That the executive committee to be elected at this annual meeting be requested and directed to make an earnest effort to have prepared and presented at the next annual meeting papers from prominent and experienced manufacturers of reciprocating engines, manufacturers of steam turbines, and the manufacturers of gas engines, as to their respective merits.

The resolution was seconded by Mr. Connette and carried.

The secretary read a communication from Mr. C. T. Rogers, president of the Street Railway Association of the State of New York, announcing its next annual meeting at Syracuse, N. Y., October 6 and 7.

FRIDAY SESSION.

Vice-President Ely called the meeting to order at 9 A. M., and requested Mr. H. H. Vreeland to preside.

The first business to be considered was the paper on "Electrical Welded Joints," by William Pestell, superintendent of motive power and machinery of the Worcester Consolidated Street Railway Company. Mr. Pestell was not present and as Mr. Richard McCulloch, the author of the paper on "The Manufacture and Distribution of Alternating-Currents for Large Cities," was present, this paper was taken up.

Mr. McCulloch opened the discussion by calling the attention of the members to such points as he particularly desired to emphasize. The paper consists of a description of the general practice in large city power plants of producing alternating current, with limited discussion of the advantages of some of the newer forms of producing the current. In general terms the conclusion of the paper is that in cities of perhaps less than 25,000 inhabitants, unless special conditions are found to exist, the best practice would be to generate direct current, and the alternating current will be serviceable more particularly to the very large cities and for cities where the greater part of the load comes from the interurban or suburban places. (This paper is reproduced in full on the other pages of this issue.)

Mr. Mailloux opened the discussion. He said it was not necessary to spend much time in a discussion of the paper. The paper was primarily a statement of facts—an analysis of the present state of the art of producing and distributing alternating current. It was a paper that will be very useful to the members as a work of reference, because it so concisely, and yet comprehensively, gives a résumé of the entire situation.

The next paper was entitled "The Evils of Maintenance and Champerty in Personal Injury Cases," by Michael Brennan, counsel of the Detroit United Railway.

Mr. Brennan, in his short paper, defined the terms "maintenance" and "champerty." "Maintenance," he said, "at the common law was an officious intermeddling in a suit that in no way belonged to one, by maintaining or assisting either party with money or otherwise to prosecute or defend it. It was an offence against public justice, as it kept alive strife and contention and perverted the remedial processes of the law into an engine of oppression." Champerty was a species of maintenance and was punished by fine and imprisonment. It derived its name from the fact that it was a bargain with a plaintiff or defendant to divide the land sued for between them if they prevailed at law. The champertor was to carry on the litigation at his own expense, and to take as his reward part of the land. He led up to the application of these terms to railway practice, and quoted the marvelous growth of railroads in this country and the multiplication of other industries, which necessarily increased the number of accidents accruing to employés and others. This condition gives rise to the existence of a class of lawyers in all large centres of population who make a specialty of pressing cases of personal injury and whose fees are contingent upon the ultimate success, whether by compromise or at the end of a suit. In the city of New York there are on the present calendar 29,697 cases for trial, and of this number 5,766 are against the surface street railway corporations. He spoke of the subterfuges and expedients which these lawyers made to secure cases from persons who had become injured in railway accidents, and showed both the humorous and serious sides of the situation. He quoted the code of procedure in Germany and Prussia and the efforts which had been made to pass statutes on the subject of expert testimony in the United States. A complete and radical remedy, he thought, would be the reenactment of the old common law prohibition against maintenance and champerty. It is true that some inconvenience and suffering might result therefrom, but the law can not take care of every ill, and the greatest good for the greatest number should be the rule.

The next paper entitled "Train Orders and Train Signals on Interurban Roads," was presented by C. A. Coons, superintendent of transportation International Railway Company, Buffalo, N. Y.

The next paper, "Freight and Express on Electric Railways," was presented by Mr. J. B. McCleary, manager of the railway department of the Birmingham Rail-

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way, Light and Power Company, Birmingham, Ala.

The paper by Mr. McCleary contained a description of the system of freight and express handled on several electric railways and gave a table of statistics showing the extent to which this was done. Upon investigation of 182 roads it was found that seventy-one roads handled freight and express. Forty-five roads admitted that it was profitable and that they intended to increase their facilities for handling their business. Thirty-seven said that this is a very attractive feature of electric railroading, while nine answered that while they carried freight, they did not think well of it. Thirty-five roads used the steam railroad classification of their states or railroad districts. Others have rate sheets of their own, based upon local conditions, and generally much lower than the steam railroads. Thirty-eight have depots at terminals and along their lines, and nine say they have none.

Mr. W. O. Gotshall: I would make a few remarks on the subject of this paper, "Freight and Express on Electric Railways." It appears to me that this is one of the most important subjects in connection with what are undoubtedly the coming electric railways, that is, the railways connecting the centres of population adjoining and about large cities. For about a year past I have been trying to get some information on this matter and the essential trend of what I have been doing has been to ascertain the income coming from this service, and the amount of money it is costing to do a given amount of business. I do not find that there is any statement in this paper showing anything from which you could derive much information concerning the point of income or the cost of doing business. I have found in going over the matter and corresponding with railroads in different parts of the country, as to the express and freight business, that they are receiving all the way from $500 to $900 per mile of single track, that is, the gross receipts for the freight and express business they are doing. I have not been able to get satisfactory information which would indicate the cost of doing that business. It is certainly unfortunate that our time is limited and that there is no disposition to discuss the paper more at the present time than there is; and it appears to me the matter might well be brought up in some other form at the next session, when we trust we shall have sufficient time to discuss all these papers. It would require three of four hours to discuss this paper properly.

After a lengthy discussion on this paper, the next paper entitled "The Right of Way," by Mr. H. H. Vreeland, president of the Interurban Street Railway Company, of New York, was read.

Mr. Vreeland gives in this short paper his ideas on the question of the right of way of street cars. The defect in all discussions seems to arise from a lack of clear statement of what is meant by "right of way." Street railroads, in the sense that steam railroads enjoy this privilege, have no right of way. If street railroad men would view the topic from the point of view that the general public has equal rights on the road, and insist that the streets are for the use of the people, instead of corporations or individuals, the whole question would take on a different aspect. A railroad company is permitted primarily to exist, not for the aggrandizement of its owners or operators, but for the accommodation of the public. A good analogy between the rights which all street railway operators claim for their vehicles seems to be found in the rules of the road concerning United States mail vans. These have the right of way everywhere, and it is a misdemeanor to obstruct their free movements. The reason of this is not because the van is labeled "United States Mail," or because of any superior authority invested in the driver, but because the vehicle contains hundreds—it may be thousands—of business communications involving complicated business interests. For this reason he had always held that a street car containing a crowd of people necessarily in haste—or they would find a cheaper and more leisurely way of reaching their destination—had rights superior to other vehicles on street surfaces. Mr. Vreeland also said:

The chairman in his address referred to the matter of rules and regulations of the steam railroads, which I was very glad to have brought out in connection with the work of this association. I had occasion back in the early eighties to examine a number of engineers and conductors for appointment on a property that required a large summer service and among the number were some men from the West. In examining them on our train orders and regulations, the most important and essential in the operation of a railroad, there was not one man who understood our orders. They were men who had run trains for fifteen or twenty years in the West. As the chairman pointed out to-day, an engineer, under the rules and regulations for the movement of trains, by telegraphic orders, who may have been running a train in California last week can to-morrow step on an engine in Maine and his rules are just the same and the engine is run under the same orders. The thing is important to us, for the reason that in New York city we are every day hiring men as motormen and they come from all parts of the United States. We have a school of examination and instruction in which these matters are gone over thoroughly, and it is the most surprising thing to find what a diversity there is in regulations in cities and states that border on each other with reference to questions concerning which there should be no difference whatever, any more than the question of running a locomotive.

The next subject, "Comparative Merits of Single and Double-Truck Cars for City Service," by Mr. John I. Beggs, Milwaukee Electric Railway and Light Company, Milwaukee, Wis., was taken up. Mr. Beggs had not prepared a paper, but as he was present he gave his views on the subject, saying:

This subject has been so thoroughly threshed out in the last seven years that there does not seem to be much left to say upon it, as it appears that most men charged with the operation of large systems have been forced, almost, to the use of double-truck cars, even for heavy city service. The principal points of advantage to result from the use of double-truck cars are, in the first place, a much higher speed, of which the public receives the benefit. As soon as the public realizes that it does not seriously affect the street railway company to have its cars obstructed, but that it is the people on the car who are discommoded, the public will awaken to the fact that it is up to them to get a better condition of affairs; so that in running double-truck cars the first point is the smooth and comfortable riding of the passenger, as compared with the single-truck car, with the great oscillation sometimes experienced running over a track which in indifferently maintained. The track may be really twice as bad, but to the riding public it would not be evident in a double-truck car. The next thing is that the large double-truck car, equipped with four motors, one on each axle, which is our practice and has been for six or seven years, enables the car to be accelerated much quicker; in other words, in many of our cities the blocks are only 300 or 400 feet long, some shorter than that. If we follow out the rules as laid out in the usual book of rules, you would not get a street car up to speed between crossings. By the time you left one crossing and used the regulation method of feeding a car, it would not be up to speed by the time it got to the next crosswalk, the consequence being the general public is delayed, and you are not giving them rapid transit. The car is limited as to the number of trips it can make over a line during the day and consequently the cost of operation is unnecessarily increased. The quicker acceleration means higher average speed; in other words, I believe that it is applicable in most cities, even where there is pretty dense traffic—I am not referring to Broadway, New York, the conditions there are unusual—but on our city lines, where traffic is sometimes quite dense, we maintain an average schedule speed of nine miles an hour, with the large seating cars you are enabled, because of the greater seating capacity, to

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maintain long headway on the lines and still take care of the traveling public. Longer headway means less car-miles and less car-hours and less trainmen, and that your trainmen are performing more service for the company, and thereby reducing the cost per car-hour or car-mile for trainmen alone. The consumption of power is possibly increased, yet not more than would be necessary, in all probbility, to put the same number of single-truck cars, with two-motor equipment, in operation. Then the cost of track repair and maintenance is less, as we discovered after an experience of seven years with double-truck cars, which run smoother, than it is with single-truck cars.

These are the principal points which seven years of use and the adoption of heavy-truck cars as standard, has brought out, and which in our experience have been more than satisfactory. We several years ago established as a standard a large double-truck car, fitted with cross seats, seating forty-four passengers. They have a capacity, when passengers stand, of over 100. These are the reasons for our maintaining that it is much more advantageous, both to the general public and the operating company, to maintain and operate large double-truck cars equipped with a motor on each axle, and with a motor of sufficient capacity to warrant you in quickly accelerating the car and getting it up to speed within about 200 feet, so that you are able to make the average speed of the car with the usual number of stops, of about nine miles an hour.

The next business in order was the report of the committee on rules for the government of employés, of which Mr. E. G. Connette, of Syracuse, was chairman.

The committee on rules for the government of employés included Messrs. E. G. Connette, T. E. Mitten, W. E. Harrington and Richard McCulloch. The report is divided into general rules, rules for conductors, rules for motormen, signals and their application, ejectments, fares and transfers, interurban rules, definitions, visible signals, audible signals, and use of signals. A series of twenty-four plates in colors shows the correct positions of conductor in giving signals, the proper equipment of trains and cars for both day and night signals, both for forward and rear-end signaling.

Mr. Connette: Mr. Chairman, the report of the rules committee has been printed and distributed among the members of this association, and the members have had the report in their possession long enough to know what it contains without my undertaking to read any portion of it. The committee, of course, in undertaking to compile a standard code of rules, met with more difficulties than any of you would imagine. For instance, when we undertook to make a rule that was applicable to the small roads as well as to the very large roads, in a good many cases we encountered serious difficulty. We have, therefore, only presented to you a code of rules general in their nature, applicable only to conductors and motormen, because they are the employés principally to whom the rules apply. A rule that will apply to a motorman and conductor running upon a small road can also be applied to one similarly employed upon a large road. The rules pertaining to interurban service, I am free to say, were practically confiscated from the rules of the American Railway Association, which is composed of the steam railroads, and the rules which are in effect upon steam railroads are the result of years of experience and study—we believe of over twenty-five, perhaps forty years' experience—and the committee did not think it could compile a set of rules which would be an improvement on the rules which were adopted and are now in effect upon the various steam railroads of the country, especially so far as the movement of trains is concerned and the use of signals.

I am now going to diverge just a little from the report. I brought this question up before the committee, but it was deemed to be perhaps not within its scope to embrace a suggestion of the plan which I am about to make, and that is upon long interurban lines, single track lines, that it is better practice, or it would be better practice when it was adopted, that instead of running more cars, separate cars, or changing the headway as the business fluctuates, it would be better to maintain a uniform schedule of headway and use the multiple control system and increase the length of the train as the business may require it, instead of changing the headway or instead of running cars in sections. In my opinion this method of operation would be more satisfactory from several standpoints: first, less liability of accident, which is a great factor in the operation of cars; second, it would reduce the expense of operation so far as the platform expense goes; third, it would take care of the traveling public, I believe, in a more satisfactory manner, because if the schedule is thirty minutes' headway on an interurban line, and that schedule is uniformly maintained, no matter what the business may be, whether you carry 1,000 or tens of thousands of people daily, instead of changing it to meet fluctuating conditions, maintain it rigidly so that the public will know that a car will be at a given point at a given time and ample cars will be provided and if one is insufficient put on two, three or four, and make the same time as you would with one, on the multiple control system, the same as the system by which the trains on the elevated roads in New York are operated. I put this out as an opinion of my own. I believe the interurban roads will come to it, and run trains as steam roads run trains, not only one car, and if a little more demand for service is made to run out another car and run it as a second section; but the cars will be run in trains. I believe the running of separate cars to meet increased demands will be done away with ultimately and that we will adhere to the timetable instead of changing the headway and mixing up the motormen and conductors and multiplying the duties of the train despatcher and getting his head balled up and causing accidents, at least increasing the hazard of them, the danger would be reduced to a minimum, and I believe the service in every respect would be the more appreciated by the public.

You will note the report of the committee in regard to the signals for interurban lines. I have said that we practically confiscated the rules and regulations of the American Railway Association. I may say that we changed the signals, not in respect to color, but instead of using flags, as is used by steam roads, we use the colored plate hanging over the dash of the car. That was done for several reasons: In the first place, when a flag is stuck on the back end of a car while the car is running it is difficult for a motorman on an approaching car to distinguish what the signal is until he has passed by it, whereas with the signal on the front of the car he sees it and notices whether it is the regular car, a section of the regular car, or an extra car.

After slight amendment the report of the committee was adopted.

The Chairman: The special committee appointed at the session yesterday to consider the matter of furnishing reports to the press is ready to report. The secretary will present the report.

The secretary read the following:

To the American Street Railway Association.

Gentlemen—Your special committee, after duly considering the question of the revision of papers and discussions prior to publication, reports as follows:

We recognize the importance and desirability of encouraging and securing a comprehensive and even confidential discussion of topics presented before the association.

We also recognize the importance and utility of the press and the desirability of not unduly restricting its privileges.

We are of the opinion that the realization of these two objects necessitates intelligent censorship of the proceedings. We recommend for adoption the following rules:

First, upon the request of any delegate, any remarks or data submitted by him shall be considered privileged communications and withheld from publication in both the press and the annual report.

Second, at the first session of each meeting of the association the chairman shall appoint from the delegates in attendance a censorship committee of three members. All reports of proceedings shall be submitted to this committee and approved by at least one member thereof before being made accessible to the press.

So far as possible all persons partici-

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pating in the discussion shall be given an opportunity by the committee to revise and correct their remarks before publication. The committee also recommends that, to promote the best interests of the association, the technical press be respectfully requested to refrain from the daily publication of the proceedings.

Respectfully submitted,
C. O. Mailloux,
John I. Beggs,
J. G. White.

The report of the committee was adopted and approved.

Mr. Beggs offered the following resolution:

Resolved, That the president of this association be requested to appoint a committee of three members to confer with the so-called "steel rail pool," to obtain, if possible, a discontinuance of or material reduction in the differential charged for high tee girder and grooved rails used in street railway construction.

Mr. W. K. Morley offered the following resolution:

Resolved, That the name of this association be and is hereby changed from "The American Street Railway Association" to "The American Electric Railway Association."

On motion the resolution was referred to the executive committee.

The chair announced the appointment of the following committee on compensation for carrying the mails: Messrs. Grant, of St. Louis, chairman; Beggs, of Milwaukee; Rogers, of Binghamton.

The report of the committee on nominations was presented as follows:

President, W. Caryl Ely, president International Railway Company, Buffalo, N. Y.

First vice-president, Elwin C. Foster, president New Orleans Railways Company, New Orleans, La.

Second vice-president, John Grant, general superintendent St. Louis Transit Company, St. Louis, Mo.

Third vice-president, James F. Shaw, president Boston & Worcester Street Railway Company, Boston, Mass.

Secretary and treasurer, T. C. Pennington, treasurer Chicago City Railway, Chicago, Ill.

EXECUTIVE COMMITTEE.

President and vice-presidents.

Jere C. Hutchins, president Detroit United Railway, Detroit, Mich.

A. B. Colvin, president Hudson Valley Railway Company, Glens Falls, N. Y.

G. Tracy Rogers, president Binghamton Railway Company, Binghamton, N. Y.

W. A. Smith, general manager Omaha & Council Bluffs Railway Company, Omaha, Neb.

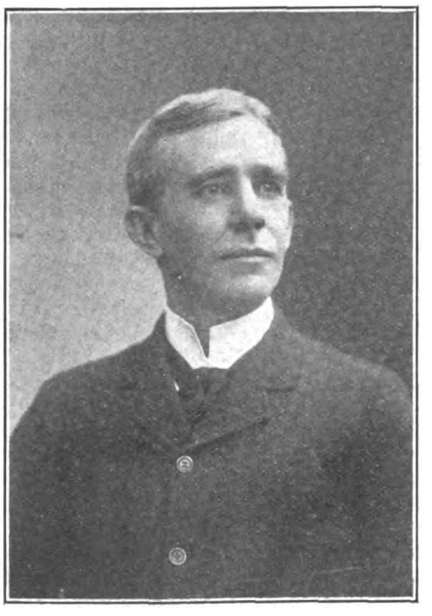
S. L. Nelson, vice-president and general manager Fort Wayne & South Western Traction Company, Fort Wayne, Ind.

The committee has received but one invitation for a place for holding the next annual meeting. The Mayor, secretary of the Chamber of Commerce and one business man of Chattanooga, Tenn., have extended an invitation to the association to meet in their city next year.

Mr. W. Caryl Ely, President American Street Railway Association.

On motion, the secretary was authorized to cast a ballot for the gentlemen named as the officers of the association.

On motion, the question of a place for the next meeting was referred to the executive committee.



Mr. J. C. Hutchins, Retiring President American Street Railway Association.

The committee on resolutions reported the following:

Resolved, That a vote of thanks of this association be given to the officers and executive committee for the able manner in which the affairs of the association have been conducted the past year.

Resolved, That a vote of thanks be extended to the General Electric Company for the excursion and luncheon and cordial reception given to the delegates and their friends at Schenectady.

Resolved, That a vote of thanks be given to the Hudson Valley Railway Company for courtesies extended to this association.

Also to the Schenectady Railway, the United Railway Company, of Albany, the telephone and telegraph companies, the local committee of arrangements and the railroad passenger associations for courtesies extended to us.

Resolved, That a vote of thanks be given to the supplymen for the splendid exhibit given the delegates of this association.

The above resolutions were unanimously carried.

President Ely: Gentlemen of the convention, I desire to return to you my sincere thanks for the very great honor which you have conferred upon me in electing me president of the association. I accept the place with a full realization of the responsibility. I deem it a position of great responsibility. I will endeavor, with the help of the other officers and the executive committee, and all concerned, the supplymen, all who are concerned in the welfare of the association and the business represented by it, to devote such an amount of whatever of ability and energy I may be possessed of, together with a sufficient amount of time, in an earnest endeavor to bring about good results during the next year.

While returning thanks, I wish to say that in the Census Bureau report upon our industry, it is stated that there are 987 companies in the United States engaged in the street railway business, and of that number we have 206. Of course, that is a large membership, but it would seem as though we ought to have more than twenty or twenty-five per cent of the companies represented in this organization, when it must be conceded by all that the benefits of association are so great; and it would seem that we might make a much larger addition to our membership during the coming year if we would all be mindful of it, and when we meet our neighbors who are not members of the association suggest to them the benefits and advantages of membership. I know that the executive committee, the vice-presidents and the secretary of the association will make a very determined effort along these lines during the coming year.

The meeting then adjourned to reassemble at the banquet at 9 o'clock in the evening.

There was a number of exhibits at convention headquarters. These were viewed with great interest and are worthy of further mention. A description and list of representatives present will be found on pages 381, 382 and 383 of this issue of the Electrical Review.

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The American Railway Mechanical and Electrical Association.

Annual Convention at Saratoga Springs, N. Y., September 1, 2, 3 and 4, 1903.

THE convention of the American Railway Mechanical and Electrical Association held at Saratoga Springs, N. Y., September 1, 2, 3 and 4, was called to order by President Thomas Farmer at 10.45 A. M.,Tuesday, September 1. Mr. Farmer introduced Mr. Joseph P. Brennan, the village attorney of Saratoga Springs, who delivered the welcoming address.

In the behalf of the association, President Farmer expressed thanks to Mr. Brennan for his remarks. After roll call the minutes of previous meetings were read, and a communication from Mr. H. H. Adams, superintendent of shops of the United Railways and Electric Company, of Baltimore, Md., and a communication from Mr. E. F. Peck, general manager of the Schenectady Railway Company, inviting the members and delegates of the association to make use of its lines in Schenectady, Albany and Troy during the convention, were read.

The secretary, Mr. Walter Mower, read the report of the executive committee, which detailed the organization of the association and the bonding of the secretary-treasurer.

The secretary-treasurer presented his report showing a list of active members numbering twenty-one, three honorary members, twenty-seven associate members, and thirty-four junior members, making a total of eighty-five. The dues from the active members to September 1, amounted to $420; from the associate members, $135, from the junior members, $102, making a total of $657.

The disbursements to September 1 were $176.77, leaving a balance on hand of $480.23.

After reading by the secretary of the list of members of the association, president Farmer called for a discussion on the best way to increase the membership, stating that although everything had been very well up to the present time, he desired that more progress should be made. This subject was discussed at length by Messrs. Olds, Mundy and Green.

The president stated that at the meeting of the executive committee prior to the opening session, it was suggested that the members of the organization get in touch with the American Street Railway Association. This was discussed by Messrs. Olds and Baker, and following this a paper by Mr. C. F. Baker, of Boston, on the "Care and Maintenance of Car Bodies," was read. This paper brought out a prolonged discussion and a number of the members of the association contributed liberally ideas from technical points of view.

Mr. Baker presented a splendid summary of the practice of maintenance of car bodies in his short paper. He spoke of the care which must be taken by the operator to keep the car clear of danger, and of the detail which must be exercised in preparing the specifications looking to accommodating the car to the service in which it is to operate. He took up the question of workmanship, the material to be used and the attention and inspection which should be given each car. He took up the question of dry wiping as against washing with water and soap, and explained in detail the process which he had found satisfactory in repainting and rehabilitating old cars, giving the constituents and quantities of material which were used in the renovating process.

Mr. John Lindall brought up the question of car insulation, saying: "There is something which interests me very much just now on account of the recent disaster in the Paris tunnel, and that is the fireproofing of cars. I think that might be taken up in connection with this paper. We try to make the elevated cars as fireproof as possible, and have the motor end of the car underneath covered with asbestos and galvanized iron. On account of some trouble we have had on account of fire igniting through the light switches, etc., we have put asbestos mats under the switches and stripped the insulation off the wire back six or eight inches and put on asbestos stockings. We are also contemplating extending that to the light sockets on new equipment. I believe there has been some discussion among the underwriters in regard to putting the wiring in the cars in conduits. I should very much like to hear that proposition discussed at this meeting."

Mr. Green: "I rather think that the electrical interests in the state of New York are up against the fire underwriters more than in any place in the country, that I know of. In regard to the use of asbestos for preventing fire, I will say that when we used the old-style rheostat, and when we had the old, short, contact boards and such things we tried that asbestos plan, and found it one of the most dangerous things we ever used. We got the asbestos cardboard and fastened it to the floor of the car, covered it with sheet iron and fastened the rheostat to that. We found the asbestos would not only hold moisture and take up all that came along, but when it got hot, and the iron got hot and heated the asbestos, the asbestos held the heat long enough to set fire to the car on several occasions. It is, in my opinion, a most dangerous thing to use where you have any amount of heat. In regard to the wiring of cars, it is certainly for the railway companies to improve on our mode of wiring, especially where the climate is such as we have in Rochester, where we have about six months in the year slush and mud, and where we use salt in the switches and you can not keep the salt away from the wires. The moisture seems to work through every crevice in the car where you have the cables. In that case it is very necessary that the car wires eventually shall be put into a conduit, not for the benefit of the underwriters as much as for the benefit of the railway companies themselves. We are now getting away from the use of the old-style rheostat so that we have something from which the heat can radiate and keep the rheostat cool. I do not think we will ever be able to get up any kind of an apparatus whereby you can teach your motorman not to run on any part of the rheostat. They will run on it and get it so hot that they will simply burn it up. You ask the motorman why he did it and he will tell you that the car was in that condition when he took it out. That is what you are up against. There is nothing, however, that could persuade me to use asbestos under any consideration."

Mr. Farmer said: "We have had trouble in Detroit with our snow-plow cables. We use salt in the tracks and after every storm—we have eight ordinary snow-plows, five or six of the snow-plows come in with the cables burned out. We took some inch and a half, inside diameter, lead pipe and made junction points at the proper place with small lead pipe leading into the larger lead pipe and put all the cables into those pipes. We have not had a car come in in four years. It is expensive, but it is an absolute protection. As to the asbestos proposition, I would state that all the cars in Detroit are heated with a stove in the centre of the car. They set in a box which is lined with asbestos inside and iron outside. We have had a great many fires in the interior of cars caused by the non-protection of the asbestos. Lately we have used merely sheet iron with a good big air space and that air space is well ventilated, both top and bottom; a good circulation of air through the box is better than any insulating material."

During the discussion, Mr. Farmer asked Mr. Baker what was done when the iron binding projected above the running board. Mr. Baker replied that, in his opinion, it was better to put on a new running board immediately, rather than have an accident which might result from a projecting iron.

Speaking of the trouble from fires, Mr.

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W. D. Wright said: "We had one quite serious fire that I am satisfied was started by heater wire, side-seat car; the car was in the repair house not many minutes before the fire started. I think it was started by a small rubber-covered wire connected with the heater becoming moist to the breaking point and finally, from some little jar, it gave way and the heater circuit happened to be on. When you opened the series circuit the rubber-covered wire would not stand it, and I am satisfied the fire started in that way. One of the first things we did to guard against fire was to stop the use of a solid conductor, especially in the smaller sizes, and for our lighting and heater circuits we use nothing but stranded wire which will not become nicked and break off inside the insulation sometimes. Inside, under the seats, we go still further and in our heater wiring use a slow-burning cover, the same as is used in houses, and get the rubber out of the way. We use nothing but stranded wire. In order to avoid trouble from the cables, due to water under the car, we adopted a plan of putting our cables as much as possible above board, even in the cross-seat cars, having a conduit for them along the side and making all taps to the cables above the floor. That seems to be the weak point of the car cables underneath the floor; and we make all taps above the floor and bring the wires from the floor through porcelain or clay tubes and not cleated to the inside of the car body; and we use a porcelain knob that will hold two wires, designed to take different sized wires. We put two wires on one knob. The idea was to give an air space around the wire which would be better than any tube you could put on. The wheels can throw water on these knobs, but they will dry off sooner, and they also prevent the lodging of mud which holds the moisture, and which affects the wood work all the time. Eliminate all these points if possible. Sometimes for resistance we bring a whole bunch of resistance wires, six or seven, in a separate cable; these are in the centre of the car and not subject to the water from the wheels, and you can protect them better. When we come to the centre line of the car-motor leads, the resistance leads are in position where they can be cleated safely in carrying the wire around the resistance boxes. In the first place we lower the leads and get them down over the car floor, and in carrying lead wires to the resistance box we never carry a wire with a rubber covering on it from one box to another or between boxes. We cut off the insulation and leave a part of the wire bare; leave it so that it can have air space. If it is necessary to insulate it, we put on a piece of porcelain or clay tube. Of course the trouble is that we have to go out of the car body somewhere. In the case of a box car, the car which gives the most trouble from water, we have been using a two-inch pipe where we go out at the corner of the car, using a forty-five-degree L, and use that pipe to go from above the floor down to a point where you would branch off and run under the platform to the controller. It pays to follow out these little details. If a thing gives trouble, get at it and see if you can not cure the trouble; we are very free from troubles due to our wiring. The insurance people are taking the matter up, and a member of the New England Insurance Exchange, with whom I am well acquainted, was down to see us to get our ideas on the matter of car wiring. I could see what they were aiming at—to get car wiring on the same basis as house wiring; that is, to have it in metal conduits, leading all the wires to the centre of the car and having branch ducts to bring out the leads. That is all good in a way and in the right direction; but I told the gentleman I could not see, from our experience in the present way of handling wires, but what we were free enough from troubles due to the wiring to feel practically safe. I do not believe in using asbestos unless you keep it where it is absolutely dry."

Mr. Ballard: "On the Boston Elevated we have experienced a little with lead cable; we have only four cars running with that cable. We took our motor leads and encased them with one and one-quarter inch lead pipe, the pipe coming up under the seat and carrying it directly over the motors. The cables are not encased in lead; only the leads. The cables are encased in linen holes and fastened up under the seat. The taps are made in the cable. For a great many years we had much trouble with the leads parting at the brush-holder or other points and taking fire and setting fire to the car underneath the seat. There is a fireproof wire brought out—made by two concerns, the Okonite Company and Washburn & Moen Company—which we use entirely on our leads, field leads, bumper leads and the taps that run to the resistance boxes. We never had a case where the fire would run more than three inches on the wire. It is impossible to burn it with a torch. There is a coating outside of it which is practically waterproof, and it is impossible to set it on fire, and we have not had a case where we have had a wire take fire and carry the wire under the seat of the car or carry it under the seat for any distance whatever; it is impossible to do it. I prevailed upon our company to get some fireproof covering for wire; we tried many thousand feet of it before we succeeded in getting the right kind, but we now have a fireproof wire that is the best thing to use on all leads to the resistance box and the motor."

Mr. Farmer said: "Where we take the taps off, we wipe the joints the same as a plumber would, so as to make them nice and smooth. We never have had a cable down since they have been put up according to these plans. These cables are on the snow-plows, the only cars we have tried them on."

Mr. E. W. Olds: "Our method of car construction is a little different from some others. We have two sills running through the full length of our cars, that are placed six inches apart, and the space between these sills is separated by a small cast-iron box, which gives a space in between these sills. Our cables are run in between them. As you come to four-motor equipment, the leads are taken out from that hose, through the sill, dropped directly to the motor, which is inside hung, on the other side of your body bolster. By so doing they are absolutely protected from the water, and the lead being very short is not injured by the swinging of the trucks. We have been using this method for about seven years, and have found it very successful. In fact, the only short-circuits we have had in any of our cables have been caused by very hot resistances, or in a few cases at the trap door where the cleaners have allowed the mud and dirt to accumulate and in very wet weather this causes a short-circuit of the wiring in the hose. At the ends of the car we used two centre platform leads coming up directly under the sill, the cables being passed in between these in the same way. Our knee-plate has an oblong hole large enough to allow the two cables to pass through that hole, pass through the lead at the left, nearly under where the motorman stands, directly to the controller, and we have found that very successful."

Mr. Ballard: "I ask the members if in car wiring they have used any method of keeping the wires separated where they go into the controller underneath the car platform, whether they put them in one post or two posts. We have had a great deal of trouble with moisture getting in from the platform and getting into the cables, and the cables being short-circuited a foot or two from the controller on either platform. In our last lot of cars we have taken the wires out of the holes entirely and run them separately, and they do not arc if the water gets near them."

Mr. Pestell: "When we get the water guard on, we are pretty careful to get it tight, and underneath the car, at the right hand of the bumper sill, we put a canvas around the cable where it comes out, nailing it on in good shape and keep it painted, and that takes the washing of the water away from the cable. The place we find they burn is where the bend comes in the cable underneath the sill. We protect that so as to keep the dust out of the controller and keep the water from getting on the cables at that point."

Mr. Mundy: "We have had some trouble in the grounding of cables, but most most of it occurred in summer cars on which the car company put the cable in. We were using at that time rubber-lined hose. They cut the hose level with the top of the floor, so that the water got into the hose and ran down it. We found if we ripped the hose open for about three feet, retaped it providing an opening so that the water could get out after it got in, the wires dried themselves off, and we stopped the short-circuit. On

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our ordinary work we run the hose three inches above the floor and set the controller on a wooden block so that the hose keeps the water from getting in. We find it better to split the hose and retape it so that any water which gets in will work out of the hose, owing to the split."

On motion, the meeting adjourned until 2.30 P. M.

AFTERNOON SESSION.

President Farmer called the meeting to order at 2.45 P. M.

Mr. Green: "Mr. President, I would like to bring up the question of the time of the meeting of our next convention. Of course, our meetings will always be held at the same time as those of the National Association, but it seems to me that it would be a great deal better for us if we could get together two days in advance of the National association. My reason for proposing that is, that I feel that if we do that we are going to get a great many more master mechanics at our meetings, because it will give them an opportunity to come and attend the convention and get the full benefit of the papers and discussions of both associations."

On motion it was decided to hold the meeting of the association two days in advance of the meeting of the American Street Railway Association, at the same place, and that there would be three sessions a day instead of two.

After considerable discussion of the question of membership of persons outside of mechanical departments, Mr. E. W. Olds presented a paper on "Improvements in Street Car Motors."

Mr. Olds stated that in order to meet the demands of to-day the service must be rapid, reliable and safe. Nearly all of the motors now designed, he said, are arranged to open at the bottom, doing practically all the repair work in the pit. In repairing double-truck car equipments, it has been found more satisfactory to lift the car body from the track, making is possible to do all of the repair work from the top. To do this, the top of all the motor frames should be designed to lift off, giving access to the armature bearings, fields, brush-holders, etc. He dwelt upon the dimensions of the gears and said these have not been increased in proportion to the motors. The life of the present gears, he said, is from eighteen to twenty-four months, and pinions from twelve to eighteen months. This, he said, should be increased 100 per cent. The desirability of using split or solid axle gears is an open question, each having its advantages and disadvantages. If split gears are used the bolts should be made larger and provided with nut locks and double nuts and cotters, making it impossible for them to become loose and fall out. The gear casing should be cast as a part of the lower half of the motor frame. The armature bearings should be longer and larger with linings that may be easily removed, and either rebabbitted or renewed. Improvements should be made in the insulation of the magnet wire used for both field and armature coils.

Mr. Pestell asked if any changes had been made in regard to bringing the leads out on either side, so as to bring the leads into the centre of the truck.

Mr. Olds: "When we ordered the motors for the cars, we had the leads changed and brought out on the axle side. We have but twenty cars with the outside hung motors, and these have the leads coming out on the axle side. They are G. E.-1,000 motors and were built in that way for us."

Mr. Pestell: "We have many trucks with the motors hung outside and the lead troubles have been reduced fifty per cent by bringing the leads on the opposite side. It occurred to me, in ordering new motors, it would be well to have holes drilled, and then plugged, so that you could use the motors either way."

Mr. Mundy: "We have gone into the motor proposition and are having some new motors built. I talked this matter over with Mr. Olds, and we placed an order. We had the privilege of pretty nearly deciding what we wanted. We carried his ideas perhaps a little further than he has done. Our motors are all outside hung and the leads brought out on the axle side. We have not only increased the bolts in the gear, but have the motors arranged so that we can use solid gear for small motors, as small as forty horse-power. As far as bringing the leads out is concerned, the company decided it would put in bushings on both sides and plug the side which was not to be used. These motors are Westinghouse. We have had some motors from the General Electric Company with the leads coming out on the axle side, and in that case we simply drill one side."

Mr. Blake: "I believe the Union Traction Company of Indiana is using solid gears. I know it is at the present time, and it has used solid gears on Westinghouse 125 ever since it started. I have been in its shops and talked with Mr. Anderson, and the last time I was down there he had two or three motors on the floor. He said he liked the solid gear very much; if anything better than he did the split gear. It only used two motors, equipped on one end of the car."

The President: "In the use of the solid gear on some of our axles, the hub goes right against the hub of the wheel. Most of us have 100-ton pressure, and we have found that we do not dare to press them off, the gear and wheel together, with a 100-ton press. We have had to split the gear, drill holes into it and split it, before we dared to shove them off together. If we try to shove them off together with a 100-ton press we would break the press. For this reason a short time ago I advised the purchase of a 200-ton press, so as to be able to shove them both at once. There is no way of getting presses in between them."

Mr. Green: "What I wanted to ask Mr. Baker especially was, what are they doing in Boston in regard to lubrication? Are they using oil or grease? I will tell you why I ask that question. We have gone to the oil entirely in Rochester. I do not know what results we are going to have when we come to cold spells—it may tell a different story—but we find that with the oil lubrication we are getting most excellent results. It seems to be a different thing entirely with your armature shafts and axles, your outside bearings, your truck bearings, on all the motors, G800, 67, G6,000, Westinghouse 3. We oil with a feed cup we get from Columbus. We are experimenting with a cup of our own and one from the Standard Oil Company. We are getting elegant results. In greasing your outside bearings, your grease gets to the back part of the box and collects dirt and dust from the street, and it hangs to that grease and just forms a perfect emery wheel on the axle, gets it out of tune and cuts it, and that dirt keeps working back into the grease if you do not watch it very closely. With the oil we find our brasses are giving us better results, and on our busiest days, where we run the eighty-mile round trip to Sodus Point and back, we never think of having a hot journal or hot brasses of any description. Our axle bearings are all babbitt."

Mr. Pastell: "What is the comparative cost of lubrication as between oil and grease?"

Mr. Green: "Up to date we have not been able to go into it deep enough to be able to tell; but this much I can say to the present time, that the improvement in the shafts and bearings all around and the cutting down of the number of boxes that we have had to babbitt, from the time we have started in with oil—the babbitting alone has dropped down more than one-half—and on our busiest days, with our long trips to Charlotte and Summerville, and the cars going out in the morning with no inspectors to take care of those things, you can smell sulphur for ten miles and what you save on those busy days alone will pay the increased cost of the oil, if there be any, without taking into consideration the benefit you get to your bearings."

In the absence of Mr. H. H. Adams, the president read the paper on "Shop Kinks."

In this paper Mr. Adams stated that in visiting the repair shops on different roads, he found that each shop had its individual kinks, and he also noticed that it was not necessarily the shop of the

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large roads that had the best kinks, and that he frequently had seen the best ideas in the shops of some of the smaller roads. The first device to which he called attention was the sand blast. While this was an old device, he desired to submit the arrangement installed on his repair shop and described the work done in connection with glasswork, particularly as applied to signs. Figures were shown illustrating the apparatus. The repair shop is supplied with compressed air at a pressure of eighty pounds, and by means of a reducing valve the working pressure for the sand blast is reduced to ten pounds. The method pursued in grinding or frosting glass was as follows: The glass to be grounded or frosted is placed in an enclosed house or box, the air pressure is then turned on, care being taken to remove all moisture from the air by draining the pipes leading to the sand blast previous to starting operations. The sand valve is then opened and the blast from the end of the nozzle directed against the glass passing over it until the surface is ground. The time required to grind a glass six inches by forty inches on one side only, is three minutes. A further use for this apparatus is in making chipped glass, which is used so extensively in the cars of to-day. This is done as follows: A glass to be chipped is ground on one side only. This is then covered with hot glue, and the same is allowed to dry. As it dries, the glue will chip the grinding from the surface of the glass, and will produce the effect desired. A device for cutting dashers for headlights was shown, illustrations being distributed to give a graphic idea of the apparatus. An arrangement for unloading cars was shown and an armature described and illustrated. Mr. Adams gave considerable attention to the question of reinsulating fields and also to induction tests for short-circuits.

The President: "With regard to the glass question, I would like to ask if it is necessary to have two sand glasses to make the glue do its work? In our case, at home, we take plain glass and put the glue on, and it will fit it every time if the glue is good."

Mr. Green: "We do not use any sand glass, Mr. President."

Mr. Bigelow: "A friend of mine, connected with the Boston & Maine, described to me a simple arrangement they had in which they had a box, the top covered with plush and about a two-inch hole through it, and a sand pipe discharging directly underneath this hole, from a pipe about one and one-half inches in diameter, and they moved the glass around on top of this plush as the writer describes. If they wanted it to come up to the edge of the glass they would put another piece of glass or cloth against it. They had no trouble with dust blowing. There was a reservoir for the sand at the side of this box and the sand dropped into the pipe from that, the same as the writer describes, with a forty-five-degree fitting, and then the sand dropped to the bottom of the box. The box was beveled."

The President: "When you form a field, after it is wound have you had any trouble with the insulation being destroyed, when you form it in the wheel press?"

Mr. Green: "We do not form a field."

The President: "In forming fields we wind with new wire, but do not use insulated wire."

Mr. Mundy: "That is the reason we have not been able to reinsulate No. 56 fields."

The President: "We used new wire, as we found in forming them up it would destroy the tape."

Mr. Olds: "Mr. Mundy gave his method of reinsulating the field, which is practically the same as Mr. Adams's. I have seen the work done in Mr. Adams's shop. so that I simply got his method, which is practically the same at the start as that of Mr. Mundy, except that the cleaning of the old insulation from the wire and the winding of the tape is all done by girls and women. He told me he found them better workers, and that they did the work neater, and after they were broken into the work they would stay by it, whereas a man would wish to advance himself to something higher. I saw some fields that he had when I was at the works last fall, that had been put in shape that certainly looked as neat as anything I had ever seen in that line."

Mr. Mundy: "By using six men we can get eight fields per day on the basis on which we work. To overcome the possibility of a man being careless in getting the tape on—of course we have to put them somewhat in the press to bring them down tight—I transform all fields, and if the man has been careless and there is a tendency to break down the transformer breaks down. If it does, I then open the field and reinsulate the place that gives the trouble. I do that with all fields that have not the glass spools upon them."

Mr. Baker: "Mr. Lindall can give us a few shop kinks in regard to steel-tired wheels. We have had to take our wheels out and grind them about every two weeks."

Mr. John Lindall: "Owing to our severe conditions, curves, etc., in Boston, we wear out the steel-tired wheels very rapidly. The road has been running now something like two years, and we have replaced something over 200 pairs of tires in that time. The way we do it is we have a gas heater. After the wheel is taken out, we heat up the old tire until it drops off. Then with a large lathe we bore out a new tire to a shrinkage fit, allowing about thirty-one one-thousandths of an inch in a thirty-three inch tire. We heat it with a gas heater. The heater is arranged so we can drop the wheel into it, and we can take off a tire in six minutes with the heater. It takes ten minutes to heat a new tire so that we can drop the wheel in it. In this way it costs us about $2 a wheel for changing the tires."

Mr. Pestell: "We are using a little scheme for regrinding engineer's air-brake valves that may be of some interest, using a small motor with a little fine wheel on it mounted to the post of a lathe, and mounting the valve seat in the lathe, revolving the valve seat, and then running this motor right across the face of it and finishing it up in two or three minutes. We have a hardened steel head for grinding the disc, a small hole to take the stud on the face of the disc, and put in ground glass and oil between the two faces, and face off the disc in a very short time, after which it is simply a matter of grinding the tube together."

The president appointed the following gentlemen as a committee on nominations, the election of officers to occur at the last session of the convention: Messrs. Olds, Green, Baker, Mundy and Mullen.

WEDNESDAY SESSION.

The convention was called to order at 10:30 and a paper on "Car Shop Practices," by Alfred Green, master mechanic of the Rochester Railway Company, Rochester, N. Y., was read.

Mr. Green described the plan of the Rochester Railway Company and some of the practices in vogue there. He described the types of machinery used and the placement of each piece of apparatus.

Mr. Bigelow: "Showing the necessity of a rigid inspection and also the power lost in tight brakes, a case that came under my observation recently might be interesting. We were making tests on some cars. We had a twenty-five-foot box-car loaded so as to weigh about 36,000 pounds, equipped with four motors and it had hand brakes. We had run the car through the early evening slowly, making numerous stops and everything had worked all right. The brakes appeared to be loose, if anything. We started on a speed run and the brakes appeared to be tight. At the end of the run we examined and found the brake shoes and wheels very warm. On further examination we found the trouble to be the large link at the end of the brake chain had become jammed into the hook at the end of the brake rod in such a manner as to shorten the chain and jammed in so tight it took several blows of the hammer to loosen it. On making the second trip, made under the same conditions and same direction, the results were quite interesting. The length of the run was five miles and we made the first trip with tight shoes, making fifteen stops of about ten seconds duration in twenty-three minutes and forty-five seconds. The second trip, same conditions and same direction, was made in twenty-one minutes and three seconds, a difference of twelve per cent in running

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time. One less stop was made and the correction has been made for this stop. But the difference in power consumption is still more interesting. We took ten-second readings of amperes and voltage. The power consumption of the first trip was 216 watt-hours per ton-mile, and the second run, 140, a difference of fifty-four per cent in power consumption, this difference being caused simply from tight brake shoes. I think that will show we have an unsuspected loss in power consumption, being caused by tight brake shoes, and also, I believe, one of the papers speaks of controlling speed of cars by not shutting off the power but by using the brake. I believe that would give a very high loss."

Mr. Hile: "It has been my business to look after the overhead line. Perhaps you won't see the connection between car inspection and what I am going to say, but I would like to enquire if any of you have any method in regard to inspection of overhead poles, trolley bases and trolley harps and sills. We are having a good many lines coming in over our line and I can see poles bent in every direction and that necessarily leads to considerable trouble on the overhead line, and it strikes me that there are a great many that don't give much attention to that and so many things can occur about a trolley post or harp that will lead to the pulling down of the wire, making stopping of traffic and perhaps accident. I have not heard anything bearing on that matter. It may be too small from your point of view to deserve consideration, but it strikes me that it is nevertheless deserving of some thought as to whether you have a method of keeping a certain tension on the wire and what attention is paid to a motorman or conductor reporting that his trolley is coming off. You may say it is the fault of the overhead line, and he goes out again and at pretty nearly every corner his trolley is flying off, and it may mean an accident, and does mean inconvenience. When you take a wheel off or run along until a wheel splits and then run along on the bearing, that means they are liable to pull down the trolley. And the same with a pole that is badly bent; then the base may get out. You know a car with standing around, there may be some little hitch and when it comes to a crotch it leaves the wire. The switchman or the street inspector calls out the gang. It is the overhead wire and they come and can not see anything wrong, and they watch car after car go over, may be one hundred or fifty cars, and nothing happens, and this car comes along and goes off and every time it goes over the line.

The next paper was presented by Mr. W. O. Mundy on "Type M Control."

Mr. Mundy described the apparatus designated as "Type M," manufactured by the General Electric Company, Schenectady, N. Y., and which is used by the Manhattan Elevated and adopted by the Interborough companies of New York city, and the Chicago, Aurora and Wheaton and a number of others. He described the conditions which the controller were designed to fill and stated that in his opinion the principal causes of troubles are that the heavier working parts of the controller must move slowly and an arc therefore is longer in being broken. This type of controller, he said, was of necessity, more complicated than ordinary series controllers, but he thought that it possessed some advantages which would give it a field outside of train use, and the easy handling of the "Type M" controller had caused quite a few locomotives to be equipped with the apparatus, although they will, in all probability, never be connected so as to use the train system feature.

Mr. Green: "Mr. President, I would have liked to have had Mr. Mundy go into the relative cost or the difference in cost of construction or maintenance and where would you draw the line with a type M control? Where would you start and where would you finish, and where would that series-parallel control come in, and what conditions would you have to operate under in order to use the type M control, for instance, with single-truck cars, using other cars as travel increased and operating them as a train? There is a great deal that could be gone into on that subject, because I am one who knows nothing about it."

Mr. Mundy: "To be able to draw a line where you should start to use train control, and stop at the series-parallel control is of course a very much disputed point and one which I don't believe any one could reach. They are installing the apparatus on equipments as small as four forty-horse-power motors. They have also apparatus made, I believe, that is to handle two forty-horse-power. The difference in expense, of course, varies materially with the size of the apparatus. Roughly speaking though, I should say that the difference between an equipment fitted with K-6 controllers, which you all probably know, and with the train control is somewhere in the neighborhood of eight to nine hundred dollars. This is an item. I may be mistaken in that and I am only getting at it by guesswork. Therefore the question of a road equipping with the train control means materially greater cost. It is a very satisfactory apparatus, in the sense that as far as the burnt tips are concerned the repairs are almost nothing. From quite a lot of experience with these contact tips that have run from nine to twelve months, they don't show much more wear with the use of current than they do if you simply make with them the same number of contacts without current. This is demonstrated more particularly in the factory where we have run one idle and the other with current, breaking arcs showing that the small arc I spoke of is not a destructive arc. The use of the apparatus on the single-truck cars is, of course, more a question of the operation of the road. You have to have, of course, some space for the apparatus and in cars of that kind it is almost impossible to get it under the floor, and you might have to resort to the scheme which the Schenectady Railway Company has on some of its in placing it up over the entrance to the door right in the hood of the car. It has them in boxes up there, but just as to what the field would be for it I think it is more a question of development that we will all have to wait and see, and can not predict just where it will start and stop."

The secretary stated that he had a notice from the agent of the Detroit & Buffalo Steamboat Company, that members holding tickets over the Wabash, Michigan Central or Grand Trunk railways might have the option of the passage on board their boats between Buffalo and Detroit.

The meeting then adjourned.

THURSDAY SESSION.

The Thursday session was called to order at 10.10 A. M. by President Farmer, who read a paper by Mr. L. F. Carver on "The Use and Abuse of Controlling Mechanism," an abstract of which follows:

"The secret of successful mechanical management is watchfulness, care, systematic inspection. Several times every day while the cars are at once off the suburban terminals the controller cases should be opened and the whole interior mechanism given a hasty cleaning and a little lubrication of the contact fingers with a good quality of refined lubricant, vaseline being one of the best, though somewhat expensive. There is a tendency on some well-managed roads to have only two points on the controller, *viz.*, on and off—the various graduations of resistances being largely a matter of form. This method gets the cars over the road and pleases passengers who like a jolt now and then, but it is exceedingly hard on the motor equipment and runs its cost of maintenance into large proportions. There are some methods provided to limit the rate of turn of the controller handle in going toward the loop and in the larger equipments the rate of application is automatic and not under the control of the motorman. In city traffic where cars and vehicles have to go over the same ground and where the vehicle has by common consent the right of way, it is not good practice to limit very much the rate of travel of the controller handle, because the men will find they can not make ordinary slow-downs for the vehicle traffic with a controller slow of application and cover the ground on schedule time, so they resort to the much worse evil of only operating the controller in case of a last resort and using the brake

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to hold down the speed, making the motors work against the load on cars as well as the brake. This is especially easy to do with power brakes—except the electric—and is a violation of rules which is very hard to detect."

This paper was discussed at length by Messrs. Morgan, Farmer, Pestell and Olds.

Secretary Mower read several communications and announced that the secretaries of both the American Street Railway Association and the Accountants' Association invited the members of the American Railway Mechanical and Electrical Association to call at their meeting and take part in the discussion.

The report of the nominating committee was presented as follows:

For the executive committee during the ensuing year:

President, E. W. Olds.

First vice-president, Alfred Green.

Second vice-president, C. F. Baker.

Third vice-president, W. O. Mundy.

For the other members of the executive committee, T. J. Mullen, H. H. Adams, D. F. Carver, H. J. Lake, and for secretary and treasurer, Walter Mower.

These gentlemen were unanimously elected and a vote of thanks was tendered to Mr. Mower for the able services he had rendered the association.

Mr. Olds thanked the nominating committee and the association for the honor conferred on him and paid a high tribute to the work which the retiring president, Mr. Farmer, had done.

After a lengthy discussion on the subject of records and report sheets by Messrs. Mundy, Baker, Lake, Bigelow, Farmer, Pestell, Miller and Watts the meeting was adjourned.

THE INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.

EIGHTH ANNUAL CONVENTION, AT ATLANTIC CITY, N. J., SEPTEMBER 2, 3, AND 4.

The eighth annual convention of the International Association of Municipal Electricians was held at Atlantic City, N. J., September 2, 3 and 4. The headquarters of the association were at the Hotel Rudolf. A special car loaded with delegates left New York city *via* the Central Railroad of New Jersey at 3.40 P. M. on September 1. Many representatives of the manufacturing and supply interests connected with the electricians were on board, and the convention opened with the largest attendance ever accorded to the association.

One hundred and eighteen delgates in the United States and Canada were represented, and the long-distance delegate proved to be Mr. Guy Owens, of Honolulu, H. I. A very interesting programme had been outlined, and this was carried out to the great satisfaction of the committee in charge and the members in attendance. The nominating committee appointed by President Thompson was as follows: J. W. Aydon, Wilmington, Del.; A. S. Hatch, Detroit, Mich.; Jere. Murphy, Cleveland, Ohio; G. T. McDonald, Ottawa, Canada, and J. B. Yeakle, Baltimore, Md.

The nominating committee presented the following ticket which was elected unanimously for the ensuing year:

President, A. C. Farrand, Atlantic City, N. J.

First vice-president, Mr. Petty, Rutherford, N. J.; second vice-president, Mr. G. F. Macdonald, Ottawa; third vice-president, Mr. F. C. Pierson, Morristown, N. J.; fourth vice-president, F. A. Cambridge.

Secretary, F. P. Foster, Corning, N. Y.

Treasurer, A. Busch, Newark, N. J.

Executive Committee—J. Murphy, Cleveland; J. B. Yeakle, Baltimore; M. J. Donohue, Niagara Falls; R. C. Mason, Brooklyn; G. A. Holderman, Indianapolis; J. W. Aydon, Wilmington; W. H. Thompson, Richmond; W. Crane, Erie; W. H. Bradt, Troy.

Finance Committee—C. E. Deihl, Harrisburg; J. F. McElholm, Lowell; J. Burns, Schenectady; Mr. Gascoyne, Detroit.

The exhibitors were as follows:

The Okonite Company, of New York, represented by Mr. Mace.

James Jones & Son, New York, represented by James Jones, Jr.

Gamewell Fire Telegraph Company, of New York, represented by Mr. Torry.

Frederick Pearce, New York, represented by Frederick Pearce.

J. F. Burns & Company, Schenectady, N. Y., represented by J. F. Burns.

The Gordon Battery Company, New York, represented by W. C. Banks and F. Sharp.

Cooper Hewitt Electric Company, New York, represented by one of its agents.

Collins Marine Wireless Telephone Company, New York, represented by A. Frederick Collins. This exhibition was fully illustrated by working apparatus and a lecture with lantern slides.

American Circular Loom Company, Chelsea, Mass., was represented by B. Bett.

National India Rubber Company was represented by H. D. Stanley.

Electric Lights on Railway Trains in Germany and Austria.

The various attempts during the past few years, says Ernest L. Harris, commercial agent, Eibenstock, Germany, to introduce electricity as a means of light on railway trains, and the many experiments connected therewith, have proved that only a very limited number of the different systems now in use may be termed a technical and economic success. A railway train running at a high rate of speed presents many difficulties which are easily overcome in the application of electricity from stationary plants. These obstacles accumulate when we take into consideration that an even volume of light must be provided for the same train, not only when it is in motion, but when it is stopping at stations as well.

To the casual observer it would seem that any arrangement which will admit of all the lamps of a whole train being lighted up from some one central dynamo must in the nature of things be the most practical method which might well be adopted. Theoretically, this could only be possible when based upon the assumption that a railway train would always be made up with the same number of cars, and that the central accumulators had been tested and finely gauged to a train the length of which is invariably the same. The best solution of the problem has been found in the method which enables each carriage of a railway train to be lighted separately and independently of the others. For example, in the Dick system, each car is supplied with a small dynamo which is attached to the axle. This dynamo drives the necessary current for creating light into the lamps while the train is in motion. Simultaneously, a small battery is charged with electricity from the same dynamo. This battery then serves the purpose of keeping up the current while the train is stopping at stations. Generally speaking, however, the lamps should be fed as long as possible directly from the dynamo in order that the battery may be spared. During stops and when the train is going at a slow rate of speed up steep grades, the lamps are always fed from the battery. The accumulators are charged while the train is in motion, and this is the case by day as well as by night.

The different systems of electric railway lights now either in use or being experimented with in Europe are known by the following names: Auvert, Stone, Moskowitz, Jaquin, Kull, Böhm, Dick, Vicarino.

The last-mentioned, or the Dick system, has been adopted by the Oesterreiche Schuckert-Werke, in Vienna, Austria, and this company has fitted up a large number of railway carriages with this apparatus.

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INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

The "New American" Turbine.

The Dayton Globe Iron Works Company, of Dayton, Ohio, is the manufacturer of the "New American" turbine,

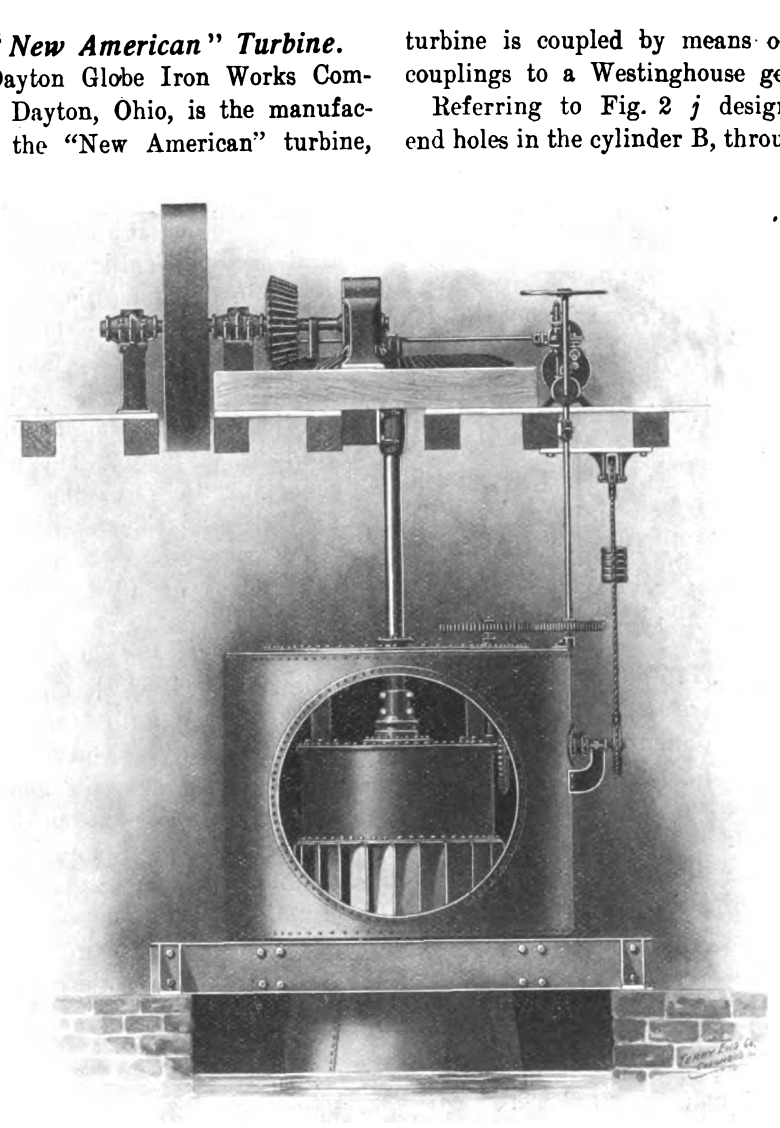

FIG. 1.—"NEW AMERICAN" VERTICAL TURBINE.

which is a development of the "American" turbine, patents for which were granted in 1859.

The accompanying illustrations give an idea of the design and work of this type of turbine. Fig. 1 represents a fifty-four inch cylinder gate "New American" turbine, enclosed in a horizontal steel flume and operating under a nine-foot head. The power is transmitted from the wheel shaft to the jack by means of a pair of bevel mortise gears, and the turbine is regulated by a Woodward governor of the compensating type.

Fig. 2 shows a pair of turbines provided with the new gate mechanism, and Fig. 3 illustrates an outfit furnished to the Boston & Montana Consolidated Copper and Silver Mining Company, of Great Falls, Mont. This is a horizontal turbine fifty-seven inches in diameter, and operates under a head of fifty feet, developing 3,946 horse-power. In this unit the turbine is coupled by means of flexible couplings to a Westinghouse generator.

Referring to Fig. 2 *j* designates the end holes in the cylinder B, through which the jibs *b* may be adjusted by means of the adjusting screws *c*. The cylinder B is bolted to the top of the chute case C, which surrounds the turbine wheel D. E designates a dome to which the cylinder B is bolted. The cylinder B, has two lugs *e* for supporting guide rods F, which act as guides for the back and forth movements of the yokes GG. The rods F also act as brace rods for the flume heads J, by connecting the cylinders B, in this manner tying the whole system together.

Referring to Fig. 3, this turbine is one of two mounted at the works of the Boston & Montana Consolidated Copper and Silver Mining Company, as described above. These turbines are mounted on a cast-iron draft chest and discharge centrally through a draft tube ten feet in diameter, encased in an iron flume fourteen feet by four inches in diameter and thirty-two feet six inches long, made of half-inch tank steel with cast-iron heads. The flume is mounted on two pairs of double I-beams, twenty inches deep and thirty-eight feet long, and receives the water through two intake pipes ten feet in diameter, entering the flume from the back opposite each wheel.

The shaft in the wheels is ten inches in diameter, forty-two feet two inches long, made in two sections, and weighs over five tons. The clamp coupling which connects these two sections of shafting in the centre of the draft chest, weighs considerably more than one ton. There are stands at each end of flume weighing 8,000 pounds each, carrying the journal boxes for the shaft. The two turbines, with their complete outfits, weigh approximately 250,000 pounds.

These turbines operate two Westing-

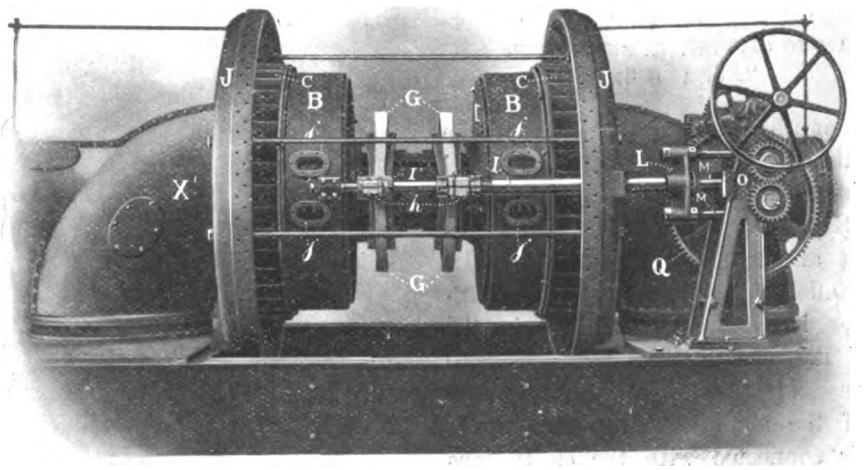

FIG. 2.—PAIR OF TURBINES, WITH NEW GATE MECHANISM.

house electric generators used for electrolytic refining. They are direct-coupled to each end of the shaft, which runs from

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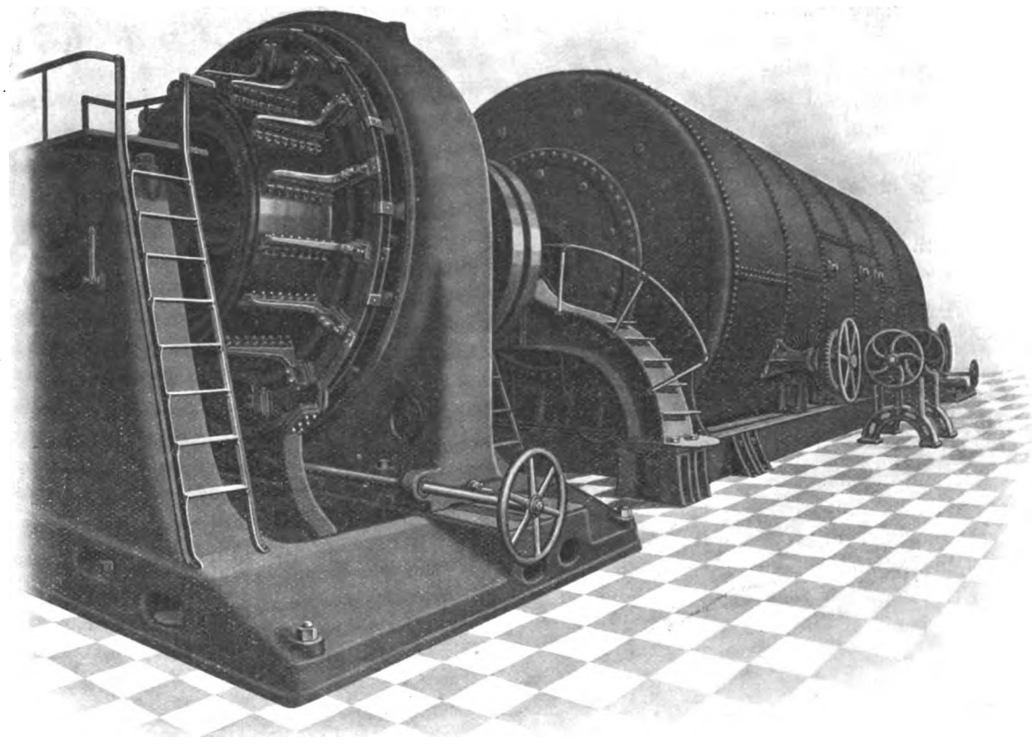
144 to 160 revolutions per minute. The varying revolutions are required in order to increase or diminish the current as conditions may require.

A portion of the power is also utilized for driving an arc light dynamo and two fifty-horse-power exciters, and is transmitted from the wheel shaft to dynamo by means of a twenty-inch double leather belt, and there still remains a surplus power for future contingencies.

These wheels were sold under a guaranteed average efficiency of eighty per cent from three-quarters to whole gate and to develop 2,800 horse-power under forty-foot head. When tested at Holyoke, as per contract, they exceeded the guarantee both in horse-power and efficiency, showing an average efficiency from three-quarters to whole gate, inclusive, of eighty-one and one-quarter per cent, certainly a remarkable performance in view of the fact that they were the first wheels of this diameter built by this company.

In consequence of the great strain on a turbine, working under a fifty-foot head, the buckets of the wheels were necessarily made very thick. Had they been made the ordinary thickness, the percentage of useful effect would have been increased to at least eighty-three and one-half to eighty-four per cent. This was the judgment of a number of engineers who made an examination of the turbines. They were tested with the ordinary straight cylinder below the wheel. Flaring draft tubes or diffusers would have increased the percentage.



4,000-Horse-Power Horizontal Turbine.

An Electrical Testing Laboratory.

The Lamp Testing Bureau has equipped, at No. 14 Jay street, New York city, a general electrical and photometrical testing laboratory, and is prepared to test electric lamps, meters, instruments and apparatus, and to provide secondary standards of candle-power, amperes, watts and standard cells, for use as standards of electromotive force. The bureau makes a specialty of the calibration of instruments against authoritative standards, of performance tests of electric meters, and of tests of incandescent lamps for candle-power efficiency and candle-hour values. The bureau is in its seventh year of business, and is now equipped with instruments and apparatus for doing every variety of work of this kind. Until recently the bureau was operated as a department of the Association of Edison Illuminating Companies, but it is now an incorporated company organized for commercial electrical testing of all kinds.

The business of the bureau has grown to a remarkable extent, and the equipment to-day has become so extensive that tests of every description can be readily made. This bureau is of great value to contractors and electrical manufacturers and dealers who would find it difficult to go to the expense of fitting up an extensive laboratory for their testing work. The laboratories of the Lamp Testing Bureau at 14 Jay street are temporary quarters, and the company has recently secured a large fireproof building at Eightieth street and East Second avenue. This building has recently been occupied by the Manhattan Electric Light Company. The bureau is now planning to equip this plant with new boilers, engines and dynamos, and will install in it a large collection of the best and most modern instruments and apparatus for electrical testing.

A spectrophotometer with brace prism, a Matthews integrating photometer, a Matthews arc lamp photometer, and a special device for the photometry of shades, reflectors, etc., are among the recent additions to the photometric equipment of the bureau.

The Ohio Electric Light Association.

The ninth annual meeting of the Ohio Electric Light Association will be held at the Hotel Chittenden, Columbus, Ohio, on October 13, 14 and 15. A number of papers will be read and discussed, and it is expected that a representative exhibit will be made at the convention headquarters.

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A New Type of Successful Oil-Burning Engine.

The inherent difficulties of producing an internal combustion engine which would utilize ordinary kerosene oil as a fuel have kept the development of this form of prime mover secondary to both the steam engine and the gas engine. While engines designed for burning common kerosene oil have been put in service and have done more or less successful work in the driving of light machinery, an engine which could be used to drive an electric generator for the production of current to be used in a lighting system requires close refinements, which the ordinary type could not meet.

Practical tests have shown that when fuel and air enter the engine either at different periods or through different inlets, they are only partly mixed, and the complete and rapid combustion of heterogeneous charges is impractical. To ensure thorough mixing it is claimed it is necessary that the fuel and air be mixed together when inhaled through the air valve. Many engineers also regard the admission of oil fuel by injection or pressure as very unreliable and unsatisfactory in results.

Keeping all these bad features in mind as a constant warning, the inventor of the Secor automatic oil electric machine has designed an apparatus which is now placed on the market and guaranteed by the General Power Company, of New York, to be a thoroughly reliable engine which will operate with the closest regulation, using as fuel common kerosene oil. This makes it valuable for private residences, churches, country clubs, public buildings, theatres, factories, etc.

The accompanying illustrations show several types of the Secor engine, Fig. 1 showing a standard Secor engine driving a generator of fifteen kilowatts capacity. This engine was installed at Dickinson College, Carlisle, Pa., and is used for lighting one of the dormitory buildings. This installation was made and the plant is being used in preference to using the current from the town central station. A similar machine of a slightly smaller capacity is being installed at the country residence of Mr. Charles Frohman, the noted playwright. Fig. 2 shows a Secor engine installed at Crosbyside, Lake George, N. Y., and it is used as a combined pumping and lighting system. Fig. 3 shows a Secor engine plant as installed at the laboratory of Mr. Stephen D. Field. This is a two and one-half horse-power engine and drives a number of lathe tools, by means of electric motors, besides charging a storage battery for a lighting system.

The machine as illustrated in Fig. 3 consists of a "Junior" type Secor engine mounted on the same base with a specially designed dynamo, to which it is solidly coupled. Both the engine and dynamo are designed to show maximum efficiency when operating as component parts of an integral machine. The base is made of cast iron and is oil-tight, forming a fuel tank of about twelve gallons capacity.

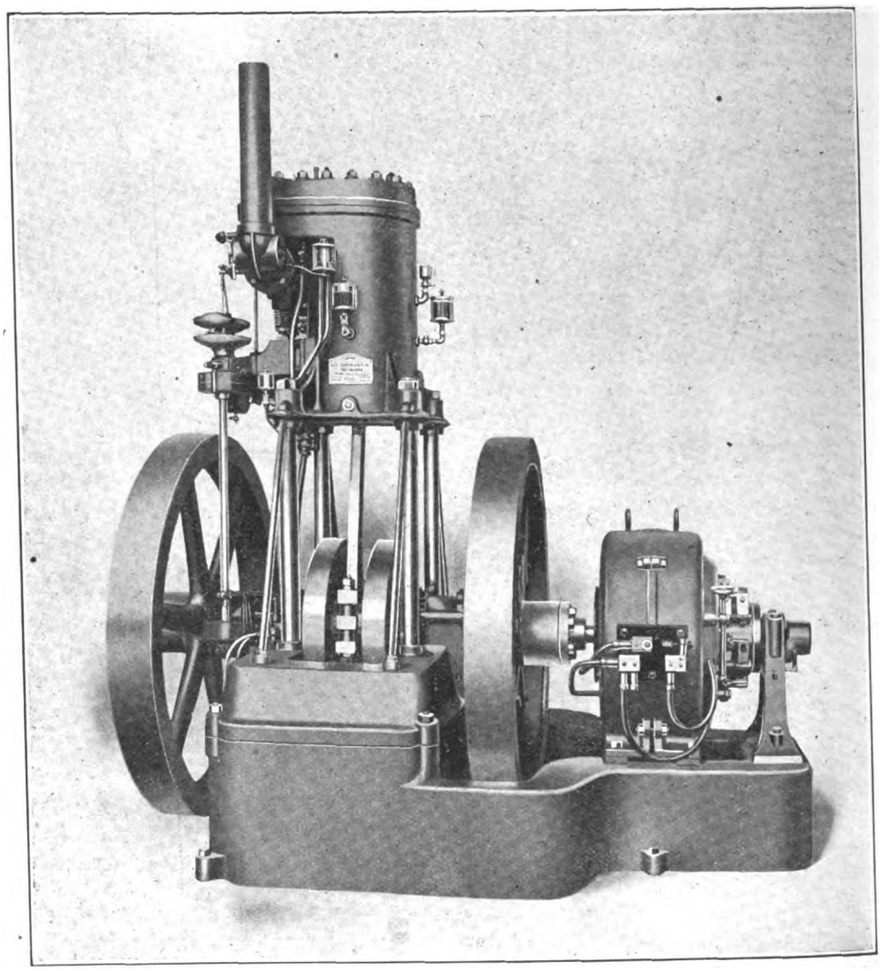

FIG. 1.—"STANDARD" SECOR OIL ENGINE, DIRECT-CONNECTED, WITH 15-KILOWATT GENERATOR.

The engine is of the single-cylinder vertical trunk type, with water-jacketed cylinder resting on an enclosed frame. All of the journals are large in diameter and length, and special provision is made for automatic lubrication and for wearing compensation. The cover for the cylinder and valve chest is made in a single casting which, when removed, exposes the whole interior of the engine without disturbing any of the working mechanism. The shaft is carefully balanced by crank counterweights, and the connecting rod is of the English high-speed marine type. Cam-operated poppet valves with spring closure are used, and the cam shaft is actuated by spur gears running in oil. The governor is of the fly-ball type, attached to the hub of the driving pulley.

The engine operates on the four-stroke cycle of Beau de Rochas. Hammer-break electrical ignition is employed, and the mechanism for making and breaking the circuit to produce the spark is attached to an easily removable firing plug inserted in the cylinder head.

The speed regulation is accomplished by automatically varying the pressure of the working impulses so as to exactly balance the electrical load. A micrometric governing mechanism automatically controls accurately proportioned homogeneous mixtures of combustible fuel and air, irrespective of the load or atmospheric conditions.

Multipolar-type generators with spherical frames are provided with each unit. The field magnets are made up of separate coils, thoroughly ventilated and insulated from the frame. The armatures are built up of annealed laminated steel discs, thoroughly ventilated and insu-

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lated. The generators are capable of carrying full-rated load for twenty-four hours continuously with a rise in temperature above the surrounding air not exceeding thirty-five degrees centigrade in the armature and field windings, and forty degrees centigrade in the commutator. Each generator is designed to carry a twenty-five per cent overload for two hours, following a twenty-four-hour run at full load, with a rise in temperature not exceeding fifty-five degrees centigrade above the surrounding air.

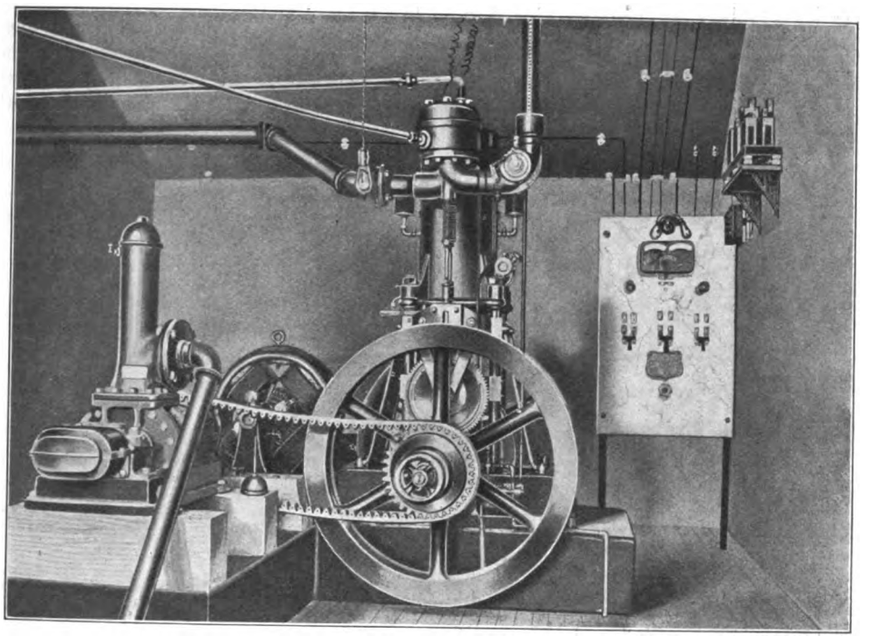


FIG. 2.—COMBINED PUMPING AND LIGHTING PLANT.

Switchboards are furnished with the machines. These are constructed of marbleized slate with adjustable iron pipe supports. The switchboards are fitted with ammeter, voltmeter, field rheostat, ground detector, pilot lamp bracket, switch for engine-room lights, and two feeder switches. Each machine is provided with a wide power pulley, so that a pump or other machine may be driven directly by belt, the power of the engine being divided as desired between the dynamo and the belted machine.

The General Power Company builds four different types of electric generating plant, as follows: Type "A," constant potential plant, to be used for illumination; type "B," automatically variable potential plant for charging automobile or other batteries; type "C," either constant or variable potential, as desired, to be used interchangeably for lighting or charging purposes; type "D" consists of a type "C" machine with special storage battery and automatic equipment, including a "G. P." controller. This is ready for instant use day or night and is known as the omnibus service plant.

The offices of the General Power Company are at 81-83 Fulton street, New York city, and the engines are built at the works of the Marine Engine and Machine Company, Harrison, N. J.

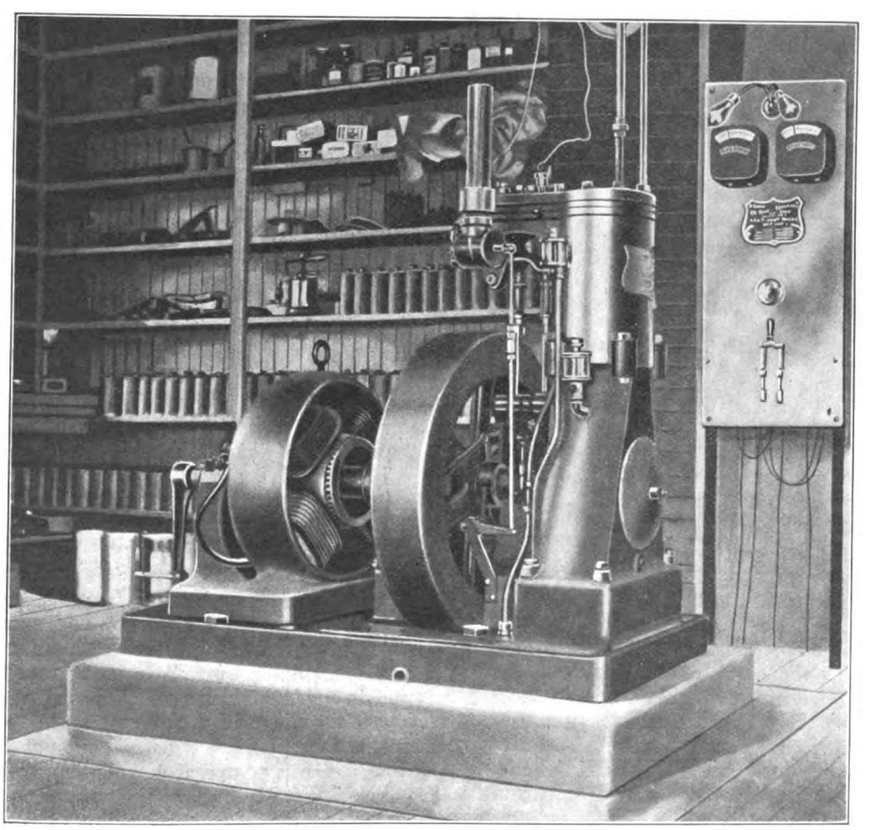
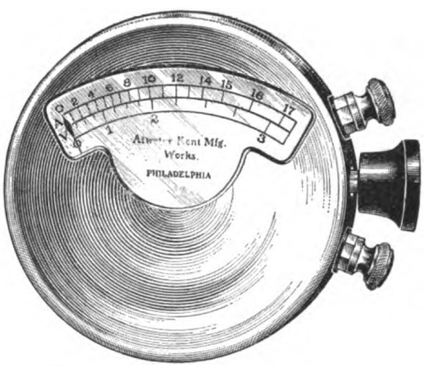


FIG. 3.—TWO AND ONE-HALF HORSE-POWER OIL ENGINE.

A New Automatic Volt-Ammeter.

The Atwater-Kent Manufacturing Works, Philadelphia, Pa., has brought out an automatic volt-ammeter which is especially designed and calibrated for testing ignition batteries.

The ampere scale reads to twenty, and the voltage scale points to five. The volt-



NEW AUTOMATIC VOLT-AMMETER.

age test is made by placing the two flexible leads furnished with each instrument on the terminals of the battery, and the ampere test is obtained simply by pressing the button on the instrument without changing the leads. This saves a large part of the time required to test a set of cells.

The needle is light and delicately

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pivoted, and is as nearly dead-beat as it is possible to make it in such a small instrument. The manufacturer states that but two seconds are required to bring the needle to rest.

This device will be of great service to users of gasoline automobiles and launches, and will show on short notice the exact condition of a battery and possibly avoid many breakdowns. The instrument is substantially constructed on scientific principles, and the company states that the workmanship is of the best.

Reorganization of the Standard Vitrified Conduit Company.

The Standard Vitrified Conduit Company, New York city, has recently made a change in its official staff, R. W. Lyle having resigned as president on account of the great volume of business on his hands for the future, he being president of several other corporations. B. S. Barnard, formerly vice-president and secretary, has been made president of the company.

The success of the Standard Vitrified Conduit Company has been somewhat phenomenal, and this is largely

MR. B. S. BARNARD.

due to Mr. Barnard's personal efforts and standing in the trade. Mr. Barnard is as well known throughout the country as he is at his desk at the home office, and the ELECTRICAL REVIEW tenders its best wishes to him in his new position.

The capacity of the factories of the Standard company has been greatly increased, and it is stated that they are producing at the present time upward of 100,000 feet of conduit per day.

The Interborough Rapid Transit Company, New York city, is using this conduit, and a contract has just been awarded to the Standard Vitrified Conduit Company for 55,000 third-rail insulators which, it is stated, will be used to equip the entire traction system of the New York subway. This insulator, as purchased, is of the "Manhattan" type, with slight alterations. The Scioto Valley Traction Company, of Ohio, has also placed its order for 29,000 "Manhattan" insulators; and the United States Steel Company has equipped several of its plants with this insulator.

A Simple Form of Trolley Catcher.

Considerable difficulty is sometimes experienced in the operation of trolley cars, not only on high-speed interurban systems, but also within city limits, due to the persistence with which the trolley-wheel leaves the wire at crossovers and at other places along the line. This is due at times to faulty construction in the line itself, and at other times it is a bad condition which appertains to higher than ordinary speeds. When a car is riding with any great velocity, particularly where span construction is used, when a trolley leaves the wire it sometimes means that several span wires in succession will be subjected to a terrific shock, due to the trolley bar striking a span; and in some cases, where a more rigid obstruction is met, the trolley pole is broken.

To obviate this difficulty, several forms of trolley catchers have been designed. The accompanying illustrations show a form of simple trolley catcher which has been placed on the market by Johnson & Morton, of Utica, N. Y. The absence of complicated parts is one great reason for the success of this catcher.

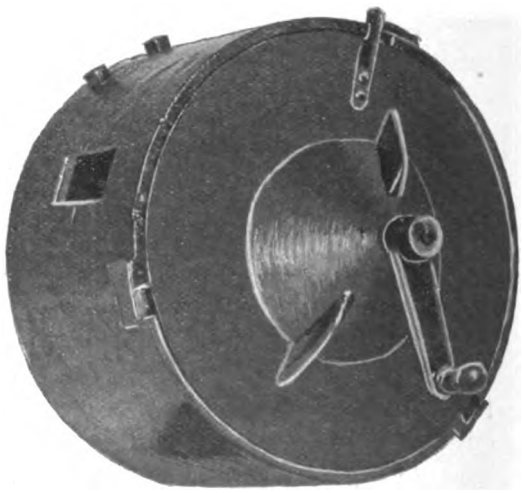
The rope drum rests by its own weight on a bearing in the case without a cap. The slack trolley rope is wound on the drum by a plain coiled spring. When the speed of the unwinding cord is suddenly increased, the drum is lifted from its bearings before the cord unwinds, and a ratchet on the drum head engages a stationary tooth in the case above it, preventing the drum from turning. This action is so rapid and positive that not more than one-half an inch of rope is paid out before the catcher operates, and the trolley is held below the level of the span wires.

This trolley catcher differs from centrifugal catchers in that it is not necessary for the drum to gather any speed whatever before the catch operates. This catcher has no dogs or triggers to break or give trouble. The parts are made substantially and solidly. The action is positive, and the moment the speed of the trolley cord increases so that the rotative inertia of the drum is greater than its weight, the drum is lifted from its bearings and locked.

The catcher will coil fifteen feet of one-quarter-inch rope. A light rope can be used, because the movement of the trolley pole after leaving the wire is so short that no severe strain is brought upon the rope.

TROLLEY CATCHER—DISASSEMBLED.

The base of the catcher is fastened to the car by three bolts and has a substantial bayonet lock, so that the catcher proper can be removed by a half turn of the case. A chain is provided on the drum, so that the trolley cord can be attached by a hook. A crank extending from the head of the case is connected with the cord drum, so that the spring can readily be wound up. The head of the case is fastened by a latch joint so arranged that



TROLLEY CATCHER—ASSEMBLED.

it can be taken off instantly, but can not become loose by accident.

Both the bearing in the case and the head are of chilled iron, to prevent wear. The drum shaft and spring shaft are of the best milled steel and can be renewed with but little trouble or expense. The ratchet upon the cord drum is of chilled iron, and the catch of case-hardened steel. The spring is fifteen feet in length, and is made of finely tempered steel. It winds upon a shaft one inch in diameter.

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Break Finder and Ground Locator.

The accompanying illustrations show a type of break finder and ground detector which the Myers Break Finder Company, of Syracuse, N. Y., has placed

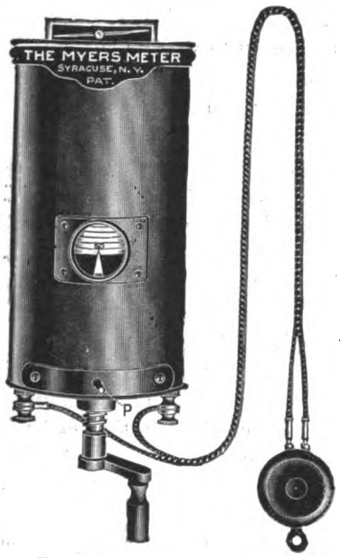

FIG. 1.—NEW TYPE METER.

on the market, and which is meeting with considerable success for locating faults in telephone and telegraph lines all over the country.

Fig. 1 shows a new form of meter manufactured by this company, which is designed for use with a telephone receiver and magnetic needle or both. The instrument is small and convenient in form, being six inches long by three in diameter, and can be used in a manhole, upon a pole or in a station. The meter is also arranged for use as an ammeter and has a fine and accurate scale, and faults can be exactly located with great facility.

Fig. 2 shows the Myers break finder,

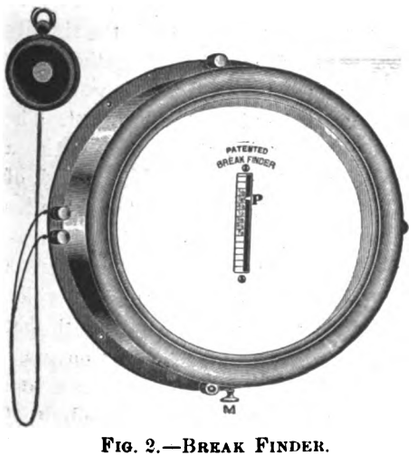

FIG. 2.—BREAK FINDER.

which is used to locate the point where an electric circuit has been broken. The scale shown represents by halves, quarters and eighths the proportionate length of the circuit under test. After the break finder has been looped into the broken circuit at the station switchboard, at the binding connection shown at the top and bottom of the instrument, a grounded variable electric current of suitable strength is switched to the post on the right. In the telephone receiver attached there will begin a buzzing, the intensity of which can be varied by sliding the pointer P in or out by means of the thumb nut M. The location of the break will be found by simply sliding the thumb nut M until the buzzing has been reduced to a minimum, when the number on the scale indicated by the pointer P will show where the broken section of the circuit is. In the illustration it is shown pointing to the one-quarter division, which would indicate that the break is one-quarter the distance out, and nearer to that end of the circuit which has been connected to the nearer binding-post—in this case the top one.

These instruments have been used by a number of telephone and telegraph engineers, and testimonials in the possession of the company show that the work done is very exact and the manipulation is easy and rapid.

Automatic Fire-Alarm System.

The accompanying illustrations show the fire-alarm apparatus manufactured by the Copenhagen Automatic Fire Alarm Company, of Sheboygan, Wis. Fig. 1 represents the "Copenhagen" thermostat. This thermostat is fastened to the ceiling of each room, closet or hall of a building to be protected, and is electrically connected by means of insulated wires with an annunciator and one or more alarm bells or gongs. Each of these thermostats or heat detectors is made to operate by closing an electric circuit automatically at from ten to twenty degrees above the maximum normal temperature of the room in which it is placed.

The thermostat consists of a copper disc and a concave silver plate or diaphragm, the two, when hermetically sealed, forming a capsule about the size of a dime, mounted on a small porcelain base, with the necessary electrical connections. In the capsule is enclosed a liquid which at a certain fixed temperature forces the silver diaphragm with a positive snap from concave to convex, closing an electric circuit. As soon as cooled off, the diaphragm snaps back to concave and is again ready for service.

Fig. 2 shows the "Copenhagen" circuit tester, which is designed for use in large buildings where there is a liability to have wires cut by accident. With the use of this circuit tester, if the wires are intact, a hole is punched in the paper dial for each circuit; if a wire is cut, no

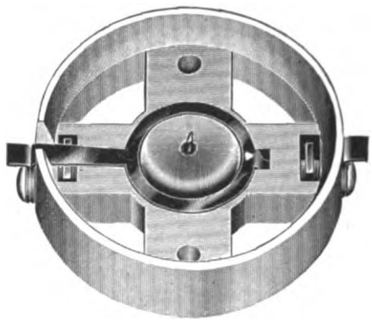

FIG. 1.—THERMOSTAT.

punch is made for that circuit. The circuit tester also plainly indicates when the main battery wire is cut. By having an auxiliary battery wire running into the

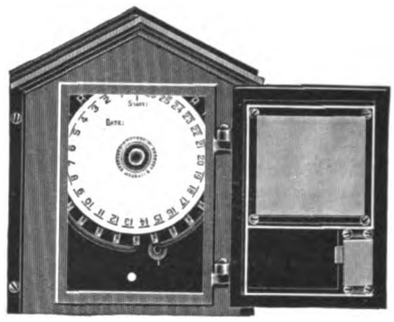

FIG. 2.—CIRCUIT TESTER.

circuit tester the fire-alarm is sounded, even if the main battery wire is cut. This tester also indicates when the battery is beginning to run down and when it must be renewed.

FIG. 3.—COILS FOR JOURNAL THERMOSTAT.

The company also manufactures an automatic alarm system for detecting overheated journals on all kinds of ma-

FIG. 4.—THERMOSTAT FOR JOURNALS.

chinery. Fig. 3 shows the "Copenhagen" thermostat for journals, and Fig. 4, the form of "Copenhagen" thermostat as used in journal boxes.

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The Tray Type Storage Battery.

The tray type of storage battery is a wide departure from all other forms of storage battery construction heretofore employed commercially.

This form of construction is composed of trays superimposed upon, but insulated from each other—the number of and size of the trays depending respectively upon the voltage and capacity desired.

The tray is made of the best rolled lead of suitable thickness, and is prepared, on both upper and lower surface, by our patent gridding machine which produces the largest practicable amount of surface and yet retains the mechanical strength of the plate unimpaired. The usual electrochemical formation produces a working surface unexcelled in the present stage of the art.

Each tray being filled with electrolyte, the bottom surface of its next succeeding superimposed tray is also submerged and the battery is ready for charging. By this method of construction two very important results are obtained. A large amount of active surface per unit of weight and a very much lower internal resistance is secured.

With the tray type the current has to pass only through the thickness of the web—not longitudinally—making the distance of its travel short and large area of cross-section, so that the total internal resistance is very low, besides allowing the working to be distributed over the entire working surfaces, reducing the tendency to distortion and disintegration and resulting in a long life and permitting a high rate of discharge.

The tray type for stationary purposes is well protected from evaporation and dirt (being entirely enclosed in glass), and the effect of electrolysis is entirely eliminated.

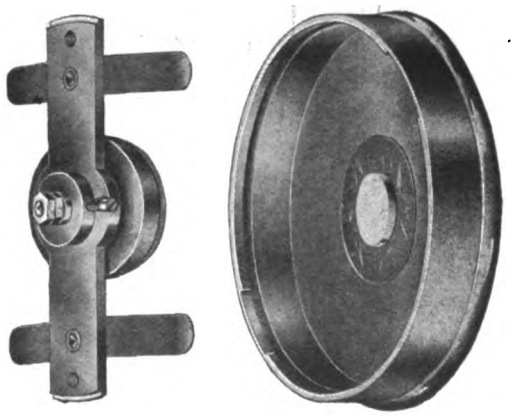
New Telephone Apparatus.

The Electric Gas Lighting Company, of Boston, Mass., has recently inaugurated a telephone department. This company has been so long identified with the electrical house goods business, that it was an easy step for it to get into the business of interior telephones, so many telephone outfits being required for hotel installations in these days, and its Ross annunciator being a very popular one among hotel men.

In getting up a line of goods as exacting as telephones are, the Electric Gas Lighting Company has the peculiar advantage of having been twenty years in the production of fine electrical goods, and in possession of a factory equipped with machinery and men capable of turning out the best possible work in this line, and accustomed to doing that sort of work. The company has gone very deliberately into the telephone business, preliminary work covering over a year having been done by one of the best telephone

NEW TYPE INTERCOMMUNICATING TELEPHONE.

experts in the country, assisted by a mechanical expert of acknowledged ability, and every detail in the instrument has been submitted to the most rigorous test both mechanically and electrically and the most severe use, not only in the



ASSEMBLY OF MECHANISM OF TRANSMITTER.

laboratory but out on actual working circuits before being considered as satisfactory goods to offer the trade. Illustrated herewith is an example of its push-button intercommunicating instrument No. 351. It shows a neat exterior, and a compact but not complicated mechanism in the inside of the box. The company has been very particular as to the small details of its goods. Nothing has been put in because it is cheap, but the permanence of the instrument has always been kept in mind. For instance the push-buttons, a frequent source of trouble in telephones, are in this instrument the same as have been used by hundreds of thousands in gas-lighting keys, so that they are known to be reliable. These consist, as most people in the trade know, of a strong German silver spring in connection with a metal push centre which is brought into positive contact with a metallic bridge, the whole being finished on the outside by a well-designed escutcheon bearing ample space for numbering or marking the pushes. The bell mechanism in these instruments is also an adaptation of an old, well-tried appliance of this company. It is the bell which has always been used on the Ross annunciators, noted for its mechanical perfection and positive and rigid contact. It is a bell which retains its adjustment under the most trying conditions.

The instrument described above belongs to the class of goods designated by the company as "Samson Junior."

It is the intention of the company to produce under the name of "Samson" a line of telephones which will be equal in every way to the highest class of instruments now on the market, whereas the "Samson Junior" line is intended to meet competition, at the same time to be so satisfactory that they will not be excelled in actual qualities by any except the "Samson" telephones. The accompanying illustration shows the mechanism of the transmitter used with "Samson Junior" telephones. The front of this instrument is drawn up from sheet brass, and is a most marvelous example of skill and capacity in punching machinery. It is of very heavy stock and might easily be taken for a casting. It has all the rigidity and solidity of a casting, together with the accuracy of sheet metal work and makes a heavy and stiff instrument. The diaphragm is of aluminum and carries a gold electrode in its centre. The back of the transmitter is a heavy straight piece of brass held rigidly in a slot in the transmitter front and carries in its centre a granule chamber at the bottom of which is a gold electrode to correspond with that on the diaphragm, and the carbon granules are surrounded by a continuous and elastic felt washer. This will admit of considerable compression without great change, and forms a perfect granule chamber, at the same time filling a useful office as a partial dampener to the diaphragm. The diaphragm is supported on its edge by a pure rubber band and dampened by springs.

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Exhibits and Exhibitors at the American Street Railway Convention.

(Some of the Apparatus Shown and a List of Representatives Present.)

EXHIBITS of manufactures were made in the large court within the Grand Union Hotel. Many booths were erected and roofed over and the night illuminations were especially effective. The Victor Herbert orchestra filled its engagement during the evening, and the evening open-air gatherings were enjoyed. The social side of the meeting brought an unusually large number of ladies, who probably were attracted by the gaieties of Saratoga. Drives, trolley excursions, and especially the excursion and entertainment tendered by the General Electric Company in the way of a special train carrying delegates, wives, sisters and sweethearts to Schenectady, were all appreciated.

Because of the diversity of interests and the lack of concentration of the exhibitions and visitors, some of the manufacturers who had gone to great expense in equipping displays and having large numbers of men present were disappointed at not accomplishing better things, but on the whole the gathering will go down in the history of these annual conventions of the street railway industry as being the noteworthy one of them all.

The exhibitions were not as elaborate and comprehensive as in years past; especially was this noticed in the absence of cars and other heavy railway equipments which heretofore have been shown. The manufacturers, on the other hand, were represented by large numbers of men.

The General Electric Company had an unusually large staff of men present. The company had artistically decorated headquarters in the centre of the court, but did not make any exhibition of apparatus, as it had arranged to carry all the visitors from Saratoga to its shops at Schenectady. This was done in a most luxurious and generous manner. A train of ten coaches took the guests direct to Schenectady. All the departments of the vast shops were open, and the company's engineers with assistants were glad to show any machinery or apparatus which the visitors might wish to inspect. A most elaborate collation was served at Schenectady before returning to Saratoga, the service for which was prepared by one of the leading New York caterers. J. R. Lovejoy, general manager of the railway department, was assisted in his duties as host, by many of the company's representatives from the various branch offices throughout the United States, and W. J. Clark, the manager of the foreign department, was here especially for the gathering; W. B. Potter, chief engineer of the railway department, was also one of the hosts.

The Stanley Manufacturing Company exhibited a complete car truck with two motors. Each of these motors was of the forty-eight-horse-power type governed by the S. K. C. No. 2 controller. This controller was adjusted for inspection. Another motor of thirty-five-horse-power was open for inspection. A new type of trolley base which allows the pole to be lowered to a parallel plane with the car for convenience in passing under tunnels and bridges was exhibited. Also a number of other special equipments used with the Stanley railway apparatus was shown.

The Westinghouse Electric and Manufacturing Company exhibited the new system of multiple unit control. This system has been well described in the ELECTRICAL REVIEW and is now pretty well understood by well-informed engineers. However, the equipment was of much interest to railway men. The exhibition included types of railway motors, controllers of many types, and much other railway apparatus of most modern construction was shown.

The Locke Insulator Manufacturing Company, Victor, N. Y., had an especially interesting demonstration of the carrying capacity of some of the high-voltage insulators manufactured in this company's factory at Victor, N. Y. The high-potential transformer perfected by Professor Smith, of Worcester Polytechnic, was installed, which transformer is able to offer a potential of 175,000 volts. It was proposed to make tests up to 115,000 and perhaps more for the benefit of visitors. Many types of insulators were shown by this company and the exhibition was one of considerable interest because of the important part which the insulator question now plays in the matter of high-voltage transmission.

The Gould Storage Battery Company showed a number of batteries and types of battery plates, especially adapted for railway service; also a large line of photographs of railway installations was shown by this company.

The H. W. Johns-Manville Company prepared a booth with plenty of flags and other effective settings, and here the company showed the Sachs "Noark" fuses. The exhibition included the fuses up to 600 amperes capacity, though the company is now making them up to 1,000 amperes for 220 and 500 volts. An exhibition of the new insulating material "transite" for underground work was also shown. The exhibition included the electric car heater, car fuse boxes, overhead line construction material.

The Rossiter-MacGovern Company had an exhibition of railway apparatus, including motor controllers and much other special equipment. A new commutator was shown which has been recently completed for the Brooklyn Rapid Transit Company which was of the 500-kilowatt generator type. Six reconstructed railway motors, both General Electric and Westinghouse types, were shown. The reconstruction was so excellently done that many railway men mistook them for new machines, and Mr. MacGovern ordered the sign "Reconstructed" hung on them. In addition an interesting showing was made of armatures and field coils in all stages of construction. Arc lamps and much other railway equipment was shown.

The Albert & J. M. Anderson Manufacturing Company had a large line of switchboard equipment and heavy current-carrying switches. A particularly interesting display was one of the earliest types of railway switches and other railway specialties which were compared with the wonderful developments of the present day.

The Pittsburg Reduction Company had one of the Waterbury Machine Company's wire drawing machines in operation. This was of great interest to many of the visitors, as it was turning out a production from one-quarter to three-thirty-seconds inches, in seven passes. The company showed also a large line of aluminum wire in different sizes, and aluminum specialties. This included samples of the large order which goes to the Standard Electric Company of California, and the Hamilton Cataract Company.

The Bullock Electric Company was the only manufacturer of large machines to make an exhibit of a large unit. This was one of five rotaries which are being made for the Scioto Valley Railway Company, Columbus, Ohio. The machine is approximately nine feet high and about ten and one-half square on the base. It receives a three-phase current and delivers 400 kilowatts direct current at 600 volts.

The National Carbon Company showed an interesting line of carbon brushes for street railway service.

The Dearborn Drug and Chemical Company had one of the most artistically draped booths and was most hospitable in the way of entertaining.

An interesting exhibit was that of the India Rubber and Gutta Percha Insulating Company. Dr. William M. Habirshaw and J. B. Olson, manager of sales, were present. Samples of the cable now in use under the Harlem river by the Manhattan Elevated system were shown. This is a leaded and armored cable B. & S. gauge 000, for three-phase service, and now under a working pressure of 11,000 volts. Also other kinds of railway cables for various voltages were exhibited.

The Ohio Brass Company exhibited its line of overhead railway equipments and electric railway construction specialties. This was one of the most elaborate of the exhibitions.

The Electric Railway Equipment Company, Cincinnati, showed several types of the single and double trolley pole. Also types of electric light poles such as are in use in Cincinnati, New York, Chicago and other cities. With those previously

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mentioned, the exhibit offered fifty different styles and types of overhead brackets.

Magneto Electric Company, Amsterdam, N. Y., exhibited in connection with the Electric Railway Equipment Company, but was especially represented by Elmer P. Morris. The exhibition included types of motor starters, rheostats, and some other special apparatus.

The Gold Car Heating and Lighting Company, New York, exhibited its complete line of electric heaters and also other types of car heating apparatus.

The Benjamin Electric Manufacturing Company, Chicago, had an exhibition of wireless clusters for lighting cars. In this exhibition was shown the styles adopted for the new Interborough cars, also the types used by the Metropolitan company in New York.

Stuart-Howland Company occupied a large parlor inside the hotel. The exhibition was one of the most comprehensive railway equipments shown by any of the supply houses.

The Electric Storage Battery Company had an exhibit which was of especial interest to railway engineers as it showed the modern practice in railway batteries and batteries' installations as adapted for street railway service. Many photographs were to be seen and the engineers could get an excellent idea as to the possibilities of battery work.

Some of the souvenirs which were distributed were costly and attractive. The Massachusetts Chemical Company gave away a rubber mat for placing under an umbrella stand or to be used in the bathroom; the Standard Paint Company distributed an attractive wallet with memorandum book done in Russia leather; the Sterling Electrical Manufacturing Company gave many pretty sterling silver pins; the Speer Carbon Company had perhaps the most effective souvenir of the day in the way of a fine pack of cards encased in a very pretty cover in the form of a leather book; the Standard Varnish Works distributed watch fobs with pretty mountings on heavy black ribbon; the John A. Roebling's Sons Company gave small silver chains for keys, and very many other companies were equally generous in these memento gifts.

Bullock Electric Manufacturing Company, Cincinnati, Ohio—R. T. Lozier, F. G. Foote, W. S. Arnold, G. B. Foster, C. Van De Venter.

Standard Paint Company—Charles Ernshaw, W. D. King, F. F. Vandewater.

Electric Storage Battery Company, Philadelphia—Charles Blizzard, J. L. Woodbridge, Albert Taylor, G. H. Atkin, H. B. Gay, F. J. Stone, W. R. Proudfoot.

Weber Railway Joint Company, New York—Percy Holbrook, J. C. Barr, F. B. Thompson, J. A. Greer, F. A. Poor, H. C. Holloway.

Lorain Steel Company—P. M. Boyd, Major H. C. Evans, D. J. Evans, R. Clitz, F. J. Drake, W. W. Kingstone, S. P. S. Ellis, H. A. Kleinschmidt, E. B. Ertiviste.

Crouse-Hinds Electric Company, Syracuse, N. Y.— A. E. Hills, Nathan Shute.

D. & W. Fuse Company, Providence, R. I—W. S. Sisson, secretary.

American Diesel Engine Company, New York—Norman McCarthy.

Magnet Wire Company, New York—George F. Valentine, J. D. McGuire.

Okonite Company, New York—George T. Manson.

Sterling Electric Manufacturing Company, Warren, Ohio—Francis Granger, New York, H. A. Daniels.

E. W. Bliss Company—C. E. Porter, B. W. Stone.

Chase-Shawmut Company, Boston, Mass.—H. P. Moore, F. D. Masterson, E. P. Howe.

Sterling-Meeker Company, Newark, N. J.—A. A. Stowe, H. E. Beech, E. W. Hemmon, Charles E. Gierling.

Adams & Westlake Company, Chicago —W. S. Bartholomew, J. A. Foster, W. H. Pierson.

William Wharton, Jr., & Company, Inc., Philadelphia—William Wharton, Jr., Victor Angerer, W. R. Wharton, A. S. Partridge, J. C. Robinson.

W. R. Garton Company, Chicago, Ill.—W. R. Garton,

F. W. Darlington, Consulting and Mechanical Engineers, of Philadelphia.

Michigan Electric Company, Detroit—Joseph E. Lockwood, president.

Harold P. Brown, New York—J. M. Coote, William Temple, George Common, James Holland and Harold P. Brown.

Pittsburg Reduction Company, Pittsburg—A. V. Davis, A. K. Lowrie, J. A. Rutherford, S. K. Colby, William Hoopes, Percy Hodges, C. M. Harris, E. H. Noyes, W. R. Donters, W. H. Hueling.

H. W. Johns-Manville Company, New York—J. W. Perry, New York; H. M. Voorhis, Pihladelphia; James Humphries, Boston; J. E. Meek, New York; C. D. Newton, Hartford; Joseph Sachs, Hartford; E. B. Hatch, Hartford; E. B. Lutch, New York.

Bryan-Marsh Company, New York—Guy V. Williams, J. P. Williams.

Continuous Rail Joint Company, New York—B. M. Barr.

Brady Brass Company, New York—Daniel M. Brady, president.

C. J. Field, New York—R. B. Murphy.

American Car and Foundry Company, Chicago—W. H. Fowler, S. Bluett.

The Universal Car Brake Company, Lancaster, Pa.—Joseph Cullman, J. F. Bimmer, W. M. Deal.

Durkin & Barrett Manufacturing Company, Scranton, Pa.—P. S. Barrett.

Magnetic Equipment Company, Chicago—Charles A. Ballard.

Archbald-Brady Company, Syracuse—William K. Archbald, P. T. Brady, J. R. McSyne, Walter Goddard.

Locke Insulator Manufacturing Company, Victor, N. Y.—Fred. M. Locke, president.

Acme Magnetic Traction Company, Chicago—Bert H. Honey.

Hipwood-Barrett Fender Company, Providence—George Hipwood, J. W. Barrett, H. S. Jenkins, A. B. Dolby, New York.

Benjamin Electric Manufacturing Company, Chicago—Basil G. Kodjbanoff, New York, eastern manager.

The Trolley Supply Company, Canton, Ohio—Robert K. Frost.

Albert and J.M.Anderson Manufacturing Company, Boston—J. R. Eckman, Boston; Ernest Wotlmann, H. F. Sanville.

Stanley Electric and Manufacturing Company, Pittsfield, Mass.—Samuel I. Dodd, M. C. Canfield, George Robb, H. R. Wilson, F. W. Garrett, W. R. Hamlin.

United States Steel Company—W. E. Reid, Louis H. Miller, West Everett, Mass.

Railway Steel Spring Company, New York—A. S. Henry, General F. C. McLewee, David Roach.

The Columbia Machine Works, Brooklyn, N. Y.—W. R. Kerschner, second vice-president.

Chicago Mica Company, Valparaiso, Ind.—E. H. Heilstedt, secretary and treasurer; Robert K. Preston, D. R. Ford.

Westinghouse Electric and Manufacturing Company—W. M. McFarland, Arthur Hartwell, L. M. Aspinwall, N. W. Storer, K. F. Elers, J. B. Ingersoll, H. P. Davis, Pittsburg; E. W. T. Gray, D. E. Drake, W. S. Rugg, Calvert Townley, J. L. Crouse, F. B. H. Paine, O. T. Smith, New York; J. R. Gordon, Atlanta, Ga.; T. P. Gaylord, Ervin Dryer, C. W. Regester, Chicago; R. S. Brown, D. E. Manson, M. H. Merrill, E. D. Mills, Boston, Mass.; C. A. Bragg, Philadelphia; N. S. Braden, W. W. Lovell, Cleveland, Ohio; Paul S. Brady, George W. Pulver, S. B. Storer, Syracuse, N. Y.; T. C. Frenyear, Buffalo, N. Y.; C. F. Medbury, Detroit, Mich.

The Westinghouse Traction Brake Company—H. H. Westinghouse, J. R. Ellicott, A. J. Brislin, G. E. Baker, C. R. Ellicott, New York; G. H. Martin, F. V. Green, Boston; I. B. Clarke, Cincinnati, Ohio; G. A. Hagar, Chicago; W. D. Ray, P. J. Myler, Cleveland; E. H. Dewson, J. F. Miller, E. M. Herr, Pittsburg.

The Westinghouse Air Brake Company—H. S. Kolseth, Boston; S. J. Kidder, St. Louis.

The Nernst Lamp Company—A. E. Flemming, Chicago; George C. Ewing, Boston.

The R. D. Nuttall & Company—F. A. Estep, Pittsburg.

The Westinghouse, Church, Kerr & Company—Wallace Franklin, Detroit.

The Westinghouse Companies Publication Department, W. M. Probosco, New York: the Westinghouse Companies Canadian interests, H. D. Bayne, Montreal.

Garton-Daniels Company, Keokuk—J. V. E. Titus, secretary.

E. P. Roberts & Company, Cleveland—William C. Andrews.

Columbia Mechanical Works, Brooklyn—J. L. Buehler.

New Haven Car Register Company, New Haven— J. S. Bradley.

S. B. Condit, Jr., & Company—S. B. Condit, president.

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Gould Storage Battery Company, New York—W. W. Donaldson, H. B. Oakman, E. L. Draffen, manager Chicago office.

The Ohio Brass Company, Mansfield, Ohio—C. K. King, James C. Warren, M. A. Berg, E. R. Mason, J. H. Jameson, O. W. Uthoff, G. M. Mead, A. L. Wilkinson, W. M. Garland, E. F. Wickwire.

The Electric Cable Joint and Appliance Company, New York—William M. Murphy.

Speer Carbon Company, St. Mary's, Pa.—John S. Speer, G. P. Fryling.

The Elliott Brothers Electric Company, Cleveland—W. H. Elliott, manager.

Ludlow Supply Company, Cleveland—Joseph B. Ludlow, W. E. Ludlow.

Federal Manufacturing Company, Cleveland—E. S. Ludlow, H. E. Keeler.

Gold Car Heating Company, New York—E. D. Gold, J. E. Ward, William Stocks, Frank Cahill.

W. I. Van Dorn Company, Chicago—W. I. Van Dorn.

Wendell & Macduffie, New York—R. L. Macduffie and C. A. Hayden.

Charles F. Johnson, Buffalo, dealer in second-hand railway equipments.

Keefer Car Switch Company, Albany—W. H. Keefer.

Johns-Pratt Company, Hartford—E. B. Hatch.

Forest City Electric Company, Cleveland—W. A. Neff.

Green Engineering Company, Chicago—A. P. Poppenhusen.

D. Van Nostrand Company, publishers, New York—Charles Speirs.

Stuart-Howland Company, Boston—H. Smith.

Philadelphia Electric Company, Philadelphia—G. Seixees.

John A. Stewart Electric Company, Cincinnati—John A. Stewart.

Le Valley Vitae Carbon Brush Company, New York—J. V. Clarke, president; William H. Bell.

Consolidated Car Heating Company, Albany, N. Y.—S. B. Keys, A. S. Knowles, Boston; William J. Walther.

National Lock Washer Company, Newark, N. J.—Daniel Hoyt, R. L. Thomas.

National Lead Company—R. L. Weithas, Arthur Benzel, F. B. Pierson.

Sherwin-Williams Company, Cleveland, Ohio—E. M. Williams, L. W. Borney, F. A. Elmquist.

John A. Roebling's Sons Company, New York—G. W. Swan, W. G. Tingley.

Consolidated Engine Stop Company, New York—Henry W. French.

Vose Spring Company, New York—P. H. Scott.

Rossiter, MacGovern & Company, New York—Frank MacGovern, J. W. Archer, J. A. Pierce, W. W. Rossiter, R. J. Randolph, Jr., Charles McDonald and George R. Davis, New York; J. A. Pierce, St. Louis.

Bridgeport Brass Company, New York—Wylie Brown.

Western Electric Company, New York—R. H. Harper and R. M. Campbell.

Elmer P. Morris Company, New York—Elmer P. Morris.

Electric Railway Equipment Company, Cincinnati—P. F. Harten and E. P. Morris.

Standard Vitrified Conduit Company, New York—B. S. Barnard, president, and Walter H. Barnard.

Partridge Carbon Works, Sandusky, Ohio—James Partridge, R. K. Mickey.

Flood & Conklin Company, Newark, N. J.—I. K. Munford, D. W. Clark, H. C. Dick.

C. J. Harrington, New York, representing Chase-Shawmut Company and Banner Electric Company.

Duff Manufacturing Company, Pittsburg, Pa.—George A. Edgin.

Mayer & Englund Company, Philadelphia, Pa.—Charles J. Mayer, A. H. Englund, W. A. Lockley, William Armstrong, Jr., J. F. McCostly, J. M. Gallagher, H. G. Lewis, D. L. Crawford.

Globe Electric Manufacturing Company, Cleveland—William C. Egert.

Peckham Manufacturing Company, New York—William M. Wangsler, E. G. Long, J. A. Hanna, Warren Boyer, F. A. Richards, E. Peckham, president; H. W. Wilkinson, J. J. Riley.

Allis-Chalmers Company, Chicago—Edw. J. Meisenheimer, E. W. Tucker, Jos. W. Lyons, Jesse Vail, J. B. Allen.

Sterling Varnish Company, Pittsburg—S. C. Schencke, H. Lee Bragg.

American Automatic Switch-Signal Company, Chicago—N. B. Madden, Robert Skeer, V. W. Bergenthal.

Bruck Solidified Oil Company, Boston—J. N. Bruck.

Baltimore Railway Specialty Company, Baltimore—J. E. Norwood.

Massachusetts Chemical Company, Boston—Elmore C. Green, president; Louis O. Ducloss.

G. M. Gest, New York—W. I. Jackson, manager of the Cincinnati office.

The General Electric Company—J. R. Lovejoy, general manager railway department; J. G. Barry, assistant manager railway department; W. B. Potter, chief engineer railway department; C. C. Pierce, Boston; R. H. Beach, J. J. Mahoney, New York; S. W. Trawick, Atlanta; A. D. Page, manager incandescent lamp sales; L. R. Pomeroy, New York; T. P. Bailey, Chicago; G. D. Rosenthal, St. Louis; F. F. Barbour, San Francisco; E. H. Mullen, New York; F. H. Gale, Schenectady.

American Steel and Wire Company, Chicago—C. S. Knight, Jr., F. A. Keyes, A. G. Greenberg.

Adam Cook's Sons, New York—A. J. Squier, G. C. Cook.

Lumer Bearing Company, Buffalo—E. P. Sharp.

The Pennsylvania Steel Company, Steelton, Pa.—G. W. Parsons, Charles S. Clark, C. W. Reinvehl, C. E. Irwin, C. A. Alden, J. A. Fitzpatrick, M. D. Pratt, J. C. Jay, Jr., W. C. Cuntz, R. E. Belknap.

India Rubber and Gutta Percha Insulating Company, New York—Dr. William M. Habirshaw, president; James B. Olsen, manager sales.

Professor W. E. Goldsborough, chief Bureau Electricity World's Fair, St. Louis.

Robins Conveyor Belt Company, New York—C. K. Baldwin, M. S. Murray.

Jandus Electric Company, Cleveland—W. R. Benham.

Electric Motor and Equipment Company, Newark, N. J.—Ed. Beatty.

Sampson Cordage Works, Boston—F. J. Coakley.

Buckeye Electric Company, Cleveland—W. R. Benham.

American Electric Works, Providence—Frank B. Baker.

Porter & Berg, Chicago—M. A. Porter, V. R. Mason.

Crocker-Wheeler Company, Ampere, N. J.—Putnam A. Bates, R. L. Barnes, F. B. De Gress, Samuel Russell, Charles W. Startsman, H. J. Sage.

J. M. Atkinson Company, Chicago—J. M. Atkinson, president.

R. W. Conant, Cambridge, Mass.

Pettingill-Andrews Company, Boston—George H. Buckminster, W. J. Keenan.

Standard Underground Cable Company—Frank C. Crosby, T. E. Hughes, Philadelphia; C. J. Marsh, New York; William McBride.

N. A. Christensen, Milwaukee.

Eugene Munsell & Company and Mica Insulator Company—Charles E. Coleman, manager Chicago office. This exhibit consisted of micanite rings, segments and Empire cloth and other lines of installation.

J. G. White & Company, New York—J. G. White, president; H. J. Dowd.

Safety Insulated Wire and Cable Company, New York—G. P. Eckert.

American Railway Supply Company, New York—Walter Chur.

Pantasote Company, New York—John High.

McRoy Clay Works, Chicago—E. F. Kirkpatrick.

Standard Pole and Tie Company, New York—Fred L. Merritt.

McGuire Manufacturing Company, Chicago—W. A. McGuire, J. A. Cook.

Ball & Wood—J. H. Marshall, manager Chicago office.

Waclark Wire Company—H. F. Sanville, Philadelphia.

Dearborn Drug and Chemical Company, Chicago and New York—William B. McVicker, second vice-president and Eastern manager; W. T. Johnson, manager Philadelphia office; Grant W. Spear.

Standard Varnish Company, New York and Pittsburg—John Wolph, manager insulating department.

Joseph Dixon Crucible Company, Jersey City—H. A. Nealley.

The National Electric Company, Milwaukee—F. C. Randall, manager the railway department, and J. F. Cunningham, S. I. Wales, R. P. Toll, J. F. Dixon, J. H. Wenton, J. S. Hamlin, Charles S. Knight, Robert Long, Charles N. West, Charles N. Leet, J. D. Maguire, W. W. Power, H. H. Ransom, J. J. Nef, J. W. Richards, C. G. Burton, W. L. Waters.

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CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

WIRELESS TELEGRAPH ON LAKE MICHIGAN—Steamer City of Milwaukee, which is equipped with wireless telegraph instruments, sent it has been asserted, the first wireless message over Lake Michigan. The message was sent when the steamer was twenty-five miles from shore to Mr. J. H. Graham, president of the Graham & Morton Line.

JAPANESE HIGH-SPEED ELECTRIC TRACTION SYSTEM—Contracts have been let for the power plant equipment for the new Japanese high-speed electric traction system to be built between Yokohama and Tokio by the Keihin Traction Company. The cars will be fitted with four motors of fifty-horse-power capacity each. The generator installation will aggregate 800 kilowatts, and two engines of 400-horse-power capacity each will be installed.

ELECTRIFICATION OF A STEAM ROAD IN CALIFORNIA—A section of the North Shore Railroad, from Sausalito to Mill Valley, Cal., a distance of fifteen miles, has been equipped for electrical operation. The equipment consists of the ordinary third-rail system. Power to operate this system will be furnished by the Bay County Power Company. To provide against emergency, an auxiliary power plant has been installed to be run by steam.

TELEPHONE LINES IN MEXICO—A telephone system is announced for the state of Sonora, Mexico, the lines to be built at once, to connect the city of Guaymas with Hermossillo, Nogales, etc. The Sonora Telephone has been organized under the laws of Arizona to carry out the enterprise. Among those primarily interested are L. W. Mix, Edward Titcomb, W. E. Bristol and C. C. Kingsley, all of Nogales, and F. E. Monteverde, of Hermossillo. The company has also power to operate in other places in the southern republic.

NEW EQUIPMENT FOR IOWA TELEPHONE COMPANY—The Iowa Telephone Company has placed the contract for building its new exchange in Des Moines, at Seventh and Pleasant streets, to F. M. Garthwait, of Chicago, at approximately $37,000. The first and fourth floors are to contain the operating apparatus. The new switchboard, which has been ordered, is being built by the Western Electric Company, Chicago; it will be a common battery, multiple board. When the new plant is completed, practically none of the several apparatus will be used.

CANADIAN COMPANY PLANS POWER SCHEME FOR MEXICAN MINES—The Mexican Light and Power Company, Limited, which is being projected by Canadian capital and is installing a plant of 80,000 horse-power at Necaxa, Puebla, to supply the city of Mexico, has announced that it will transmit power to the great mining camps of El Oro and Talpujahua. The building of the Mexican Light and Power Company's plant is progressing with great rapidity, and work is going on night and day on the three tunnels necessary for the first installation of 40,000 horse-power. A difficult feature of this work is the excavation for the pipe line, which is to follow a perpendicular cliff for 12,000 feet.

A TRANS-CONTINENTAL ELECTRIC LINE—From Peoria, Ill., the news comes that a communication has been received by Mayor Woodruff, asking his personal cooperation in the establishment of a vast system of connecting electric lines, reaching across the United States, and offering residents of cities through which it will pass stock in the general company. The home office of the new company, which is to be known as the Rapid Transit Railway, is said to be St. Louis, and it is specially designed to convey persons to the World's Fair. The plans of the corporation, it is stated, are to start with the operation of street cars in St. Louis, and from there to extend the system over a national turnpike east and west and establish a national trunk line with seaport terminals.

ALASKA TELEGRAPH LINES READY—Major Scriven, acting chief officer of the army, has been informed that telegraphic communication is now established in all parts of Alaska covered by the signal corps lines. Forest fires in the Tanana valley interrupted the building and completion of the line for nearly two months; but lines which were destroyed have been rebuilt, and the government is now within telegraphic reach of forts Egbert and St. Michael and the entire Yukon district; also with the Copper river country. The Alaskan points are reached at present over the Canadian lines, an arrangement having been made with the Canadian Government for their use; but it is expected that a cable from Puget Sound to Skagway and Valdez will give through connection by wires owned and operated by the United States.

ELECTRICITY AT THE NEW ORLEANS NAVAL SHOPS—In the new shops of the New Orleans naval station which the United States Government is now erecting at New Orleans, La., electricity is to play an important part in the operation of the shop tools. According to the plans and specifications now being prepared under the auspices of the Bureau of the Yard and Docks at Washington, D. C., the only steam that will be employed for running the various machines, no matter how intricate or cumbersome, will be produced for the sole and exclusive use of generating electric power for operating all the tools in every shop. The new power-house for the naval station will furnish power for every building at the station with the exception of the machine shop, which is nearing completion and will be run by a small but thoroughly equipped power-house which will soon be turned over to the government for final acceptance.

NEW LONG-DISTANCE TELEPHONE COMPANY FOR ALABAMA AND GEORGIA—A new long-distance telephone company in Georgia and Alabama, and which will probably reach out into South Carolina and Florida, has been organized and contracts signed at Atlanta, Ga., between C. Jerome Simmons, of Atlanta, and W. A. Bisbee, of Savannah. Negotiations are under way to secure the Atlanta Telephone and Telegraph Company as a connection at the Atlanta end. Mr. Simmons is president of the Atlanta Company, and Mr. Bisbee is president of the Georgia Telephone and Telegraph Company, of Savannah. He is also connected with the Southern Long-Distance Telephone and Telegraph Company, which is soon to be chartered, and which proposes to put in operation the new long-distance system. It is proposed to connect by the new system the cities of Atlanta, Savannah, Augusta, Montgomery, Birmingham and all intermediate points, including perhaps Columbia, S. C., and Jacksonville, Fla.

EXTENSIVE TROLLEY MERGER—It is stated that an electric railway operating between Cleveland and Pittsburg will be established within a year. The new road will be capitalized at $10,000,000. The distance between Cleveland and Pittsburg by electric railway will be 137 miles, according to plans which have been laid out. A large portion of the contemplated road is already built, and the most of the work to be done in the enterprise will be the merging of the various companies or at least the establishment of an agreement between them. The Eastern Ohio Traction Company has a line running from Cleveland to Garrettsville. From Garrettsville to Leavittsburg, a distance of thirteen miles, there is no road, but one will be built in a short time by the Eastern Ohio Traction Company. The Pennsylvania & Mahoning Valley Company's lines run from Leavittsburg to Youngstown, and the Youngstown & East Liverpool line operates between Youngstown and East Liverpool. The remaining distance from East Liverpool to Pittsburg will be covered by another line, a company having been formed for the purpose of building it.

PENNSYLVANIA RAILROAD'S NEW POWER-HOUSE—Work is to commence this month on the big power-house of the Pennsylvania & Long Island tunnel, and for the Atlantic avenue division of the Long Island Railroad between the Flatbush avenue station and Jamaica. The power-house, which will be located at Long Island City, L. I., will be 250 feet by 500 feet and 100 feet or more in height from the sidewalk to the eaves. The generators to be installed for the Atlantic avenue division will have a capacity of about 16,500 kilowatts, from 22,000 to 25,000 horse-power, which can be

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increased with an overload to approximately 30,000 horse-power. Sixty-four ducts will be laid for feeding wires on the Atlantic avenue division between Flatbush avenue, Brooklyn, and Jamaica. The entire work of this electrical plant installation and the power-house of the Pennsylvania & Long Island tunnel from Jersey City, under the North and East rivers and Manhattan Island and Long Island City, will be modern and of best class throughout, and will be under the direction of Westinghouse, Church, Kerr & Company. Consulting engineers are Charles M. Jacobs, Alfred Noble, William H. Brown, of the Pennsylvania Railroad; Lester Lindenthal, Lieutenant-Colonel Raymond, of the United States Engineering Corps, and George S. Gibbs. Mr. Gibbs is also a member of the board of directors of the Tunnel Railroad Company. A similar power-house to the above is to be erected at Jersey City, and the company will provide itself with a duplicate set of engines, dynamos and of other necessary machinery for the entire system, to be used in case of a breakdown or while repairs are being made.

NEW YORK CITY TRACTION HOLDINGS CHANGES HANDS AGAIN—Official confirmation has been given of the sale of Kuhn, Loeb & Company's holdings in Metropolitan Securities to the Whitney-Ryan party, this announcement being made at the office of Kuhn, Loeb & Company: "Messrs. Kuhn, Loeb & Company confirm the report that they have sold their holdings of Metropolitan Securities Company stock to Mr. Thomas F. Ryan and his associates, their willingness to sell having been determined by the necessity of giving more and closer attention to the details of the management of the properties and the practical operation of the roads than they found practicable to give." The Metropolitan Securities Company was incorporated under the laws of New York on February 14, 1902, as a security-holding company, with a capital of $30,000,000, for the purpose of providing for the present and future needs of the Metropolitan Street Railway Company. The powers of the company are very broad, and allow it to acquire the securities of corporations which own, operate or lease or which are organized for the purpose of constructing, owning, operating or leasing surface railroads, elevated railroads, rapid transit railroads, underground railroads, etc. It is privileged to purchase, acquire, hold and dispose of the stocks, bonds and other evidences of indebtedness of any corporation, domestic or foreign, and issue in exchange therefor its stocks, bonds or other obligations. The duration of the corporation is a thousand years. The Interurban Street Railway Company leased the Metropolitan Street Railway Company, guaranteeing seven per cent dividends on its stock, besides all fixed charges. Stockholders of the Metropolitan Street Railway Company were given the right to subscribe for $23,400,000 of the $30,000,000 Metropolitan Securities Company's stock, the remainder going to new interests. The stock of the Metropolitan Securities Company was underwritten by Kuhn, Loeb & Company at par. The Securities company agreed to pay $23,000,000 in cash into the treasury of the Interurban company, receiving in return stock of the latter at par, and debentures bearing interest at not exceeding four per cent. The agreement also provided that the Securities company should acquire any further stock and securities that the Interurban company might issue in the future. The lease was ratified on March 20, 1902.

AUTOMOBILE NOTES.

THE AMERICAN AUTOMOBILE ASSOCIATION, 753 Fifth avenue, New York, announces the following schedule of race meets, licensed by the American Automobile Association: September 4 and 5, Cleveland Automobile Club, Cleveland, Ohio. September 7 and 8, Detroit Automobile Racing Association, Detroit, Mich. September 7 to 10, Nashua Fair Association, Nashua, N. H. September 12, New York State Fair (auspices of Syracuse Automobile Club), Syracuse, N. Y. September 19, Rhode Island Automobile Club, Providence, R. I. October 3, Empire City Trotting Club, Yonkers, N. Y. October 10, Automobile Club, of Philadelphia, Philadelphia, Pa. January 25 to February 6, 1904, Florida East Coast Automobile Association, Daytona Beach, Fla.

AUTOMOBILE RUN TO BOSTON—The governors of the Automobile Club of America have authorized the Runs and Tours Committee to organize a tour to Boston and return, September 25 to 30, inclusive, for members, their families and guests. The start will be made from New York on Friday morning, September 25, and the following route has been selected: Friday, September 25, New York to Hartford, 121 miles; Saturday, September 26, Hartford to Boston, *via* Springfield, 124 miles; Sunday, in Boston; Monday, September 28, Boston to Springfield, 97 miles; Tuesday, Springfield to Lenox and Pittsfield, luncheon in Pittsfield Tuesday afternoon; Wednesday, September 30, the morning will be spent in optional runs in the vicinity of Pittsfield. The rendezvous Tuesday evening will be at Poughkeepsie, at which time the run from Pittsfield to Poughkeepsie, a distance of sixty-nine miles, will have been made. Thursday, October 1, the run will be from Poughkeepsie to New York, seventy-five miles, making a total of 535 miles. Each day's run will be "go as you please" and members will rendezvous at the night stops in Hartford, Boston, Springfield, Pittsfield and Poughkeepsie, where ample hotel accommodations and garage facilities are afforded. A full description of the route, which is largely over good roads, will be issued, as well as a list of available hotels where luncheon may be had, and a list of stations along the route where supplies may be obtained and repairs made, if needed, during each day's run. Mr. Emerson Brooks is chairman of the Committee on Runs and Tours, and the headquarters of the Automobile Club of America is at 753 Fifth avenue, New York city.

ELECTRIC LIGHTING.

CLINTON, LA.—The Clinton Light Company's plant has been completed and put in operation.

ELMHURST, N. Y.—The Glen Cove Light and Power Company has been organized with a capital of $15,000.

SCHENECTADY, N. Y.—The Schenectady Railway Company has signed a contract to light the village of Rexfords Flats.

CROOKSTON, MINN.—An electric light franchise has been granted by the village of Bagley to M. J. Kolb and John Bohmer.

CULPEPER, VA.—The Messrs. Reckford, of Bel Air, Md., have secured the corporation franchise for the purpose of putting in an electric light plant.

JERMYN, PA.—The ordinance granting a franchise to the Household Electric Light, Heat and Power Company has been passed by the council.

MANSFIELD, MASS.—Work is being hastened on the municipal plant for this city, and it is expected that it will be in operation in about four months.

TRENTON, TENN.—At the election held to determine whether bonds should be issued to buy the electric plant now operated by Treeman & Wood, and put in an up-to-date plant, the issuance of bonds was defeated.

MINNEAPOLIS, MINN.—Work has been commenced on the rebuilding of the plant of the Winona Railway and Light Company at an outlay of $100,000. The new enclosed arcs for lighting the city are to be ready by October 1.

GRANVILLE, N. Y.—The directors of the Granville Electric Light and Gas Company have elected the following officers: President, Frank D. Pember, Granville; vice-president, B. G. Higley, Sandy Hill; secretary and treasurer, E. R. Norton, Granville. The additional directors are James E. Norton, Joseph B. McCormick, Granville; N. T. Drake, W. J. Gallagher, Sandy Hill.

BROCKPORT, N. Y.—The Albion Electric Light and Power Company, which bought out the local plant several weeks ago, has begun the construction of a transmission line from Albion to this village, taking in not only the villages between the two points, but also several stone quarries which will now use electric power for operating their machinery in place of steam, as formerly.

DOYLESTOWN, PA.—The Sellersville Electric Light and Power Company, which has a contract with the city of Sellersville for street lighting, has completed its plant. In addition to this contract, the company has made arrangements to do a large private business. D. A. Walmbold is president of the company, and M. A. Clymer, secretary and treasurer. The stock is owned exclusively by Sellersville interests.

LOUISIANA, MO.—At the adjourned meeting of the city council an ordinance was passed granting a twenty-year franchise to the Louisiana Gas and Electric Light Company, of this city. By the terms of the new franchise all former franchises are repealed. The price of street lamps of 2,000 candle-power remains unchanged, at $80 per year, additional lights to be furnished at $60 per year. The old franchise had six years to run, but the plant recently changed hands and the new owners applied for another franchise.

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PERSONAL MENTION.

PROFESSOR L. D. CRAIN has been appointed head of the new department of electrical engineering at the Agricultural College at Fort Collins, Col.

E. J. WALSH, secretary and treasurer of the Acme Electric Company, Chicago, has recently returned to the home office after an extended business trip in the West.

PROFESSOR J. H. GILL, of the Montana State University, has been appointed to the chair of mechanical and electrical engineering in the James Millikin University at Decatur, Ill.

H. E. RICHARDS, advertising manager of the F. Bissel Company, Toledo, Ohio, has been visiting the East accompanied by Mrs. Richards. Mr. Richards is now at headquarters in Toledo.

M. I. BERGER, president of the Vought-Berger Company, La Crosse, Wis., has completed an extensive trip through the Northwest, where he found independent telephone interests very active.

PROFESSOR VICTOR C. ALDERSON, formerly dean of the Armour Institute of Technology, Chicago, Ill., has assumed the duties of the presidency of the Colorado School of Mines, at Golden, Col.

MR. GEORGE W. SCOTT, Chicago, Ill., has been commissioned by the executive board of the Indiana State University, Bloomington, Ind., to design a complete heating, lighting and power plant for the university.

MR. GEORGE JACOB DAVIS, JR., formerly instructor in civil engineering at the University of Wisconsin, has accepted a position with Norman B. Levermore, civil and hydraulic engineer, at San Francisco, Cal.

MR. HENRY J. HALLBERG, for several years connected with the General Incandescent Arc Light Company, has tendered his resignation to accept the superintendency of the electric light department of the Cincinnati (Ohio) Gas and Electric Company.

MR. I. L. STOREY, the designer of the Storey motor, has joined the staff of the Magneto Electric Company, Amsterdam, N. Y., and has under construction plans for a new line of motors ranging from one to ten horse-power, which that company will put on the market.

MR. S. H. BAYLEY, of McKeesport, Pa., general superintendent of the Federal Telephone Company, has tendered his resignation to the company to take effect October 15, 1903. Mr. Bayley will remain in McKeesport and expects to open up a general electrical business.

M. ROZAL, of Paris, has invented a system of electrical perforating characters on a moving band connected with a typesetting machine. The new system dispenses with transcription for press purposes and has already engaged the attention of the French Academy of Science.

THE HON. MARSDEN J. PERRY, the well-known electric light and traction magnate, Providence, R. I., was a New York visitor last week. While Mr. Perry has many other large interests, he has never forsaken his first love and remains a forceful factor in the electrical development of his city and state.

MR. J. S. STONE, a lecturer in the Massachusetts Institute of Technology, who has made important researches in the matter of wireless telegraphing, has, it is asserted, succeeded in sending messages from Cambridge to Lynn, a distance of about twelve miles, in the immediate vicinity of electric railways.

MR. L. W. KITTMAN, the energetic representative of the Marshall-Sanders Company, Boston, will hereafter make his headquarters in Chicago, and devote his entire time to the interests of the electrical trade west of Pittsburg. This move is necessitated by the great development of the company's western interests.

MR. WILLIAM CARPENTER WOODWARD, Providence, R. I., spent several days in New York last week. He reports continuous development of the electric lighting interests of his city. The Narragansett Electric Lighting Company, of which Mr. Woodward is electrical engineer, is a progressive and ably managed company.

MR. HENRY C. MEYER, JR., the well-known consulting engineer, of New York, has been commissioned to design and superintend the construction of a central heating and lighting station to be erected at West Point, N. Y. The new station will constitute a part of the improvements to be made at the United States Military Academy.

MR. C. P. SKINNER, vice-president of the Electric Contract Company, New York city, has returned from an extended trip abroad, where he spent considerable time. Mr. Skinner closed several large sales for his company to foreign government purchases. He states that American dry batteries are being well received abroad, and are even taking precedence over German manufactures in Germany.

MR. HENRY MARQUETTE LANE, formerly principal of the school of mechanical engineering of the International Correspondence School, Scranton, Pa., has become a member of the staff of the *Railroad Herald* of Atlanta, Ga. Mr. Lane is a graduate of Purdue University, and has had considerable experience as a consulting and constructing engineer, and as an instructor. Mr. Lane has now become mechanical editor of the *Railroad Herald*.

DR. EMILE BERLINER, of Washington, D. C., inventor of the Berliner telephone transmitter and several scientific instruments, has devised an aeroplane which has successfully maintained itself in flight. The Berliner aeroplane is made of aluminum and tinplate, with rods of oak and metal tubing. The whole machine is ten feet wide by ten feet long. Wheels are employed to facilitate the start, which is made from the ground and without any propelling force or trackway.

GENERAL A. W. GREELY has returned from Berlin, bringing the report of the American delegates to the International Wireless Congress. The General proceeded to Washington to present the report to the State Department. It is understood that the proceedings of the congress will be published simultaneously on both sides of the Atlantic at an early day, the foreign governments having agreed to defer publication until the American delegates could hand in their report.

DR. GEORGE F. SEVER, adjunct professor of electrical engineering at Columbia University, New York city, in his official capacity of chief electrical engineer of the Department of Water Supply, Gas and Electricity, of the Borough of Manhattan, is superintending the investigation now being made in Manhattan to determine to what extent electrolysis is going on in the underground pipe line of the city. Dr. Sever is assisted by the engineers of the department and the railroad companies.

MR. THOMAS A. EDISON, according to recent statements in the daily press, has evolved a theory for the cure of cancer and other malignant humors. He believes that in the case of such diseases there is a constant deterioration of blood cells due to the debilitation produced around the seat of injury. If an injection of blood from a healthy person, untainted with cancer, were introduced near the diseased portion, the growth would be attacked by germs possessing the strength to conquer the malady.

MR. GEORGE WESTINGHOUSE ON ELECTRIC RAILWAY ACCIDENTS—In a recent article in the New York *Times*, Mr. George Westinghouse urges the use of incombustible material in train construction and station work for underground and elevated electric railway work. He writes:

The following requirements, among others, can easily be complied with, and are respectfully suggested for consideration and discussion.

1. Trains to be constructed of iron or steel, with the interior finish of incombustible materials.
2. The division of the third rail for the supply of electric current into suitable sections, each section being supplied with current only when required to propel a train.
3. The limitation, by suitable devices, of the amount of current supplied to each section so that in the event of a short-circuit on the train the current will be automatically and instantaneously cut off at a point some distance from such section of the third rail.
4. Provision for the cutting off of the current from each supply section of the third rail at the will of the motorman.
5. No other live conductors than the third rail to be in close proximity to the line.
6. No wires carrying high voltages except upon motor cars, and motor cars only at the ends of a train.

The state of the electric art has so advanced that compliance with the foregoing requirements is simply a matter of additional expense, incomparable, however, to the financial losses which the companies will suffer if they do not make the electric operation of their railways absolutely safe.

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ELECTRICAL SECURITIES.

Speculation was dull last week and operations were governed mainly by the opinions of a few small traders who made slight raids on well-established securities. Good firmness was displayed, however, and in the main the tone was one of steadiness. It is not expected that speculation will recover very much for some little time, as this season is one of general dulness. The weather equation at the present time is also one of various moods and the crop certainly will have a moving influence upon conditions for a month at least.

There is some little talk abroad as to the certainty that when the books are balanced for the year there will be measured up a much decreased consumption. This, some people say, will have a reflex action, which will tighten things materially, and it is broadly hinted that there may be expected a full year of market dulness.

ELECTRICAL SECURITIES FOR THE WEEK ENDING SEPTEMBER 5.

New York:	*Closing.*
Brooklyn Rapid Transit	45½
Consolidated Gas	174¼
General Electric	163
Kings County Electric	150
Manhattan Elevated	135½
Metropolitan Street Railway	112¾
New York & New Jersey Telephone	148
Westinghouse Manufacturing Company	175

The directors of the Commercial Cable Company have declared the regular quarterly dividend of 2 per cent, payable October 1. Books close September 19 and reopen October 2.

Boston:	*Closing.*
American Telephone and Telegraph	133⅛
Edison Electric Illuminating	230
Massachusetts Electric	80
New England Telephone	126
Western Telephone and Telegraph preferred	81

Application has been made to the New York Stock Exchange to list $21,950,200 additional capital stock of the American Telephone and Telegraph Company.

Philadelphia:	*Closing.*
Electric Company of America	8½
Electric Storage Battery common	56½
Electric Storage Battery preferred	56½
Philadelphia Electric	6⅛
Union Traction	43⅞
United Gas Improvement	84½

The gross earnings of the Philadelphia Rapid Transit Company for the month of August increased at the rate of about $2,300 a day over the corresponding days in August, 1902.

Chicago:	*Closing.*
Chicago Telephone	120
Chicago Edison Light	145
Metropolitan Elevated preferred	58
National Carbon common	20
National Carbon preferred	88
Union Traction common	4½
Union Traction preferred	34

Chicago Telephone directors have declared the regular quarterly dividend of 2½ per cent, payable September 30. Books close September 15 and reopen October 1.

Metropolitan Elevated's daily passenger average during August was 102,971, an increase of 2,872.

South Side Elevated for August showed a daily average of 72,646 passengers carried, an increase of 4,312.

Lake Street Elevated's daily average of passengers carried for August was 41,644, an increase of 1,129.

ELECTRIC RAILWAYS.

TABOR, IOWA—The Tabor & Northern Railroad that runs from this place to Malvern, nine miles, will be turned into an electric road in the near future.

LANCASTER, PA.—An independent company has been formed to build a trolley line from Bowmansville to connect with the Lancaster and Ephrata line.

ATLANTIC CITY, N. J.—The Atlantic City & Suburban Traction Company filed a certificate at Trenton increasing its capital from $500,000 to $750,000. This company is building a trolley line running from Pleasantville to Atlantic City.

DECATUR, ILL.—The Decatur, Tuscola & Champaign Railroad Company has been incorporated by the Secretary of State. Decatur is the headquarters and the capital is $50,000. The incorporators are: J. H. Culver, Charles S. Hankins, William H. Black, J. M. Clokey, D. L. Campbell, J. L. Ray, Ashton Campbell, Charles Eckhart and A. W. Wallace.

GREENSBURG, PA.—The Pittsburg, McKeesport & Greensburg Railway Company has purchased the right of way for a direct line along the Pennsylvania Railroad between Manor and Irwin. Work is to begin soon. When completed the line will pass through Manor and Shafton and cut off two miles. After the road's completion to Irwin the line will be extended to Trafford City.

COLUMBUS, OHIO—The Covington, Bradford & Versailles Traction Company, which is to build an extension of the Dayton, Covington & Piqua line from Covington to Versailles, through Bradford, has been incorporated by E. C. Spring, Dennis Dwyer and Albert Emmanuel, of Dayton, and B. M. Hopkins and T. Russell Robinson, of New York, with a capital of $15,000.

PHILADELPHIA, PA.—The route of the proposed trolley line from Reading to Birdsboro has been definitely determined upon, and everything pertaining to the building of the road has been arranged for except procuring the right of way. The completion of this line and the building of a projected line from Birdsboro to Pottstown will place Reading in trolley communication with Philadelphia in the near future.

CONNELLSVILLE, PA.—The Pottstown & Suburban Street Railway Company has filed the extension papers in Berks County Court for a line from Pottstown to Boyertown, a total length of twelve miles. The new line when completed will furnish the connecting link between Reading and Philadelphia by trolley, and will leave only seven miles between Myerstown and Womelsdorf of having Lebanon connected by trolley with Philadelphia.

NEW LONDON, CT.—The incorporators of the Groton & Stonington Street Railway Company have voted to accept the charter recently granted by the General Assembly. The capital stock of the company is fixed at $600,000, and the proposed road will run from New London through Groton, Mystic and Stonington to the Rhode Island boundary at Westerly. The incorporators will shortly perfect organization. Surveys of the road have been made and after organization has been completed arrangements will be made for building the line.

MADISON, WIS.—The second electric railroad from Madison to the territory south of here has been incorporated. The company is named the Interstate Electric Railway and is formed for the purpose of building, operating and maintaining a system of interurban electric railway from Madison, running thence southeasterly through Verona, through Albany and Brodhead, all in the state of Wisconsin, thence southerly to a point on the Wisconsin-Illinois state line in the southeastern part of Green County. The entire length of the proposed line within Wisconsin is forty-nine miles.

OBITUARY NOTICE.

HENRY CLAY RANEY.

MR. HENRY C. RANEY, ex-president of the Interstate Independent Telephone Association, died at his home in Fairfield, Iowa, on August 21, the funeral being held on August 23 at Fairfield. Mr. Raney was born in Jefferson County, Iowa, in December, 1856, and had always lived in Fairfield or its immediate vicinity. He was educated in the common schools and at Parsons College, Fairfield. In 1884 Mr. Raney was admitted to the bar, practising until the time of his death, and was a member of the firm of Raney & Simmons. Mr. Raney became deeply interested in telephone matters, especially those which related to independent systems. About eight years ago he organized the Jefferson County Telephone Company, of which he was made president. When the Interstate Independent Telephone Association was formed in Chicago in the spring of 1902, Mr. Raney was elected its first president. He had also served as president of the Iowa Telephone Association, and at the time of his death was a member of the executive committee of that body.

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INDUSTRIAL ITEMS.

THE ELKIN MACHINE COMPANY, Elkin, N. C., advises that its factory capacity is now sufficient for the production of 6,000 oak insulated pins and brackets daily.

THE BULLOCK ELECTRIC MANUFACTURING COMPANY, Cincinnati, Ohio, in its September card calendar presents a photograph in colors of Heinrich Hertz. This is card No. 21 of its series of great men of science and engineering.

STANDARD TELEPHONE AND ELECTRIC COMPANY, Madison, Wis., reports that owing to the increased business of the company, its factory space has recently been greatly enlarged and several thousand dollars worth of new and improved machinery have been installed.

THE ELECTRIC APPLIANCE COMPANY, Chicago, Ill., well-known agent for the Gutmann wattmeters, will mail its catalogue of these meters on request. This wattmeter catalogue contains valuable information of a general character, and is well worthy of perusal by any one operating meters.

THE WYCKOFF PIPE AND CREOSOTING COMPANY, Stamford, Ct., with works at Portsmouth, Pa., has just sold to Westinghouse, Church, Kerr & Company a lot of its creosoted wooden conduits for the third-rail system that Westinghouse, Church, Kerr & Company is building in Pennsylvania.

THOMAS E. CLARK WIRELESS TELEPHONE AND TELEGRAPH COMPANY, Detroit, Mich., announces that it is erecting stations at Pontiac, Mich., on the State Fair Grounds for the purpose of carrying on commercial telegraphing. A new bulletin with a full description of instruments and valuable information on "Space Telegraphing," by Thomas E. Clark, will be sent on request.

SARGENT, CONANT AND COMPANY, INC., Boston, Mass., have prepared a booklet entitled "Industrial Electricity." This booklet is published in recognition of numerous requests for information regarding the work this company has been and is doing, particularly with reference to manufacturing industries. The booklet describes and illustrates a number of typical installations, and may be had on request.

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, Pittsburg, Pa., has issued three splendid bulletins, Nos. 1044, 1048 and 1068, respectively. These describe and illustrate direct-connected railway generators, the Westinghouse No. 68 motor, the Westinghouse No. 68C motor, and type S motors for direct current. These will be sent to any one who has been missed upon request to the company.

MARSHALL-SANDERS COMPANY, Boston, Mass., advises that the new model push-button switch, which was exhibited at the Contractors' convention in Detroit some weeks ago, has already found a large market, and that orders for it are being received from all parts of the country. These switches require only one style of face-plates, the National Electrical Contractors' Association standard size, two and one-half by four and one-quarter.

THE PLUNGER ELEVATOR COMPANY, on September 1, moved its New York office from 156 Fifth avenue to room 509 Whitehall Building, 17 Battery Place. This move was occasioned by the demand for increased office space and the desirability of a downtown office location. The company has just closed a contract, through its New York sales agent, W. L. Lawton, for ten elevators for the new factory of Eaton, Cole & Burnham, of Bridgeport, Ct.

C. W. HUNT COMPANY, West New Brighton, N. Y., has recently installed at the Lincoln power station of the Boston Elevated Railroad Company coal-handling machinery which it is asserted has lowered the world's record for rapid unloading. Coal was raised ninety feet above tide water and delivered to the storage pockets at the rate of 320 tons per hour. Installations follow in general design the "Standard" Hunt steeple tower rig, the moving gears and coal cracker being electrically driven and the hoisting engine direct-connected. The overhang of the folding boom is forty feet and the capacity of the shovel is two tons.

GENERAL ELECTRIC COMPANY, Schenectady, N. Y., has increased its series of "bulletins" by six pamphlets, Nos. 4,327 to 4,333, which treat of the following subjects, respectively: Small direct-current motors for stationary service, twelve pages; direct-current generators for railway service, sixteen pages; motor-starting rheostats, twelve pages; circuit-breakers for 125 and 250-volt circuits, two pages; a device for measuring the torque of wattmeters, two pages; enclosed arc lamps and auxiliary devices, forty pages. Accompanying these are some smaller pamphlets, two of which are catalogues of parts, Nos. 7,579 and 7,580, referring to recording wattmeters and direct-current enclosed arc lamps. The small pamphlet is a price-list of switches.

THE STERLING ELECTRICAL MANUFACTURING COMPANY, Warren, Ohio. William Coale, vice-president of this company, was in New York and the East during the early part of the month, and in an interview expressed enthusiasm for the demand for the output for the manufacturing of products and equipments to be used in electric lighting and kindred construction work. Mr. Coale said "Our factory at Warren is now pumping 10,000 incandescent lamps a day, and we have contracts on hand that will take the output of the factory for the next six months at this same rate of production." Mr. Coale added, "This production consists of about one-half of the type of lamps known as the 'Sterling Special,' the demand for which has developed during the last two years, as this type of lamp had never been manufactured prior to that date."

THE WESTERN ELECTRICAL SUPPLY COMPANY, St. Louis, Mo., announced that owing to the constant growth of its business during the past ten years, it has been found advisable to increase the cash capital and to divide the business into two parts. That portion of the business relating to electrical supplies has been sold to the Wesco Supply Company, a new company just organized with ample capital to continue that business under the personal management of Mr. R. B. Scudder. The other part of the business, that of railway supplies and building of electric lighting plants and electric railroads, will be retained by the Western Electrical Supply Company. The company now has on hand contracts calling for orders to the extent of nearly $1,000,000. It is expected shortly to increase the capital of $300,000. The company will continue to be personally managed by Mr. H. K. Gilman, with offices at the Chemical Building, St. Louis, Mo. Mr. Gilman, of the Western Electrical Supply Company, will retain an interest in the Wesco Supply Company and serve as one of its directors.

THE UNION SWITCH AND SIGNAL COMPANY, Swissvale, Pa., has made two recent and important contracts, one for the Interborough Rapid Transit Company (Subway), of New York, and one for the North Shore Railway of California. The Westinghouse electro-pneumatic system is to be installed on the first named, but a new feature is to be introduced, that of using alternating current. It is obvious that the use of track circuits on third-rail roads, where the rails are used for the return circuit, and at the same time for the signaling circuit, introduces what may be serious complications. In order to avoid these difficulties, the signals will be controlled by alternating current, through relays that are sensitive to alternating current only, and which will not be affected by the direct current used for train service in the subway. On the North Shore Railway, which runs about thirty miles north from Sausalito, Cal., across the bay from San Francisco, the electric semaphore system of automatic block signals is to be used with a track circuit. This being a high-tension third-rail electric road, alternating current will be used for the signal system.

SANGAMO ELECTRIC COMPANY and its agent, the Electrical Appliance Company, Chicago, announce the placing on the market of the Gutmann Duplex wattmeter for alternating currents. This meter is identically the same in appearance with one exception as the "Standard" 100-volt Gutmann meter and is of the same width and dimensions. The only change of external appearance is that instead of having a single shunt wire connection in the connection box underneath the meter, it has two shunt connections, one marked fifty volts and the other 100 volts. One of the advantages of the Gutmann Duplex wattmeter is that it can be placed in a circuit with an electromotive force of fifty volts, or it can be used with equally as accurate results in a circuit with an electromotive force of 100 volts without any change whatever in the mechanism of the meter and without calibration. The Gutmann "Duplex" wattmeter is different from the "Standard" wattmeter in that it has four binding-posts for connection instead of two. One pair of binding-posts are for use when connected in a fifty-volt circuit and the other pair are for use when connected in a 100-volt circuit. The change of connections of the binding-post is all that is necessary to be done when transferring this meter from a fifty-volt circuit to a 100-volt circuit, or *vice versa*.

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CHARLES W. PRICE . . . . . PRESIDENT AND EDITOR
STEPHEN H. GODDARD . . . . . SECRETARY AND MANAGER
WM. HAND BROWNE, JR. . . . . TECHNICAL EDITOR
AINSLIE A. GRAY . . . . . ASSISTANT EDITOR

PUBLISHING OFFICE . . . . . 13-21 Park Row, New York
WESTERN OFFICE: 40 Dearborn Street, Chicago, Ill. . . CHARLES FFRENCH, Manager
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CONTENTS

EDITORIALS 389, 390, 391
Meeting of the Electrochemical Society 389
Fireproof Cars 389
Electrical Instruments 389
Electricity Used to Operate Pumping Station for Drainage and Sewerage Purposes in the Southern States 390
Two Modern Developments 390
Reasons and Remedies for Municipal Ownership 391
Shop Testing of Motors and Generators for Commercial Service, by Bertrand B. Abry 392
Coal Handling Machinery Driven by Electric Motors, by D. A. Willey 394
Important Decision on Tesla Split-Phase Patents 397
Recent Steam Turbine Developments, by W. L. R. Emmet 398
Selenium and a New Form of Photo-Telegraph 401
Improved Governor for Steam Turbines 401
Polarization of Roentgen Rays 401
Electric Shock 401
Book Reviews 402
Oil Engines for Electrical Use, by G. E. Walsh 403
The Association of Edison Illuminating Companies 404
The Department of Machinery, Louisiana Purchase Exposition, St. Louis, Mo . . . 406
Some Data Relative to the Susquehanna River Development 407
Foreign Students at German Universities 407
Wind-Driven Generators 407
The Right of Way, by H. H. Vreeland 408
Report of the Mexico Electric Tramway, Limited 409
New Marine Steam Turbine 409
Electrical Patents 410
Motor Cars as Railway Feeders 411
Review of Current Engineering and Scientific Literature 412
The American Electrotherapeutic Association 413
The Manufacture of Incandescent Lamps 413
INDUSTRIAL SECTION:
Wireless Telegraph Apparatus 414
An Automatic Oil Filtering and Oiling System 415
Erie Railroad Company Experimenting with Telephones 415
Stombaugh Guy Anchors 416
Combination Arc and Incandescent Headlight 416
Telephone Apparatus Under Construction 417
The Lawrence-Hall Electric Company 417
Production of Coke in 1902 417
Air-Blast Transformers 418
A Small Engine-Generator Set 419
CURRENT ELECTRICAL NEWS:
Domestic and Export 420
Electric Lighting 420
Electrical Securities 421
Legal Notes 422
Telephone and Telegraph 422
Personal Mention 423
Electric Railways 423
Industrial Items 424

A suit against a telephone company, because the instrument failed to work when used to call the fire department, has been brought in New York state. This is believed to be the first suit of the kind on record and the decision will be watched with much interest. The claim is made that damage was done by the fire which, had the telephone been properly connected and in working order, would have been prevented. The suit would seem to turn on the interpretation of the contract under which the instrument was installed. The question is, however, of general interest; because the liability of telephone companies for defects in wires or instruments—causing "misconnections," in the language of the complaint—is a new one in the courts.

MEETING OF THE ELECTROCHEMICAL SOCIETY.

The fourth general meeting of the American Electrochemical Society is being held at Niagara Falls this week. This society is forging ahead rapidly and the meeting promises to be as successful as those already held. A good programme was prepared and at this writing a good attendance is indicated.

FIREPROOF CARS.

Why has there not been an effective effort to introduce all-metal passenger cars for railway purposes? The all-steel freight car has met with deserved success and the railroads can not secure them fast enough, yet the step from the construction of an all-steel freight car to the construction of an all-steel passenger car is not an insurmountable one, and we have been informed that one of the western steam roads has a steel car in service. The advantages of steel for this purpose are evident—it is light, strong and, above all, incombustible. Let us hope that the day when all passenger cars will be built without the use of wood may not be long delayed.

ELECTRICAL INSTRUMENTS.

It is not difficult to find many good reasons for the rapid development and application of electricity in its various forms to its manifold uses. One reason is undoubtedly the ease with which electrical energy may be accurately measured.

Electrical energy, from its very nature, can not be measured as water or gas, but must be estimated by certain effects which it produces, and this measurement can be made without interfering to any practical degree with the normal flow of the current. Thus, the engineer of a generating station is able at any instant to see not only what has been the total production of electrical energy for the day, but at what rate and in what form it is at that moment being produced by the station as a whole by the several generating units, and at what rate it is being delivered to each of the sections supplied.

The importance and convenience of this is very great, and therefore the manufacture of electrical instruments of all kinds has become a most important industry. These instruments may depend for their action upon one of several effects produced by the passage of the current. They may be of all grades, from the cheapest indicator which gives only a rough idea of what is going on to the type of instrument used in scientific research, which may have an accuracy and sensibility far exceeding that of any other type of physical measuring instrument. The manufacture of these instruments has called for the design of entirely new machinery and a special training of a high order. It is a fact—although it is not generally known—that the work done on certain classes of electrical instruments is as delicate and accurate as that done in the best watch manufactories of the world.

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ELECTRICITY USED TO OPERATE PUMPING STATIONS FOR DRAINAGE AND SEWERAGE PURPOSES IN THE SOUTHERN STATES.

In 1897 the New Orleans Drainage Commission called for bids on a large portion of the drainage system to be constructed in that city. Bidders were requested to submit figures on either a number of separately operated steam pumping stations or the same number of electrically operated pumping stations, and a power-house to furnish the necessary current. The two methods of operation were thus placed in competition. After canvass of the bids the commission let the contract for an electrically operated system, using current at 3,150 volts on the line and synchronous electric motors taking current direct from the line to operate the various pumps. Subsequent to 1897 additional contracts were let for the installation of additional pumping machinery, additional power generating machinery and two additional pumping stations which have recently been completed. Both of these last stations are now under test. There are now five electrically operated pumping stations with a partial equipment, and there will ultimately be two more pumping stations. Unfortunately this particular system is not now being increased to the capacity originally contemplated.

Superiority of the Electrically Driven Equipment.

The electrical features of this system have proven entirely successful. The only difficulty that has arisen has been in securing a reasonably high efficiency of the pumping machinery when operated at other heads than those for which the individual pumps are especially designed. The synchronous motors are subject to speed control only by controlling the speed of the generators, and as all of the various pumping stations are designed to operate independently off of any generating unit at central station or off of all the generating units in multiple, it is not usually practicable to vary the speed. The system is also operating at a very great disadvantage owing to the utter inadequacy of the present equipment as regards capacity, not through any fault of the machinery, but owing to its being only a partial equipment. Even taking these things into consideration, however, the expense of operation and the convenience of the electrical system make it unquestionably superior to the system of independent steam-driven stations.

Electrically Operated Sewage Pumps to Be Used.

Following in the footsteps of the Drainage Commission, the Sewerage and Water Board recently let contracts for a number of electrically operated pumping stations, located at various points on the main sewer to be built in the city of New Orleans. The power is to be generated at one of the pumping stations and transmitted to the others through a high-tension line enclosed in a conduit which is run immediately above the main sewer and built as a part of the sewer. The Sewerage and Water Board did not award contracts for complete pumping stations, but contracted first for the machinery only, requesting contractors to submit competitive designs. After the design was selected pumping stations were to be designed to accommodate the machinery contracted for. In this way the board aims to prevent any difficulties arising from forcing the machinery maker to build pumping stations which are out of his regular line, or forcing the general contractor to be responsible for machinery which he does not design.

Much to Recommend the Electrically Operated Pumps.

There are several pumping systems for drainage and irrigation purposes operated by electricity which are now being constructed or which are in contemplation in the southern states, and the prospect for a considerable increase in the amount of this work in the future is good. Electrically driven pumps for the substations forms a part of the sewerage plan of the city of Havana. This method of pumping sewage and drainage water recommends itself most strongly from the points of view of reliability and economy. The electrical matters which require the most attention are the proper protection of the line, because the machinery must be infallible during severe storms, and proper provision for starting the machinery where synchronous motors are used. This last provision is of the greatest importance, but the subject may be attacked from a mechanical rather than an electrical standpoint by so designing the station that the machinery does not have to start under load. Much more attention is required in the design of pumps for this kind of service, as the efficiency which is theoretically possible at the pump itself under the varying conditions of actual service is very much higher than the all-around efficiency that has actually been achieved up to the present time.

TWO MODERN DEVELOPMENTS.

The exposition given of the steam turbine during the recent convention of the American Street Railway Association, at Saratoga Springs, N. Y., was good and convincing. Mr. Emmet's paper, with the attending discussion, supplies what has been looked for eagerly by central station men. Facts covering actual commercial performance appeal to the manager of the light and power factory as no amount of theorizing will ever do—and facts came forth in good measure covering several plants. As regards the Chicago installation by the Commonwealth Electric Company, while conclusive results have not as yet been obtained, the preliminary tests are most reassuring and full of the promise of complete success.

A Single-Phase Railway.

It is a pleasure to be brought closely in touch with elements, which, of a certainty, are contributing an important quota to progress in great branches of the electrical industry. The delegates to the convention had this pleasure when enjoying a ride on the single-phase repulsion motor, experimental railway car equipment, which runs out over a good stretch of track along the canal at Schenectady. Under the conditions imposed the car accelerated smoothly, ran evenly and was under perfect control. The motors showed no indications of sparking at the commutators while running, although the latter were somewhat pitted from the effects of previous service. In the light of what we know of the three distinct systems that are now under process of rapid development, we can but feel that ultimate success of the single-phase railway, especially as applied to interurban and trunk line service, is well-nigh assured. What a prospect—to add to the present comforts of a trip from New York to Chicago, the pleasures of a "trolley ride"!

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REASONS AND REMEDIES FOR MUNICIPAL OWNERSHIP.

Municipal ownership of electric light plants is increasing in the United States. Statistics, as far as they are available, indicate that the great majority of these plants have been acquired within the last decade.

Statistics for a Single State.

The complete statistics for a single state, Massachusetts, as recorded in the annual reports of its gas and electric light commissioners, show that, compared with a single municipal electric light plant on June 30, 1892, there were seventeen such plants on the like date of 1902. At the earlier of these two dates the investment in the single municipal electric plant was $15,000, and on June 30, 1902, the total investment in the seventeen municipal plants, three of which included both gas and electric equipment, was $1,828,708. In the three combined gas and electric plants the investment was $467,711 on the date last named. Late in 1902 the city of Holyoke, Mass., acquired both gas and electric plants at a cost of more than $700,000.

Thirteen Municipal Plants in Large Cities.

Complete figures showing the rate at which municipal electric plants have increased are not at hand, but this can be done for comparatively large cities. In the bulletin of the United States Department of Labor for September, 1902, it was shown that thirteen cities, of more than 30,000 population each, had municipal electric light plants at that time. The names of these cities, arranged according to the years in which their plants were acquired, are as follows:

Chicago, 1888; Little Rock, 1888; Topeka, 1888; St. Joseph, 1889; Allegheny, 1890; Wheeling, 1892; Tacoma, 1893; Galveston, 1894; Detroit, 1895; Taunton, 1897; Columbus, 1898; Grand Rapids, 1899; Springfield, Ill., 1900.

Many Towns Have Municipal Plants.

This list of cities with over 30,000 population each that have municipal electric light plants gives no adequate idea of the growth in the number of such plants, because this growth has been mainly confined to small cities and towns. Massachusetts offers an example of this fact, for of the eighteen municipal electric plants in that state, only three, those at Taunton, Chicopee and Holyoke, are in the cities, the other fifteen plants being owned by towns.

Municipal Plants Constitute Large Part of Total.

The extent of municipal activity in electric light plants throughout the entire United States is brought out for the first time by the recent bulletin of the United States Census Office on the electric light and power industry. According to this bulletin, of the 3,619 central electric light stations in the entire country, not counting electric railway stations that do some lighting, 815 were operated as municipal plants on June 30, 1902. The number of municipal plants was thus 22.5 per cent of the total, and the investment in these municipal plants was $22,020,473 or 4.3 per cent of the entire investment for all the lighting systems.

Development More Rapid in Small than in Large Towns.

Comparison of the percentage of municipal plants to the total number of lighting stations with the percentage of the total investment that is found in these plants, that is comparison of 22.5 with 4.3 furnishes another proof that the development of municipal electric plants has been much more rapid in small than among large places.

The Political Significance.

The fact last noted is of especial interest in an effort to determine the cause of this municipal activity in electric lighting. It has been thought by some that hungry politicians looking for jobs are the most potent factors in the development, but this idea hardly stands the test of the fact just stated. It will hardly be contended that politicians are more powerful in the local affairs of small than of very large places, or that the New England town meeting, where the majority of all the town's voters rule, presents a particularly good field for jobbery.

Municipal Plants Due to Popular Demand.

Probably it is far nearer the truth to say that people in general have got an exaggerated idea of the profits to be made in electric lighting, and that towns, being more influenced than large cities by popular ideas, have, therefore, more frequently invested in municipal lighting plants. To many persons, at least, it will appear on a little reflection that the movement toward municipal electric plants is based mainly on the desire to make or save money for the town or for consumers.

Remedy Is Education.

If this is true the evident remedy is education. Make the accounts of electric light companies so plain and so public that all who care to read may know how much and how little there is in the business. Such a course involves no danger to the interests of the great majority of electric light companies, for these companies are seldom making more, and frequently making less, than that fair return on the value of property which the Constitution of the United States guarantees to those engaged in public service, in spite of any attempted regulation of rates.

If the secrecy of accounts of electric light systems continues and over issues of securities based on them is not checked, it is hard to see how the popular error as to large profits in this line of business is to be mended.

An Ineffective Law.

Some have thought that laws which force cities and towns to buy out existing electric light plants before engaging in like enterprises would check municipal activity along this line, but this has not proved to be the result in Massachusetts. Every municipal plant save one in that state has been acquired under a law that requires a city or town to purchase existing electric plants within its limits, at the election of their owners, before a similar plant is established.

Victories Not to Be Won by Selling Out.

Victory for private enterprise can not be won, however, by retreat. To sell out the plant of a private company to the city or town and then quit the field is to give up the fight. Such a course may be the better part of valor where two competing private companies are concerned, for in that case ability to stand financial loss is the only limit of competition.

When the competition is between a private company and a city or town other considerations come in. Taxpayers will not long submit while electrical energy is sold to consumers below cost. Moreover, legal means are not wanting to restrain officials who waste public money in unfair competition.

Municipal Plants Not Necessarily a Menace to Private Enterprise.

In eight cities and towns of Massachusetts where there are municipal electric plants gas companies do a paying business, and in several of these places a part of the electric lighting is done by private companies.

Municipal lighting plants at Chicago and Detroit have not proved to be a serious menace to private electric corporations in these cities.

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Shop Testing of Motors and Generators for Commercial Service—I.

By Bertrand B. Abry.

IN THE production of electrical apparatus the natural sequence of operation is: design, manufacture, test.

In general, tests may be divided into two classes, namely, those of a full and complete nature as applied to new designs, and those of a less complete and more general nature, applied to machines which have become standard and are being built in large numbers. In the case of a new machine, a complete test is made, for two purposes. First, to prove the design; second, to prove the manufacture or the process of building the different parts into the whole. In proving the design the actual electrical performance of the apparatus is determined. Proving the manufacture determines the quality of workmanship and material and the perfection of mechanical details.

In shop practice certain standard tests have been adopted for new types of machinery. Such tests may or may not be applied in detail to every machine built. But entirely new designs call for minute and complete tests. The electrical performance must be proven, as well as the workmanship and mechanical construction. A new type of motor, for example, will require all the standard tests, and very often a number of special tests. Particular features of electrical performance are expected, perhaps, in this new design. Hence, more than the usual number of tests may be necessary to determine these new features.

New designs become standard designs, in that it is not necessary to apply all tests when once machines so built have been thoroughly tested and calculated results verified. It is to be expected, then, that numbers of machines built from standard specifications from time to time, and alike in all respects, will give the same electrical results. This must follow if the quality of workmanship and mechanical construction, in other words, the process of manufacture, is uniform. In such cases the nature of the tests is more to determine the perfection of mechanical construction, the quality of material used, and the adjustment of the various parts. When these things bear their proper relation, the previously determined electrical performance follows.

Whether the series of tests be specific and complete or less extensive in their nature, there are a great many things to be borne in mind in connection with the actual conduct of the test, which, if properly cared for, necessarily aid in obtaining correct and satisfactory results. If neglected, not only unsatisfactory results are secured, but very often serious accidents occur, involving delay and extra expense.

In general, then, the satisfactory carrying on of tests of this kind makes it imperative on the operator that he be thoroughly familiar with all the circuits and wiring. High-tension wiring especially should be thoroughly understood and carefully arranged. To facilitate the tests, an operating table—a table for carrying all the instruments, switches, and other auxiliary controlling apparatus—will be found very convenient and will lessen the danger of complications and accidents. Instruments should be carefully calibrated and a record of the calibration kept at hand for checking and correcting results. The instrument observations, and in fact all the observations made during a test, should be carefully preserved by themselves for future use in making calculations. Before starting any test, it is well to examine the machine itself. This will bring out mechanical errors of adjustment, balance, or omission, due to shop carelessness. It should include a close inspection of the brushes, oil rings, bearings, etc., so that all friction losses may be reduced to a minimum by proper adjustment of these various parts.

In the several articles which will follow, it is proposed to consider the usual shop tests as ordinarily applied to new designs of direct and alternating-current motors and generators, beginning with the direct-current generator.

I—THE DIRECT-CURRENT GENERATOR.

The compound generator is here suggested for consideration in the main, since tests on such a machine include all that might be desired in the case of a shunt generator. The usual tests made are as follows:

1. Resistance measurements, hot and cold.
2. Iron loss and saturation test.
3. Electromotive force regulation test.
4. Calculation of efficiency.
5. Temperature test.
6. Insulation test.

1. Resistance Measurements—Cold resistances are usually taken while preparing for the test, and hot resistances at the conclusion of a temperature run. The fall-of-potential method is the one generally employed in making these measurements.

Armature resistances can be obtained only when the machine is at rest. Make connections and arrange instruments as shown in Fig. 1. For small multipolar machines and railway motors, two copper brushes are used for passing the current through the armature. Each brush is made with its face a little narrower than a segment of the commutator and is arranged to bear on one bar only, insuring a better contact than the ordinary carbon brush. For measuring the drop, two steel points are used with voltmeter leads connecting to a low-reading voltmeter.

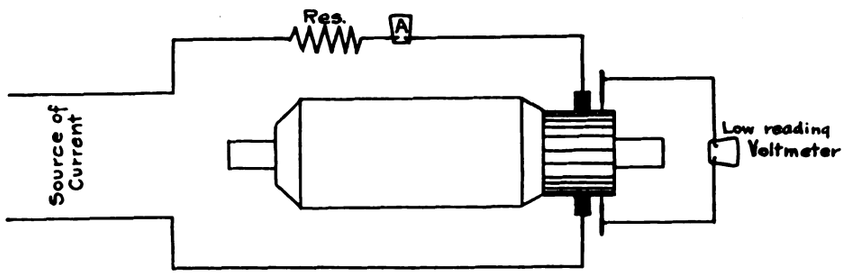

FIG. 1.—WIRING FOR RESISTANCE MEASUREMENT.

In large machines it is impracticable to use the copper brush. The regular carbon is employed and the drop measured by applying the steel points right on the surface of the commutator bar.

Take a series of five or six readings, varying the current each time by means of a suitable resistance rack, or lamp bank. In measuring armature resistances, the current should be kept as low as possible consistent with a satisfactory voltmeter deflection so as not to cause undue heating when making the measurements.

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Shift the position of the armature once or twice and repeat. The average of the resistances figured from these observed voltages and currents should be considered as the armature resistance (cold) in further calculations.

The field resistance may be obtained while the machine is running or while standing still. Usually it is taken when at rest. For measuring field drops it will be necessary to use a higher reading voltmeter than in the case of the armature. As before, take a series of five or six readings, varying the current each time and noting the drop. Take the average of these results as the field resistance.

2. Iron Loss and Saturation Test—To determine the iron loss and saturation, the generator is belt-connected to a shunt motor and driven at its rated speed. Fig. 2 shows the wiring and connections. The observations made on such a test are as follows:

Motor.			Generator.		
Volts.	Amps.	Field Amps.	Speed.	Volts	Field Amps.

When ready to begin the test, bring the generator up to speed, and keep the speed constant throughout the test. This may be done by holding the line voltage on the motor constant and varying the motor field current as the load varies.

It is customary in making these shop tests to take ascending iron loss and saturation curves. That is, begin with zero generator field amperes and gradually increase step by step until a voltage say twenty-five per cent higher than the rated voltage is obtained. If there is any residual magnetism in the generator field, it will be noted that although the field current is zero the voltmeter needle will be slightly deflected. This reading should be recorded since it will constitute the first point on the saturation curve. The volts, amperes and field current of the motor should also be noted and recorded at the same time as well as the generator speed. After each successive observation the generator field current is slightly increased and a series of readings again taken. About every fourth or fifth increase in the field current it is advisable to again bring it to zero. If no abnormal conditions, such as undue friction, exist, the instruments should read practically the same as they did on the start. Any such abnormal condition may be detected by noting whether the motor amperes are the same or nearly so, as in the first set of readings. If results do not check, the trouble should be remedied and the test begun again. If the results do check with the first zero field current readings, the test may be continued. That is, increase the generator field current to a point slightly above the amount recorded just before opening the field circuit, and proceed.

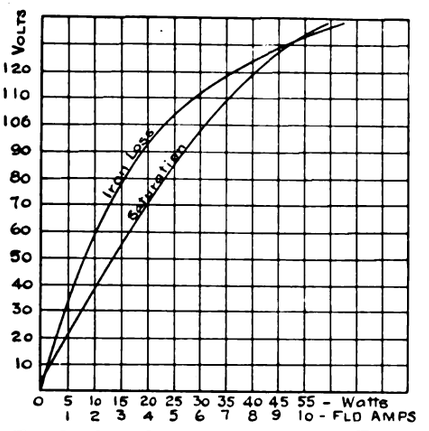

Fig. 3.—Iron Loss and Saturation Test.

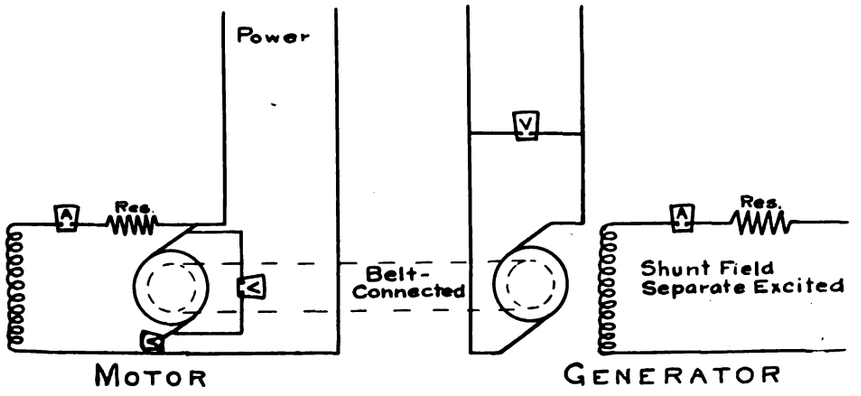

Fig. 2.—Wiring for Iron Loss and Saturation Test.

In making an iron loss test on a direct-current machine, the brush friction and bearing friction and windage losses should also be noted. The watts lost due to brush friction may be determined in the following manner: After the last reading has been taken again reduce the field current to zero and make sure that the friction has not increased any so that a minimum motor armature current may be obtained. The energy expended by the motor in driving the generator under these conditions we may call the "no-load watts." Next raise the generator brushes from the commutator. Take another set of readings, keeping the speed constant at all times. The difference between the motor input in each case, that is, motor input with brushes down minus motor input with brushes up, equals brush friction loss.

To measure the bearing friction and windage, keep the generator running at constant speed with field current zero. Read the instruments. Then throw the belt off. The difference in the motor input, brushes up and belt on minus motor input, belt off equals bearing friction and windage.

After obtaining these results it remains to plot the curves. It will be seen from the above test that the generator iron loss is equivalent to the difference in the watts required to drive the motor with a field charge on the generator and zero field charge. The difference may be designated as the "watts lost."

From the test results we may calculate and tabulate somewhat in the following manner. The input to the motor (less field current), that is, armature volts by armature amperes, we will call the "motor watts."

Motor Watts.	Iron Loss in Watts or Watts Lost.	Generator.	
		Volts.	Field Current.

To obtain the watts lost compute the difference between the motor watts with zero generator field current and the successive motor watts with increasing generator field currents. In other words, the watts at any reading of the motor voltmeter and ammeter minus motor watts at no load (when generator field current is zero) equals the watts lost, or the energy expended by the motor in driving the generator. In tests where great accuracy is desired, it is customary to make an allowance for the C^2R loss in the armature of the driving motor, which should not be charged to the generator as iron loss. The columns of "generator volts" and "field current" are transferred directly from the test sheet. With these results in hand the curves may be readily plotted.

(To be continued.)

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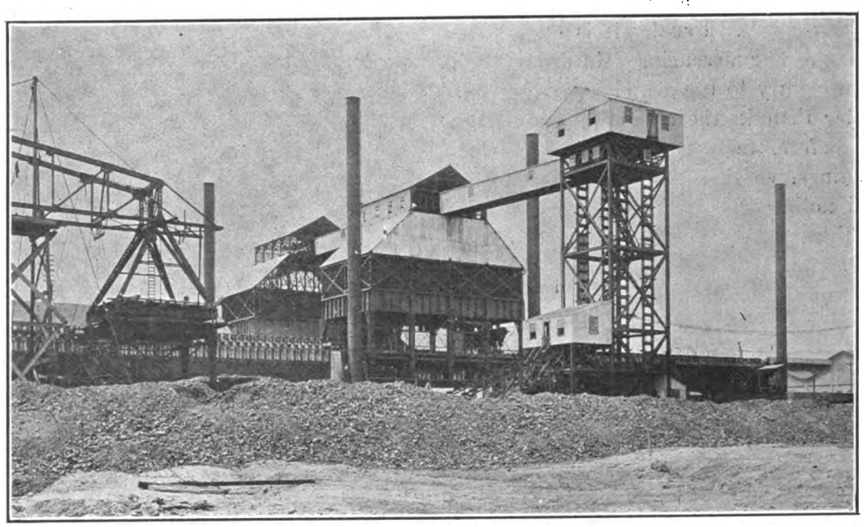
Coal Handling Machinery Driven by Electric Motors.

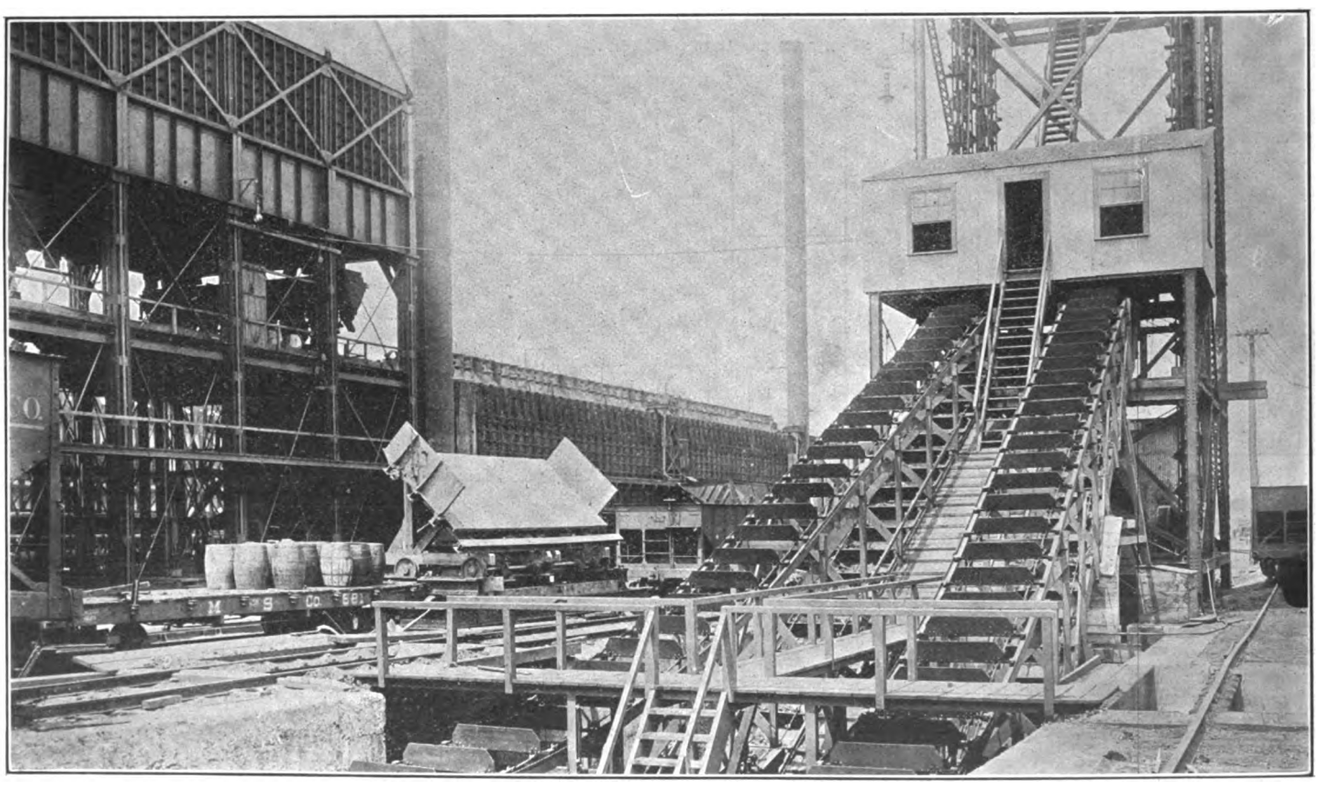
By D. A. Willey.

THE employment of electric service in handling and storing coal is well illustrated in the plant which has recently been installed at Sparrows Point, Md., in connection with the works of the Maryland Steel Company. To supply the necessary coke for its furnaces, the company has recently completed one of the most elaborate sets of coke ovens in the United States, representing the latest improvements in this apparatus. The coke is secured from bituminous coal of the ordinary run-of-mines grade, which is brought to Sparrows Point by train. It is not only resolved into coke but gas, as well as several other products, the coking plant having a capacity for producing 10,000,000 feet of gas every twenty-four hours.

The ovens are divided into four batteries, arranged in sets of two each, and require at least 1,600 tons of fuel daily, when all are in operation. To provide ample storage, it was decided to have the storage plant of 50,000 tons' capacity, the ovens being served by two elevated bins, holding 1,000 tons each. The apparatus installed for the various processes, forms one of the most complete automatic systems yet planned in this country, for the unloading of the cars, storing of the coal, assorting and crushing it, as well as elevating it to the supply bins and serving it to the ovens, are performed entirely by machinery operated by isolated motors, which secure current from the electric power station maintained by the company.



GENERAL VIEW OF COAL PILE AND HANDLING PLANT.



ELEVATING CONVEYORS CONNECTING WITH TRACK HOPPERS. AT THE LEFT IS ONE OF THE STORAGE BINS AND A TROLLEY LINE FOR TRANSPORTING THE OVEN "LARRIES."

For the purpose of storage, the Dodge circular system has been employed, which comprises a swinging span of 280 feet maximum dimensions. This is operated by the suspended system, with which is connected a two-ton bucket of the clam-shell type which is used in loading and unloading. The system is so arranged that it will receive coal simultaneously from two cars and distribute it by means of the bucket to any part of the storage area. It is also reloaded from the storage plant and delivered directly through chutes to the system which conveys it to

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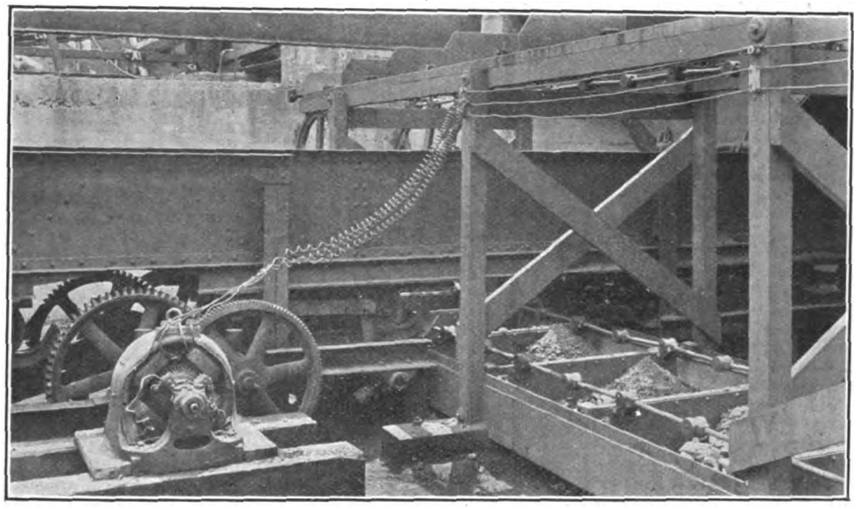
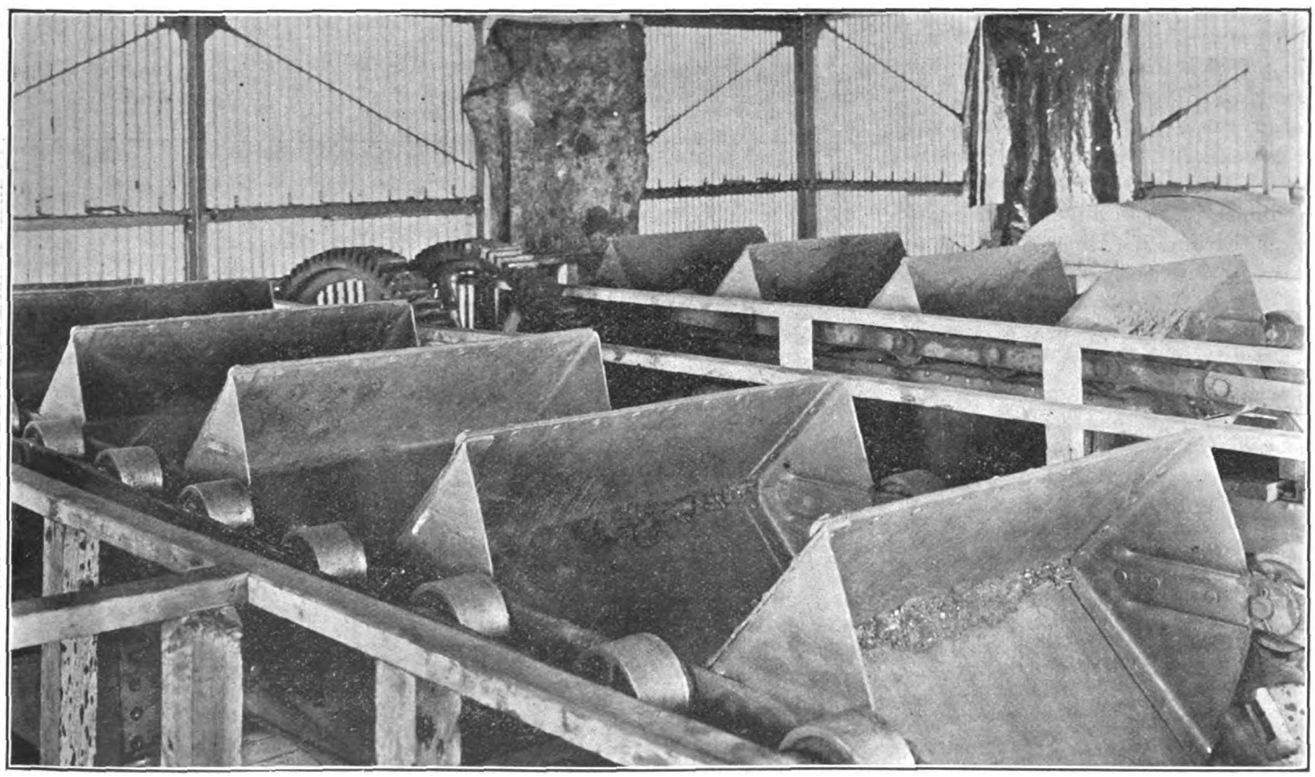
the crushing bins and ovens. The conveying system, which is the principal feature of the entire equipment, is operated throughout by isolated electric motors. For serving the conveyors, four steel track hoppers have been installed, located on two tracks which are thirty-seven feet apart, the hoppers being equipped with feed gates which automatically deliver the coal in proper quantities to conveyors of the inclined scraper type serving the crushers. The crushing rollers are two in number, the rollers proper being forty-six inches in diameter and thirty-six inches in width and provided with fluted surfaces to increase their efficiency. The rollers are operated differentially to give the proper grinding effect. Before entering the crushers, however, the coal, which is received from the mines in the various sizes, passes over bar screens which separate the portion which is smaller than one inch in size. Consequently the lumps which are an inch and over are treated by the crushers.



METHOD OF INSTALLING MOTORS.

The finer coal and that which has passed between the rollers is conveyed by scraper conveyors to the two elevators, each having a capacity of 160 tons per hour. Therefore in continuous service the elevators will fill the serving bins in less than seven hours. The buckets connected with the elevators are what are known as the "V" type, each being four feet long, twenty-four inches wide, with a depth of twelve inches. They are attached to heavy steel link roller chains and deliver overhead in a belt conveyor which also automatically distributes the coal in the bins. It may be said here that the elevators are ninety feet in height. The endless belt is of sufficient capacity to transport the coal from both elevators when working simultaneously and fills the bins by means of a self-propelling tripper. Owing to the service required the conveyor belt is made of woven cotton, which is considered one of the most durable materials for this purpose. The trough of the belt, however, is made extremely shallow with a view of having the conveyor as flat as possible without sacrificing the capacity. As the photographs show the storage bins are at such an elevation above the oven plant that the fuel can be loaded into the serving cars by gravity and the ovens filled in a very short space of time.

In transferring the coal from the track hoppers to the elevating apparatus what is termed a reciprocating feeder is employed. It consists of a flat metal apron operating under the discharge opening of the hopper and is governed by a crank mechanism connected with the conveyor. The hopper is so arranged as to relieve the feeder of the weight of the material the hopper contains. The feeder is practically an automatic gate which controls the de-



CONVEYORS SERVING CRUSHING MACHINERY.

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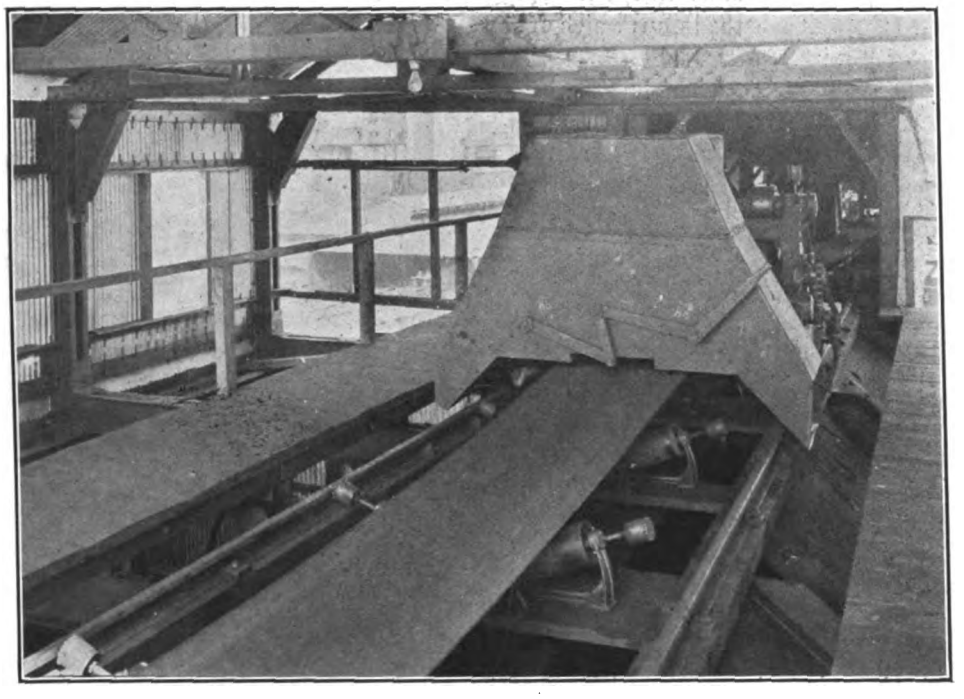
livery of the coal in any size. By this method the services of a man to regulate the flow of coal from the hopper are not required and there is no possibility of jamming or overloading the conveyors.

ated by a fifty-horse-power, compound-wound motor, of the open type. Each bucket elevator, connecting the crushers with the bin-feeding belt, is operated by a forty-horse-power motor of the same



Belt Conveyor and Chute for Loading It from Elevators.

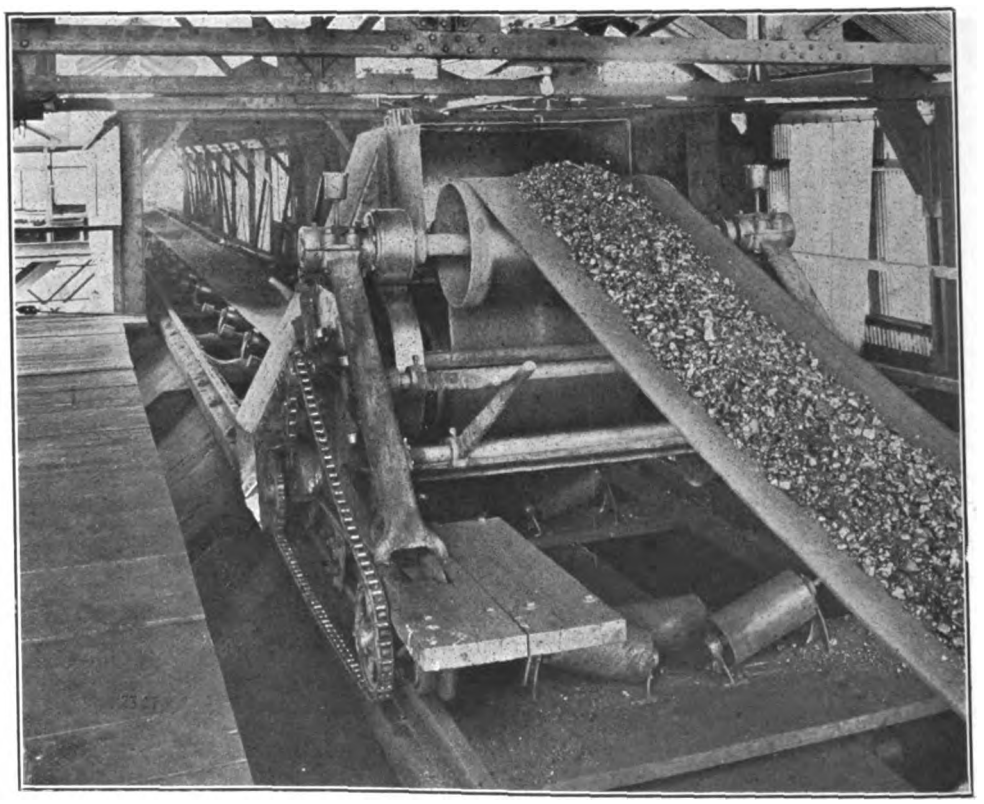
The electric service for the storage plant proper is arranged as follows: For hoisting over the surface of the fuel pile an eighty-horse-power motor is employed, of the General Electric type, compound-wound, and working at 500 revolutions per minute. It is specially built for heavy service, having the solenoid type of switches, controlled by a foot lever. The overhead trolley for moving the reloading bucket, is operated by one fifty-horse-power, series motor of the Westinghouse 38B type, running at 500 revolutions per minute. To swing the bridge used for trimming the storage pile, the traverse motion is produced by two thirty-horse-power motors of the Westinghouse 12A type, operated by a series parallel controller, each protected by an individual circuit-breaker.

For the purpose of convenience, the handling plant is arranged in two divisions of equal capacity, so that one section can be operated independently of the other, when desired. The only exception is the conveyor from the elevator to the storage bins. The coal, as it falls from the cars, is received on the shakers, which pass it into the feeding hoppers. The shakers in each section are operated by a five-horse-power motor of the closed type. The conveyors running between hoppers and crushers are each served by a twenty-five-horse-power Westinghouse motor, of the open type, while each crusher is operated by a twenty-five-horse-power motor of the closed type, while the endless belt requires but one twenty-five-horse-power motor, although, as already stated, it is of sufficient capacity to handle all of the coal delivered to it from each elevating plant, when both are running at full speed.

The cars, or "larries," serving the ovens, travel upon a track elevated to such a height that their contents can be emptied into the coke ovens by gravity. They are hauled to and fro by an overhead trolley operated by a twenty-five-horse-power Westinghouse railroad motor.

The plant, which was installed by the Link Belt Engineering Company, of Philadelphia, has been in operation about two months, during which time tests have been made demonstrating its economical operation.

During one test when the coal was being handled at the rate of 220 tons an hour, both elevators being in service, it was found that the two conveyors required energy equal to twenty-five horse-power; when loading the two reciprocating feeders, 10.8 horse-power; the pair of crushers required thirty-three maximum horse-power; the elevators 34.4 horse-power, and the conveyor serving the storage bins 11.7 horse-power. Assuming that the expense per horse-power-hour is two cents, the actual power cost for this service would be but 1.05 cents per ton excluding manual labor. This has been found to be 0.8 cent per ton handled, making the total cost of operating the entire plant less than two cents per ton of fuel handled.



Endless Belt (Loaded) for Serving Overhead Bins.

A large steam turbine driving two generators has been built by Brown, Boveri & Company for the Electric Company, of Essen, Germany. The turbine, which is of the Parsons type, has a capacity of 10,000 horse-power. Direct-connected to it are a direct-current dynamo of 1,500-kilowatt capacity at 600 volts, and a polyphase generator of 5,000-kilowatt output at 5,000 volts pressure. The guaranteed efficiency of the set is one kilowatt-hour for 15.4 pounds steam.

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Important Decision on Tesla Split-Phase Patents.

Judge Archbold, in the United States Circuit Court, Eastern District of Pennsylvania, has just handed down a decision in the suit of the Westinghouse Electric and Manufacturing Company *vs.* H. C. Roberts and the Sangamo Electric Company, which has an important bearing on alternating-current meters and fan motors. The suit was under the so-called Tesla split-phase patents. The defendants' device against which suit was brought was the Sangamo electric meter. The Court, after a careful review of the testimony, decided that the complainant had proved satisfactorily that Tesla's date of invention preceded that of Ferraris's and others, and that the device in question was an infringement.

The importance of these patents is great, as some of the most successful alternating-current meters and motors of small size are tributary to them.

The following is an abstract of Judge Archbold's review of the testimony:

The patents in suit and those on which they are based, or which are kindred to them, have been so fully considered in previous cases which until recently have also been uniformly in their favor, that little is left to be brought forward with regard to them.

The derivitive patents in suit, numbers 511,559 and 511,560, were first considered in the Dayton fan and motor case, 106 Fed. 724; affirmed in 118 Fed. 562, and a decision rendered in substantial accord with those which had preceded it. One defence there, as here attempted to be made, was that it involved no inventive skill when once the practicable use of alternating currents of different phase was established, to substitute the dephased split current which was a well recognized equivalent; but it was not so held, nor can it be here.

The patents in suit were also before Judge Lacombe in the Westinghouse Electric and Manufacturing Company *vs.* the Catskill Illuminating and Power Company, 110 Fed. 377. In addition to the attack made upon them in other cases, it was further urged that, in a paper read by Professor Ferraris before the Royal Academy of Sciences, of Turin, Italy, March 18, 1888, a portion of which was published on April 22 following, at Milan, in *L'Elettricita,* not only was there a full disclosure of the transmission of electric power by means of alternating currents of different phase, but also the use for the same purpose of a dephased split current derived from a single source, the same as in the patents in suit. Upon a due consideration of the opposing proofs the invention of Tesla was held to be carried back of this publication; but on appeal, the decision was reversed, the evidence brought forward by the complainants not being considered sufficient for that purpose; 121 Fed. 831; a conclusion which was followed by Judge Colt in a case by the same plaintiffs against the Stanley Instrument Company, in the first circuit, not yet in print. This, and the matter of infringement, are the overshadowing questions in the present case.

The Ferraris publication, as we have seen, was April 22, 1888, and the patents in suits were not applied for until December 8 following. To relieve from this apparent priority the invention has, therefore, to be carried back of the earlier date by competent and convincing evidence. That Tesla, early in May, 1888, had a complete grasp of the split-phase idea is established by his application of May 15 for patents, Nos. 511,915 and 555,190, which embody it, the same that were before Judge McPherson in the Scott & Janney case 97 Fed. 582, already alluded to. This is important evidence which can not be contradicted and I, therefore, start with it. Not only is the invention beyond question carried back by it to the date named, which is within twenty-three days of the Ferraris publication, but from the known order of events, a patent not being able to be worked out in a day, ground is thus persuasively laid for an earlier date if there is any fair evidence to warrant it. In the face of it, I hardly see how we can doubt the accuracy of Mr. Page's statement that Tesla disclosed to him the principles of the invention somewhere in the first part of April of that year. His testimony on this point is specific and convincing. In the fall of 1887 and spring of 1888, as he says, he was engaged in developing in the Patent Office a number of Tesla's inventions, and among them the polyphase motors and transformers which were patented May 1, 1888. These were prosecuted to an allowance in the early part of April, the final fees, as shown by the books of the firm of which he was a member, having been forwarded to Washington on April 6. After having secured the allowance of this group and made arrangements for similar applications in a number of foreign countries for patent to issue simultaneously therewith, Tesla gave him the material for application one feature of which was the inducing of one current from another in the operation or construction of a motor, and in this connection disclosed to him his plan for operating his polyphase motors by means of a single split-phase circuit. Startled by this revelation and questioning whether the claims which he had drawn in the pending cases would protect this new improvement he had a long conference with Tesla, getting from him all that he could as to the different ways he proposed to operate this two-wire system. It seems to me convincingly established that prior to April 22 the date of the Ferraris publication, Tesla had disclosed to Mr. Page, his solicitor, the principle of his split-phase adaptation.

But the testimony of Mr. Page is by no means all there is upon this subject. Mr. A. S. Brown formerly connected with the Western Union Telegraph Company, became interested in the summer or fall of 1887 in bringing out the original Tesla motor; and he testifies that once when it was first brought to his notice it occurred to him as a great objection that it required two separate currents; not long after which Tesla showed him how it could be operated on a single main line from the generator.

So far as I have considered only the proofs, about which no question can be raised, and basing my decision solely upon them, I am satisfied that the patents should be sustained.

The question of infringement still remains. At the time suit was brought, the defendant, Roberts, was engaged at Philadelphia in the sale of Gutmann recording wattmeters, as agent for the Sangamo Electric Company, of Springfield, Ill., by whom they were made.

It is contended that a meter is not a motor, and that on this ground of itself no infringement can be charged. No doubt the strict object of a meter of this class is to measure and record the element which passes through or actuates it, gas, water, the electric current, or whatever it may be; but where, as here, it is, in mechanical construction, nothing more than an adopted motor with meter attachments, it can not escape infringement on that plea.

The Tesla motor as an invention, was first in its own peculiar field, and is entitled in consequence to a liberal application of the doctrine of equivalents, and of the substantial equivalency of the defendants' device I am fully convinced. The significant thing in each is the conjoint or resultant action of the two opposite sets of poles, the magnetic influence, whether of attraction or repulsion, waxing and waning, and shifting progressively about the armature, of the existence of which there can be little doubt. It is persuasive of the equivalency of operation which is so contended for, although by no means conclusive of it, in a patent applied for by Tesla May 20, and granted December 3, 1889, this equivalency is assumed without explanation as being within the terms of the invention. Other confirmations of the equivalency of the two arrangements with that of a Tesla motor, as well as with each other, could be drawn from this record, but these must suffice. They establish to my satisfaction the general infringing character of the defendants' meter as is charged.

Finding therefore that the patents in suit are valid and have been infringed, a decree is directed in favor of the complainants in the usual form, with costs.

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investment—the depreciation, insurance, taxes, and all things which constitute fixed charges—you will find you must have greater efficiency and economy in your coal to come out even. In that particular case, I found that instead of coming out $100,000 ahead as against the steam turbines, we would be more nearly that much behind each year. It is needless to say I did not advise my clients to adopt the gas engine plant in that case. On the other hand, I had a case of a pumping plant in Mexico, where coal is $15 a ton, delivered on the mountain 700 miles from the nearest coal mine. I found in that case a gas engine, operated with producer gas, though it might cost more than the steam turbine, would pay for itself in something like three or four years. The pumping duty is constant and it lasts twenty-four hours a day. There is an ideal load curve, which is an exactly suitable condition for the best economy to be obtained by the use of the gas engine. I had occasion to investigate a case in Arizona where the power was to be used for lighting and traction, and found in that case that the cost was very nearly even. The company was one which produced gas as well as electricity. It makes the gas and could procure it at the lowest cost, but after a careful investigation it decided to adopt steam turbines. Further investigation in the case shows that in the present state of manufacture the cost per kilowatt of the gas engine outfit is at least twice that of the steam turbine outfit. I have had a station operating under my direction which has been installed for a year, running one unit per year and for the last five or six months running two units of 400 kilowatts each. The results have been extremely satisfactory and we have recently ordered two units of 3,000 kilowatts each. I do not think I am telling any trade secrets if I state that the cost per kilowatt for the last two units ordered is under $28, for the unit installed, not including the piping or condensers. The great point in the steam turbine which appeals to me, as the result of my experience, is that it enables the station equipment to be greatly simplified, not only in detail, but also those things which eventually tell on the maintenance. You have fewer parts; there are no adjusting parts and various other things of that kind are much simpler in the steam turbine. But there is one other feature which is, I think, of the greatest utility, and that is the ability to apply superheat in the use of the steam turbine. I pointed out in the discussion last year that there is no limit to the superheat that you can apply in the case of the turbine; there are no conditions of lubrication to impose limitations; no packing, nothing to prevent you from applying all of the superheat possible to get. The steam turbine is related to the question of the design of the plant in another way—heretofore we have been accustomed, when we wanted a higher efficiency in our steam-producing outfit, to consider the introduction of fuel economizers. We have also been obliged to resort to extremely high steam pressures. We find with the steam turbine, allowing yourself ample superheating, with a moderate steam pressure, 150 pounds, which is high as compared to ten years ago, but low as compared with the practice of to-day—with a steam pressure of 150 pounds and superheating up to 600 degrees, you are enabled to get as good economy as you would get with perhaps 175 or 180 pounds of steam pressure, using fuel economizers. The cost of the station is less, expense of running much less, and all things considered the cost of producing power is much reduced.

J. G. WHITE, NEW YORK.

I assume that many others are in practically the same position as myself in reference to this important subject, and that is that probably most of the people who have given the subject any considerable attention appreciate the necessity of high vacuum and high steam pressure, which is obtained by the turbine, and also the advantages of reduced space, saving in initial investment, saving in oil, and other supplies—but what most of us want to know is what can be depended upon as to reliability? Can we install steam turbines to-day and be certain that they will start off without serious interruption, or at least that after a few weeks of operation they can then be depended upon to take up the regular load and carry it day after day? I understand that at Newport there are two turbines in operation, the original one which gave considerable trouble in its experimental stages, which is now said to be down to a regular working basis and running with considerable regularity, and also a second unit which I understand is in operation and running satisfactorily.

W. L. R. EMMET, SCHENECTADY, N. Y.

We have had experience with two turbines, one of 600 kilowatts in Schenectady, which is of the older type, and a vertical shaft turbine at Newport, which is of the newest type. The machine at Schenectady involved no radically new or peculiar mechanical devices, and was put in service two years ago and has run almost continuously without having any interruption of service or trouble of any kind. The machine located at Newport has carried its load continuously, and it is only through an excess of conscientiousness that in the paper I tell you anything of the troubles we have had, because there have been practically none which interrupted the service. We have made a record of all stoppages, and I think there were three stoppages which interrupted the service in Newport, between June and September, and the longest stoppage was less than twenty minutes. This, however, was inspired by a certain amount of trouble going on in the valves which had to be corrected from time to time. However, the Newport machine as it stands, if it had to be kept in its present condition without improvement, and simply maintained by the renewal of those valve parts as they give out, would be maintained and run at a small fraction of what it would cost to maintain any reciprocating engine of equal capacity. On comparing turbines and gas engines, it is purely a question of the cost of fuel; that is, with the turbine in its present state of development. The actual fuel economy of the gas engine in its greatest state of perfection is greater than that of any steam engine heretofore produced. However, the very highest results obtained so far with steam turbines, in the matter of fuel economy, that is, actual consumption of combustibles, are not so far below the thermic results obtained from gas engines. The very best gas engine that has ever been operated on a theoretical basis produced a fuel economy something like thirty-two per cent, total work units or mechanical equivalent from the heat in the coal. The best results produced with highly superheated steam under favorable conditions, I can not say just exactly what the thermal economy is, but they operate at something like twenty-three or twenty-four per cent. The gas engines which actually operate on commercial basis do not run anywhere near the engines which had an efficiency of thirty-two per cent; they run nearly twenty-six or twenty-seven per cent, and while they compare favorably with ordinary engine performances, they are not very much in advance of the best steam turbine performances. Furthermore, the cost of the gas engine is possibly twice the cost of the steam turbine unit. If, however, the steam turbine unit is credited with the possible simplifications which surround it, the difference will be much greater. The steam turbine needs no heavy foundation. A power station for boilers and turbines could be floated on three feet of concrete on any salt meadow, and a like inexpensive structure made to shelter it, and its efficiency be as good as if it were installed in the most expensive station. There will be simplifications in this direction—the ideal turbine station which will be far removed, maybe, from the city, will be laid out more on the lines of a coalyard, or any similar place than on lines where a large and expensive building will be required. On this basis, if we capitalize the difference in fuel consumption between the two engines, it will not cover the first cost. Furthermore, the turbine is ideally simple and the gas engine is very complicated. Every one knows how simple the steam turbine is in a proper state of development. The only experience we have had in this country with steam turbines is with very new steam turbines. The troubles now experienced we think are of a purely temporary character. The steam turbine, as it will be in six months from to-day, can be operated by a child indefinitely, virtually without maintenance. The wear and deterioration is nothing, and the whole plant can be reduced to an ideal condition of simplification. Against this we must consider a gas plant, in which gas must be produced, and in which an immense maintenance

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cost goes on in connection with deterioration and renewal of converters and mechanism which must be attended to—the maintenance of engines twice the size of steam engines, twice as complicated, and less perfectly lubricated. The gas engine is a gasoline automobile on a large scale, and perhaps some of you have had experience with those; whereas the steam turbine is as simple as an ordinary grindstone. Naturally every one is interested in the development of the gas engine, and we all realize that some day if coal continues to increase in cost, and gas engines are improved at the same rate that the turbine has been improved, the time will come when fuel economy will be the only consideration and gas engines will come into more extensive use. I think, however, the introduction of a steam turbine is certain to give the gas engine a long setback.

Selenium and a New Form of Photo-Telegraph.

Professor Korn, of Munich, Germany, has devised a new system of photographing by telegraph. This system depends on the property of selenium which has the characteristic of being a poor conductor in the dark, but becoming a good conductor when exposed to the light, the degree of resistance varying according to the amount of illumination to which the selenium is subjected. The apparatus at the sending station consists of a hollow glass cylinder which turns on its axis while moving parallel to the direction of this axis. On this transparent cylinder a photographic negative film is fastened. The rays of light emitted by the source are condensed by a lens on the point of the negative which they traverse and then strike the selenium battery placed in the interior of the cylinder. An electric current passing through the selenium, whose conductivity changes at each instant under the action of the more or less intense light that it receives, passes over the line to the receiving station. At this point the current passes through a D'Arsonval galvanometer with a light aluminum needle to a vacuum tube similar to the Geissler tube, entirely blackened save at the lower extremity, where there is a little aperture situated close above a revolving cylinder covered with a sensitive photographic film. When the galvanometer needle moves under the action of the current transmitted by the line, the curved ends of the needle approach to or recede from a metallic piece which causes currents of high frequency to illumine the interior of the vacuum tube. The light rays escape through the orifice, and the photograph is thus reproduced, point by point, as a positive image.

Improved Governor for Steam Turbines.

A recent British patent to the Hon. C. A. Parsons and James Swinburne describes a device for enabling steam turbines to be run in parallel with one another and for running reciprocating engines in parallel with steam turbines. In steam turbines it is found important for good parallel running that the puffs of steam by which the governing is affected should be coincident in the various units; or in the case of one or more turbines running in parallel with one or more reciprocating engines, the puffs of steam in the turbines should be coincident with the maximum efforts of the cranks of the reciprocating engines. To accomplish this each turbine is supplied with a separate admission valve controlled by a secondary valve actuated by an eccentric. Each turbine is also governed by a separate electric solenoid device having a plunger which acts so as to regulate the length of time during which the main valve is open. All the eccentrics which control the secondary valves are mounted on a common shaft which is driven by an independent motor. This arrangement ensures that the admission valves of all the turbines are open at the same time, although the length of time during which each valve is open is determined by its own governing device. The variations of speed of the driven alternators are thus simultaneous and a steadier running is thereby attained.

Polarization of Roentgen Rays.

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Electric Shock.

In a paper read before the Verein Deutscher Revisionsingenieure, Dr. Kath treated of the conditions for the safety of the men driving electrical plant. Direct current, he pointed out, will, as a rule, become really dangerous only in the case of several unlucky circumstances being present at the same time, as its tension seldom exceeds 500 volts. Direct-current machines should be enclosed tightly, so that sparking, liable to endanger the surrounding medium, is prevented. As regards the properties of the human body, the author draws attention to the fact that an electric shock will essentially act on the nervous system, as the nervous substance is a conductor of electricity surrounded by less conductive fat and muscle substance. The paths most frequently followed by the current in the case of accidents will afford an evidence as to which nerve strings are most likely to be struck, which functions most liable to be paralyzed, as being controlled by these nerves. In the case of the shock entering by a hand or the head and leaving by the other hand or a foot, the nerve descending from the neck and leading to the lungs and heart—the so-called *nervus vagus*—will be struck, and as the latter regulates both the respiration and the action of the heart, respiration will first be stopped, and the action of the heart will eventually cease in the graver cases. A shock entering by the points of the fingers and leaving by the upper arm, however, will, as a rule, not be attended by fatal results, the above nerve not lying on its way. The best assistance in the case of an accident will be rendered in the way of producing artificial respiration, enforcing the heart action and diminishing the pressure of blood, the latter being obtained by injecting one to three drops of amyl nitrate, The dangers of electric currents will, moreover, vary to a high degree according to personal predisposition, persons subject to alcholism, as well as those easily frightened, suffering much more from the effect of electric shock than normal people. The limit of danger is considered as coinciding with 0.1 ampere.

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investment—the depreciation, insurance, taxes, and all things which constitute fixed charges—you will find you must have greater efficiency and economy in your coal to come out even. In that particular case, I found that instead of coming out $100,000 ahead as against the steam turbines, we would be more nearly that much behind each year. It is needless to say I did not advise my clients to adopt the gas engine plant in that case. On the other hand, I had a case of a pumping plant in Mexico, where coal is $15 a ton, delivered on the mountain 700 miles from the nearest coal mine. I found in that case a gas engine, operated with producer gas, though it might cost more than the steam turbine, would pay for itself in something like three or four years. The pumping duty is constant and it lasts twenty-four hours a day. There is an ideal load curve, which is an exactly suitable condition for the best economy to be obtained by the use of the gas engine. I had occasion to investigate a case in Arizona where the power was to be used for lighting and traction, and found in that case that the cost was very nearly even. The company was one which produced gas as well as electricity. It makes the gas and could procure it at the lowest cost, but after a careful investigation it decided to adopt steam turbines. Further investigation in the case shows that in the present state of manufacture the cost per kilowatt of the gas engine outfit is at least twice that of the steam turbine outfit. I have had a station operating under my direction which has been installed for a year, running one unit per year and for the last five or six months running two units of 400 kilowatts each. The results have been extremely satisfactory and we have recently ordered two units of 3,000 kilowatts each. I do not think I am telling any trade secrets if I state that the cost per kilowatt for the last two units ordered is under $28, for the unit installed, not including the piping or condensers. The great point in the steam turbine which appeals to me, as the result of my experience, is that it enables the station equipment to be greatly simplified, not only in detail, but also those things which eventually tell on the maintenance. You have fewer parts; there are no adjusting parts and various other things of that kind are much simpler in the steam turbine. But there is one other feature which is, I think, of the greatest utility, and that is the ability to apply superheat in the use of the steam turbine. I pointed out in the discussion last year that there is no limit to the superheat that you can apply in the case of the turbine; there are no conditions of lubrication to impose limitations; no packing, nothing to prevent you from applying all of the superheat possible to get. The steam turbine is related to the question of the design of the plant in another way—heretofore we have been accustomed, when we wanted a higher efficiency in our steam-producing outfit, to consider the introduction of fuel economizers. We have also been obliged to resort to extremely high steam pressures. We find with the steam turbine, allowing yourself ample superheating, with a moderate steam pressure, 150 pounds, which is high as compared to ten years ago, but low as compared with the practice of to-day—with a steam pressure of 150 pounds and superheating up to 600 degrees, you are enabled to get as good economy as you would get with perhaps 175 or 180 pounds of steam pressure, using fuel economizers. The cost of the station is less, expense of running much less, and all things considered the cost of producing power is much reduced.

J. G. WHITE, NEW YORK.

I assume that many others are in practically the same position as myself in reference to this important subject, and that is that probably most of the people who have given the subject any considerable attention appreciate the necessity of high vacuum and high steam pressure, which is obtained by the turbine, and also the advantages of reduced space, saving in initial investment, saving in oil, and other supplies—but what most of us want to know is what can be depended upon as to reliability? Can we install steam turbines to-day and be certain that they will start off without serious interruption, or at least that after a few weeks of operation they can then be depended upon to take up the regular load and carry it day after day? I understand that at Newport there are two turbines in operation, the original one which gave considerable trouble in its experimental stages, which is now said to be down to a regular working basis and running with considerable regularity, and also a second unit which I understand is in operation and running satisfactorily.

W. L. R. EMMET, SCHENECTADY, N. Y.

We have had experience with two turbines, one of 600 kilowatts in Schenectady, which is of the older type, and a vertical shaft turbine at Newport, which is of the newest type. The machine at Schenectady involved no radically new or peculiar mechanical devices, and was put in service two years ago and has run almost continuously without having any interruption of service or trouble of any kind. The machine located at Newport has carried its load continuously, and it is only through an excess of conscientiousness that in the paper I tell you anything of the troubles we have had, because there have been practically none which interrupted the service. We have made a record of all stoppages, and I think there were three stoppages which interrupted the service in Newport, between June and September, and the longest stoppage was less than twenty minutes. This, however, was inspired by a certain amount of trouble going on in the valves which had to be corrected from time to time. However, the Newport machine as it stands, if it had to be kept in its present condition without improvement, and simply maintained by the renewal of those valve parts as they give out, would be maintained and run at a small fraction of what it would cost to maintain any reciprocating engine of equal capacity. On comparing turbines and gas engines, it is purely a question of the cost of fuel; that is, with the turbine in its present state of development. The actual fuel economy of the gas engine in its greatest state of perfection is greater than that of any steam engine heretofore produced. However, the very highest results obtained so far with steam turbines, in the matter of fuel economy, that is, actual consumption of combustibles, are not so far below the thermic results obtained from gas engines. The very best gas engine that has ever been operated on a theoretical basis produced a fuel economy something like thirty-two per cent, total work units or mechanical equivalent from the heat in the coal. The best results produced with highly superheated steam under favorable conditions, I can not say just exactly what the thermal economy is, but they operate at something like twenty-three or twenty-four per cent. The gas engines which actually operate on commercial basis do not run anywhere near the engines which had an efficiency of thirty-two per cent; they run nearly twenty-six or twenty-seven per cent, and while they compare favorably with ordinary engine performances, they are not very much in advance of the best steam turbine performances. Furthermore, the cost of the gas engine is possibly twice the cost of the steam turbine unit. If, however, the steam turbine unit is credited with the possible simplifications which surround it, the difference will be much greater. The steam turbine needs no heavy foundation. A power station for boilers and turbines could be floated on three feet of concrete on any salt meadow, and a like inexpensive structure made to shelter it, and its efficiency be as good as if it were installed in the most expensive station. There will be simplifications in this direction—the ideal turbine station which will be far removed, maybe, from the city, will be laid out more on the lines of a coalyard, or any similar place than on lines where a large and expensive building will be required. On this basis, if we capitalize the difference in fuel consumption between the two engines, it will not cover the first cost. Furthermore, the turbine is ideally simple and the gas engine is very complicated. Every one knows how simple the steam turbine is in a proper state of development. The only experience we have had in this country with steam turbines is with very new steam turbines. The troubles now experienced we think are of a purely temporary character. The steam turbine, as it will be in six months from to-day, can be operated by a child indefinitely, virtually without maintenance. The wear and deterioration is nothing, and the whole plant can be reduced to an ideal condition of simplification. Against this we must consider a gas plant, in which gas must be produced, and in which an immense maintenance

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cost goes on in connection with deterioration and renewal of converters and mechanism which must be attended to—the maintenance of engines twice the size of steam engines, twice as complicated, and less perfectly lubricated. The gas engine is a gasoline automobile on a large scale, and perhaps some of you have had experience with those; whereas the steam turbine is as simple as an ordinary grindstone. Naturally every one is interested in the development of the gas engine, and we all realize that some day if coal continues to increase in cost, and gas engines are improved at the same rate that the turbine has been improved, the time will come when fuel economy will be the only consideration and gas engines will come into more extensive use. I think, however, the introduction of a steam turbine is certain to give the gas engine a long setback.

Selenium and a New Form of Photo-Telegraph.

Professor Korn, of Munich, Germany, has devised a new system of photographing by telegraph. This system depends on the property of selenium which has the characteristic of being a poor conductor in the dark, but becoming a good conductor when exposed to the light, the degree of resistance varying according to the amount of illumination to which the selenium is subjected. The apparatus at the sending station consists of a hollow glass cylinder which turns on its axis while moving parallel to the direction of this axis. On this transparent cylinder a photographic negative film is fastened. The rays of light emitted by the source are condensed by a lens on the point of the negative which they traverse and then strike the selenium battery placed in the interior of the cylinder. An electric current passing through the selenium, whose conductivity changes at each instant under the action of the more or less intense light that it receives, passes over the line to the receiving station. At this point the current passes through a D'Arsonval galvanometer with a light aluminum needle to a vacuum tube similar to the Geissler tube, entirely blackened save at the lower extremity, where there is a little aperture situated close above a revolving cylinder covered with a sensitive photographic film. When the galvanometer needle moves under the action of the current transmitted by the line, the curved ends of the needle approach to or recede from a metallic piece which causes currents of high frequency to illumine the interior of the vacuum tube. The light rays escape through the orifice, and the photograph is thus reproduced, point by point, as a positive image.

Improved Governor for Steam Turbines.

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BOOK REVIEWS.

"The Practical Application of the Rœntgen Rays in Therapeutics and Diagnosis." William Allen Pusey, A. M., M. D., professor of dermatology in the University of Illinois; member of the American Dermatological Association; and Eugene Wilson Caldwell, B. S., director of the Edward N. Gibbs X-Ray Laboratory, University and Bellevue Hospital Medical College, New York, member of the Rœntgen Society, of London, associate member of the American Institute of Electrical Engineers. 8vo. pp. 590. W. B. Saunders & Company, Philadelphia, 1903. Supplied by the ELECTRICAL REVIEW at $4.50 in cloth, $5.50 sheep or half morocco.

This book really comprises two distinct but complementary treatises. Part I by Mr. Caldwell, treats of "X-Ray Apparatus and Its Use in Diagnosis." In the introductory chapter is given a brief historical review of the discovery of X-rays; chapters i, ii, iii and iv deal with the construction and manipulation of X-ray apparatus; chapter v, with fluoroscopy; chapters vi and vii, with radiography; and chapter viii, which completes this part, with the choice of an X-ray outfit. Part II, by Professor Pusey, treats of "The Therapeutic Application of X-Rays." Its three first chapters deal with those changes, both gross and minute, which result from exposure of the tissues of the body to X-rays, and with the effects of X-rays on pathologicic tissues and tissue-processes. In chapter iv, the causes of these effects are discussed, and the actinic effects of X-rays are compared with those of light rays. Then follows a chapter on radio-therapeutic technique, one on the treatment of X-ray burns, then on the actual value of X-rays in the treatment of individual diseases and disease-products, and a final chapter summarizing in general terms the present state of radiotherapy. Both parts of the work are preeminently practical treatises —written by men, each of whom has gained by individual observation and experience, as well as by careful study of the literature, an actual finger-end knowledge of the subject, and written for those who wish to acquire such knowledge. Such being the case the reviewer is confident that the value of the book will become more and more evident the more it is used—by which is meant not merely read, but used as a guide in connection with actual X-ray work. The explanations of apparatus and of procedure-methods are simple and concise, yet full enough for practical workers and the theoretical considerations are ample and have been carefully drawn up. The typography and general make-up of the book are excellent, and the 176 illustrations, many of which are photographic reproductions and four of which are beautifully colored plates, are all exquisitely executed. The authors and publishers alike deserve the hearty congratulations of the medical and electrical professions for the production of this valuable handbook, and there is little doubt that it will rank high among standard works on the subject.

"Continuous-Current Dynamos and Motors and Their Control." W. R. Kelsey, B. Sc., A. I. E. E., F. Ph. S., electrical inspector under the Board of Trade to the Taunton Corporation. (Being a series of articles reprinted from the *Practical Engineer* and completed by the author). New York. D. Van Nostrand Company. Cloth. 440 pages. 5¼ by 7¾ inches. Illustrated. Supplied by the ELECTRICAL REVIEW at $2.50.

The chief merit of this work lies in the fact that it gives in small compass and at a moderate price a general treatment of the essential features of continuous-current dynamo and motor construction and operation. As stated in the title, it is put together in a rather peculiar manner and for this reason it lacks the unity of treatment possessed by some other works in this field. The attempt is made to cover topically the whole subject from the most elementary motions of the magnetic field to the analysis of dynamo and motor operation characteristics and of the intricate subject of commutation. The result is a book which will be helpful to those persons already familiar with the form and general features of direct-current machinery and who wish to know something of its theory. These will probably omit the study of certain pages of theory of commutation and of methods for estimating magnetic leakage, as well as of a number of armature winding diagrams chiefly of interest to designers. There will remain plenty of material of a most beneficial character. There is not enough description of the actual form of modern machines, and it is to be hoped that in a later edition the author will omit the cuts and description of those forms of field magnets and of armature windings not of present-day interest. In their places might be presented a typical modern machine from each class of motors and dynamos. In analyzing the book its material may be divided into three general parts, namely, the elements of electric and magnetic circuits and materials, 85 pages; the design and structural features of continuous-current machines, 226 pages; the operating features of dynamos and motors, 125 pages. The first of these sections contains the conventional matter covering the properties of electrical circuits and of magnetic materials, with the methods for detecting and measuring these. This is clearly expressed in non-mathematical language. In the part devoted to structural features, in accordance with the classification made above, undue space is devoted to armature winding diagrams similar to those found in great profusion in the classic work of Parshall and Hobart. These diagrams, however, are clear and the descriptions enable the reader to follow them well and, to a certain extent, to appreciate the relative merits of the many windings presented. The space devoted to the mounting of conductors upon laminated structures is relatively small, but the subject of commutator construction is fairly well covered. Field magnets are described and illustrated by a lot of obsolete types, mostly two-pole, and too much space, for a book of this nature, is devoted to magnetic leakage. The mechanical matters of shafting, bearings and brush gear are well treated and illustrated. In our opinion the chapter on commutation is out of place in this work, in spite of its excellence as a study of that subject. It is coming to be understood that this is a most intricate matter, and it is doubtful if any considerable number of readers of this work will care or will be able to go into it with the thoroughness which it demands. Hence it would be better to state plainly the difficulties of commutation and in a general way to indicate the plans used for overcoming these. The designer who is interested in commutation from the practical standpoint, and the scientist who studies it to familiarize himself with electrical laws, are the only ones who can be expected to study such a subject, and they will not be likely to refer to elementary works for their information.

What we regard as the best part of the book is that in which the interrelation of speed, torque, current and electromotive force of dynamos is studied. These are matters which interest every one and the author has taken up and clearly illustrated the various characteristics which show these relations. The diagrams are plain and their applications to the control of motors and dynamos are evident. A considerable space is given to the series, constant-potential motor, which is preeminently the machine for traction purposes. This is justified by the general use of electric traction throughout the world. We have no hesitation in commending this work to those students of electrical matters who are already engaged in electrical pursuits or who have access to examples of modern practice in electrical machinery. It is a reference rather than a text-book, for it is not planned from the pedagogical standpoint. The author's ambition, as stated in the introduction, is "that this little book may be the means of directing some practical engineers to that work which is essential to a clear understanding of the applications of electrical energy."

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OIL ENGINES FOR ELECTRICAL USE.

BY GEORGE E. WALSH.

The extended use of kerosene oil for generating heat and power has brought the oil engine for special electrical work into prominent use, and the development of the engine to a high degree of efficiency has been noteworthy in the past year or two. One of the greatest advantages of the kerosene oil engine over most other prime movers is that its fuel is so clean and compact that it is easily transported or stowed away in small spaces. One barrel of crude oil weighing about four hundred pounds gives about equivalent results in the engine to a ton of coal. The consumption of oil in the various types of engines varies from half to a full pound per actual or brake-horse-power per hour. Besides having the advantage of a more compact fuel than the steam engine burning coal, the oil engine requires little water for operation.

In plants where the conditions of bulk and weight do not count, the oil is not of much superior advantage; but in isolated regions the oil engine as a prime mover for temporary or permanent electric lighting plants is important. The electric lighting engines are belted to the engines or connected directly. In the latter condition there is a great economy of space obtained. In the arid regions of the West where electric lighting and power are being more generally used than ever before, the oil engines have come to take the place of nearly all other prime movers. Water is a scarce and uncertain article, while coal and other fuel are very costly. The oil can be shipped to those places at less cost than any other known fuel, and without requiring much water can be obtained to run the dynamos.

Of course some water is required, but in the case of the oil engine it is only for cooling the working apparatus, and not for boiler purposes to generate steam. Since the discovery of extensive oil deposits in Texas and California, the price of oil has been greatly reduced, and the cost of operating an oil engine is remarkably low. A good many of the engines are built to-day to use the crude oil without any refining, and in the Southwestern arid regions engines of this type are in special demand. The oil just as it comes from the ground is carried to the engines and immediately burnt without any preliminary improvements. The cost of fuel for this purpose is from one-third to one cent per horse-power-hour.

Kerosene oil engines are constantly in demand for electric light plants in country houses where neatness, compactness and cheapness are demanded. The whole plant is stored away in a small space in the basement of an adjoining house outside where little trouble or expense is incurred. Where the power is transmitted by belt from the oil engine to the dynamo there is a loss of about five per cent, and a great many of the small-house electric lighting plants save this loss by direct-connection. Almost the ideal method of lighting on a small scale has been obtained in this way, and the popularity of the engines and direct-connected dynamos is rapidly increasing.

The portability of the oil engine has opened the way for serviceable electric plants which can easily be shifted. In street work, sewer connecting and tunneling, portable electric lighting plants are quite needful. The use of gas engines designed to burn the city gas, tapped by small pipes running from the gas mains, has enabled contractors to set up portable electric lighting plants with fair success; but the kerosene engine coupled with its own dynamo, either direct or by belt, meets the demands of the case even more satisfactorily. A ten-horse-power electric plant can thus be mounted on its own truck, and contractors can move it several times a day to suit their needs. There is no piping to be made every time the plant is moved, and even the question of storing the fuel is simplified. A barrel of oil can be carted about as easily as the ordinary tools of the workmen.

These portable electric lighting outfits mounted on their own trucks are popular among a wide class of general contractors who must use powerful lights day and night for their work. It has been found possible to work night shifts of men on the streets in this way, where before it was entirely impractical. Likewise in tunnel work, portable electric lighting plants are needed to shift from position to position as the work progresses. There are very few accidents due to kerosene explosions, and this fuel is considered one of the safest yet used for inside work.

Petroleum as a fuel has received special notice in the past year because of the prolonged coal strike and the high prices asked for coal. A great many steam plants were induced to experiment with the fuel, and many of them were installed with grates and furnaces which could use either petroleum or coal. This advantage of being able to turn from one to the other promises to enable manufacturers to save themselves in the future from expensive coal bills through strikes. The ordinary steam plant uses oil fuel only as an auxiliary, and in times when coal soars too high to be used profitably. A number of the large city lighting electric plants were also modified so that either coal or oil could be used.

The danger of burning petroleum freely in manufacturing plants is that the increased demand for it will send the prices above a point where it can be regarded as an economical fuel. Its value is dependent entirely upon inexhaustible supplies of the oil, and consequent low prices. Since the partial exhaustion of the oil supply in Texas prices for oil have steadily advanced, and in the vicinity of coal-beds and mines it is no longer a fuel that can compete with coal. On the seaboard, where the oil is carried in quantities by tank steamers at comparatively little cost, it is still a fuel that can be used sometimes at less expense than coal. In New York petroleum has advanced to over $5 per barrel, which is prohibitive so far as general use for steaming purposes is concerned. In California, however, the cost is only a trifle over fifty cents a barrel, while coal is five or more per ton.

The cost of oil for general steaming purpose is thus a matter dependent upon locality, and consequently its use will never become general except for particular lines of work or as an auxiliary fuel. For small oil engines, for portable electric lighting plants, and for plants where space of storage fuel must count as an important factor, it may always prove a great advantage. Likewise in arid regions, and in localities where pure water for steaming purposes is hard to get, petroleum as a fuel will continue to drive coal and gas out.

In the use of coal, gas and oil for fuel, manufacturers are quick to discover that dependence upon any one to the entire exclusion of all others is unwise, and the tendency is toward the installation of plants with two or more types of engines. It is not uncommon to find in plants and manufactories to-day operated by steam power, small electric lighting and electric power plants run by oil or gas fuel. Oil, gas and coal have combined to make the factories more independent of any one fuel, and with the development of the different types of engines for commercial purposes this tendency will become more manifest. It is only comparatively recently that the manufacturers of gas and oil engines produced engines of large output; but to-day they run up to almost any size needed.

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Vol. 43—No. 12

The Association of Edison Illuminating Companies.

Twenty-fourth Convention, Thousand Islands, N. Y., September 8, 9 and 10.

THE twenty-fourth convention of the Association of Edison Illuminating Companies was opened at the Hotel Frontenac, Thousand Islands, on September 8, 1903, by its president, Mr. Louis A. Ferguson.

The following gentlemen were present representing the members and the General Electric Company:

General Electric Company, Schenectady, N. Y.—W. S. Andrews, Frank H. Gale, E. E. Gilbert, Caryl D. Haskins, E. M. Hewlett, engineer switchboard department; H. W. Hillman, J. R. Lovejoy, manager lighting department; J. R. McKee, general manager purchasing and maintenance department; Louis C. Marburg, E. W. Rice, Jr., vice-president General Electric Company; Charles P. Steinmetz, P. D. Waggoner.

The Edison Electric Illuminating Company of Boston—William H. Atkins, general superintendent, Charles L. Edgar, president; Leonard L. Elden, chief electrician; William H. Francis, purchasing agent; R. S. Hale, William P. Hancock, superintendent generating department; Welles E. Holmes, district superintendent; Sidney Hosmer, superintendent of installations; Robert P. Mitchell, manager Milton district; F. Ellwood Smith, district manager; Leon M. Wallace, auditor.

Chicago Edison Company—W. L. Abbott, chief operating engineer; Walter M. Anthony, comptroller; George N. Eastman, engineer; Robert L. Elliott, assistant secretary; Louis A. Ferguson, second vice-president; John Foster Gilchrist, contracting agent; Robert Charles Petyt Holmes, purchasing agent; Samuel Insull, president; Edward William Lloyd, assistant construction superintendent; Ernest Lunn, battery superintendent; Carl Schwartz, electrical engineer.

New York Edison Company—Thomas E. Murray, second vice-president and general manager; J. W. Lieb, Jr., third vice-president and associate general manager; H. M. Edwards, auditor; W. F. Wells, superintendent Waterside station; A. H. Ackerman, engineer meter department.

Edison Electric Light Company of Philadelphia—P. H. Bartlett, superintendent installation; W. C. L. Eglin, electrical engineer; W. H. Johnson, president; A. E. Kennelly, Harvard, Cambridge, Mass. (by permission of Mr. Eglin); H. C. Lucas, purchasing agent; Joseph B. McCall, James T. Maxwell.

The Edison Illuminating Company of Detroit—Alex Dow, vice-president and general manager; Hoyt Post, director and attorney; W. B. Thompson, chief inspector.

Edison Electric Illuminating Company of Brooklyn—W. W. Freeman, secretary; E. A. Leslie, second vice-president and general manager.

The Columbus Edison Company—A. W. Field, secretary; L. G. White, assistant general superintendent.

The New Bedford Gas and Edison Light Company—Charles R. Price, treasurer; George R. Stetson, president and general manager.

General Electric Company, Philadelphia, Pa.—W. J. Buddy, G. L. Thompson, supply department.

Edison Sault Electric Company—William Chandler, vice-president and secretary; J. G. White, constructing engineer.

Potomac Electric Power Company, Washington, D. C.—H. W. Fuller, general manager; E. S. Marlow, treasurer.

The Edison Electric Illuminating Company, Altoona, Pa.—Edgar B. Greene, superintendent.

United Electric Light and Power Company, Baltimore, Md.—P. O. Kielholtz, consulting engineer.

Massachusetts Board of Gas and Electric Light Commissioners, 145 State House, Boston, Mass.—F. E. Barker, chairman.

General Electric Company, Boston, Mass.—Fred M. Kimball, manager small motor department; Sidney B. Paine.

Buffalo General Electric Company—Charles R. Huntley, vice-president and general manager.

Chattanooga Light and Power Company—Byron T. Burt, secretary and general manager.

General Electric Company, Chicago, Ill.—B. E. Sunny.

Erie County Electric Company, Erie, Pa.—Thomas G. O'Dea.

Edison Lamp Works, General Electric Company, Harrison, N. J.—John W. Howell, engineer; Francis W. Willcox.

Indianapolis Light and Power Company—Charles C. Perry, secretary and treasurer.

Jackson Light and Power Company, Jackson, Mich.—W. A. Foote, president.

Johnstown Electric Light Company, Johnstown, Pa.—J. W. Reeves, general manager.

Louisville Lighting Company, Louisville, Ky.—A. M. Worthington, manager.

General Electric Company, Lynn, Mass.—F. P. Cox, meter engineer.

Portland General Electric Company—William S. Barstow, 56 Pine street, New York.

General Electric Company, New York—F. C. Bates.

Association Edison Illuminating Companies—Wilson S. Howell, Eightieth street and East End avenue.

General Electric Company, Paris, France—Edgar W. Mix.

Peoria Gas and Electric Company, Peoria, Ill.—R. L. Wallace, superintendent electrical department.

Edison Electric Illuminating Company of Pottsville, Pottsville, Pa.—VanDusen Rickert, secretary and manager.

Rochester Gas and Electric Company, Rochester, N. Y.—George A. Redman, general superintendent electric department.

Rockford Edison Company, Rockford, Ill.—M. A. Beal, manager.

The Seattle Electric Company, Seattle, Wash.—Joseph B. Lukes, superintendent of lighting and power.

Edison Electric Light Company, Schenectady, N. Y.—Henry W. Darling, president.

Schenectady Illuminating Company, Schenectady, N. Y.—A. L. Rohrer.

The Toledo Railway and Light Company, Toledo, Ohio—Ernest J. Bechtel, superintendent lighting.

Edison Electric Illuminating Company of Williamsport, Pa.—Ernest H. Davis, general manager.

Edison Electric Light Company, York, Pa.—J. F. Dusman, general manager.

At the first session, held Tuesday morning, September 8, the reports of the Lamp and Meter committees and of the Committee on National Code were received and discussed.

A paper on "Overhead Pole Line Construction and Operation," by Mr. A. H. Manwaring and Mr. J. T. Hutchings, of Philadelphia, was read.

In this paper Messrs. Manwaring and Hutchings took up the necessary stages in the solution of the problem of current distribution. The old time construction, it is found, was usually light and cheaply erected, and lack of proper maintenance increased the number of accidents, which, together with the unsightly appearance of the poles, strongly agitated public opinion against the entire construction. Various forms of wooden and metal poles were described, and also arrangements of circuits. The methods of fastening and dimensions of cross-arms were illustrated and described, and short chapters were given up to a discussion of braces, pins, insulators, lightning arresters, fuse boxes, location and installation of transformers on the pole line, location and construction of main or trunk lines, grounding of secondaries, and complaints and rules.

At the afternoon session, the report of the Storage Battery Committee was received and discussed, some very interesting information as to the Edison battery being furnished; a paper on the "Selection and Installation of High-Tension Switch Apparatus," by Mr. L. L. Elden, of Boston, was read; and a paper on the "Operating Features of High-Tension Power Stations," by Mr. W. F. Wells, of New York, was read.

The paper by Mr. L. L. Elden, on "The Selection and Installation of High-Tension Switching Apparatus," discussed the development of alternating-current generating and transmitting apparatus, and emphasized the great consideration which is necessary to-day in the designing of the switchboard apparatus. The types of switches which have been developed were detailed and several opinions cited as to the best method of locating the switchboard, the proper bus-bar arrangement, and the distribution of generator switches. Chapters are given to a study of feeder switches, operating means for switches, construction, and general recommendations.

When considering the construction of a switchboard there are several points to be carefully considered before proceeding with the selection of the switching ap-

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paratus. The operating requirements should largely govern this selection and on this point it is necessary to decide whether a considerable amount of the responsibility be allowed to rest with the operators, or whether a certain amount of special apparatus be installed with the end in view of rendering the entire installation automatic. The former course is without question the proper one to pursue, as the special apparatus devised to care for unusual occurrences is at times very erratic and unreliable in action, and under some conditions inoperative.

When the reliability of the generating and transforming apparatus now furnished by the manufacturers and the freedom from burn-outs which it enjoys are given full allowance, there is no good reason for complicating the switchboard to avoid an occasional emergency, which may momentarily cause use of the apparatus in excess of its rating.

The emergencies that occur in a well controlled station which can not be cared for safely and properly by a vigilant operator are few and far between, and in general fewer interruptions to the service occur in stations where the switchboards are arranged with simplicity in view and reliable attendants are employed.

On Wednesday, September 9, the session opened with a paper on "Commercial Experience with Nernst and Meridian Lamps," by Mr. W. B. Thompson, of Detroit, the discussion upon which was participated in by Mr. A. J. Wurtz, manager of the Nernst Lamp Company, and others.

Papers were read by Mr. E. W. Lloyd, of Chicago, on "Purchased Electric Power in Factories;" by Mr. Douglass Burnett, of New York, on "The Central Station and the Isolated Plant;" by Mr. Edward A. Leslie, of Brooklyn, on "The Development of Summer Lighting;" and by Mr. Charles Schwartz, of Chicago, on "Comparison of European and American Engineering Practice."

The paper by Mr. E. W. Lloyd, on "Purchased Electric Power in Factories," reviewed the growth of electric power loads in central stations during the past ten years. There is scarcely a doubt but that the connected central station power load in large cities will equal the connected light load at a very early day, as the removal of large isolated plants in office buildings and mercantile houses has increased the power loads of central stations very greatly. The experience of one company demonstrates that in a great number of cases factory plant costs per kilowatt-hour were much in excess of what the central station is able to sell them current for at a profit. Typical installations were described and illustrated and figures given to show the improvement of operation and margin of profit in the use of electric power in factories.

Low power rates are a detriment to central station business as these rates are published by customers from place to place, and often business is lost because the prospective customer hears of an extremely low price in another city, where the local conditions or more often the anxiety of the company to get a power load, prompt them to give a low rate without learning what it actually costs to operate the isolated plant.

Before giving a prospective customer a price per kilowatt-hour, it is well to know what his factory plant costs are. In ascertaining these costs one will probably meet with difficulties.

"The manufacturer with engineering training, or having a mechanical or electrical engineer as manager, thinks he can generate power just as cheaply as we can sell it. We find, however, that a large portion of the customers with whom we ultimately do business, know little of their actual plant costs, and if their estimate of costs is taken, we would find a cost per kilowatt-hour with which it would be impossible for us to compete. A careful investigation of the plant will determine whether their figures are correct."

The paper by Mr. Edward A. Leslie, on "The Development of Summer Lighting," is, in the main, a description of the work of the Edison company in connection with the illumination at Coney Island. Curves were shown, giving the load curve for one of the heaviest days of last December and the load curve for June 27 of the present year.

On Thursday, September 10, the session opened with a paper entitled "Notes on Commercial Features of European Lighting Practice," by Mr. Arthur Williams, of New York. A further discussion was held on the paper by Mr. Charles Schwartz. A paper on "Profitable Advertising," by Mr. Walter H. Johnson, of Philadelphia, was read, as also a written discussion thereof by Mr. J. F. Gilchrist, of Chicago. The discussion on the report of the Meter Committee was concluded.

A further discussion was had on the report of the Storage Battery Committee, which was participated in by Mr. John R. Williams, the second vice-president, and Mr. Charles Blizzard, general sales manager of the Electric Storage Battery Company, and others, which opened the afternoon session. A paper on "Depreciation in Electric Light Plants," by Mr. H. M. Edwards, of New York, was read, as also a supplemental paper by Mr. H. A. Anthony, of Chicago. A most interesting paper on "Results Obtained with Steam Turbines in Milan," by Mr. Guido Semenza, of Milan, Italy, was read, as also a paper on "Steam Turbines," by Mr. August Kruesi, of Schenectady.

At night, a very valuable and interesting "Lecture on Illumination" was given by Dr. Charles P. Steinmetz.

The following officers and members of the executive committee were elected:

President, Mr. J. B. McCall, of Philadelphia.

Vice-president, Mr. C. C. Perry, of Indianapolis.

Secretary, Mr. W. S. Barstow, of Portland, Ore.

Treasurer, Mr. Alex Dow, of Detroit.

Executive Committee—C. L. Edgar, of Boston; Samuel Insull, of Chicago; J. W. Lieb, Jr., of New York; L. A. Ferguson, of Chicago; T. E. Murray, of Brooklyn.

SOCIAL FEATURES OF THE CONVENTION.

A daylight ride on the yacht Idler was made by the ladies on Tuesday morning, and on Wednesday evening an island ramble by searchlight. Golf and bowling contests were also indulged in.

On Tuesday a handicap golf tournament for members was held, Mr. J. B. McCall, of Philadelphia, winning the first prize with the net score of 75, and Mr. J. W. Howell, of Harrison, the second prize with the net score of 77. The prizes for the tournament were kindly donated by the General Electric Company.

On Tuesday evening a progressive card party for the ladies was held, Mrs. J. H. Quine winning the first prize, Mrs. A. L. Rohrer, the second, and Mrs. Samuel Insull, the third.

The croquet tournament for the ladies, which began on Tuesday, was concluded on Wednesday, Miss Alice Anthony winning the first prize and Mrs. C. D. Haskins, the second.

A mixed tournament was played on Wednesday afternoon, which resulted in Mrs. J. R. Lovejoy and Mr. W. H. Johnson winning the first prize by the net score of 87, and Mr. and Mrs. Louis A. Ferguson, the second prize by the net score of 95. The prizes were donated by the General Electric Company.

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The Department of Machinery, Louisiana Purchase Exposition, St. Louis, Mo.

There will be installed on the main floor of Machinery Hall, the World's Fair, St. Louis, 1904, engines representing 60,000 horse-power. This exhibit will embrace more horse-power than ever seen at any exposition in this or any other country. There will be utilized in performing various functions of the exposition fully 40,000 horse-power, and the remaining 20,000 horse-power will appear in exhibit form only. More than 200,000 square feet is the area demanded for the 40,000 horse-power employed in the exposition work. The total floor area comprised in Machinery Hall and in the "Steam, Gas and Fuels Building" is equivalent to more than nine acres, and the floor space in Machinery Hall alone has been applied for several times over. All the moving machinery and accessories, condensers and pumps making up the plant will be installed in the westerly half of Machinery Hall. In the easterly section the floor space will be devoted to machine tools, woodworking machinery and fire engines and apparatus.

Thomas M. Moore is the chief of the machinery department. Mr. Moore had charge of the machinery display at the Pan-American Exposition in 1901, and at the close of the Buffalo exposition was called to St. Louis to take charge of the World's Fair machinery department. A number of the items of the power plant are of foreign origin, and these were negotiated for by Lieutenant Godfrey L. Carden, R. C. S., machinery department. Mr. Moore originated the idea that power could be secured for the exhibition on a strictly exhibit basis, and, under his instructions, the manufacturing establishments of the old world were scoured for late types of engines, boilers and other accessories essential for a power plant.

As now arranged the visitor will find on passing into Machinery Hall through the central entrance to the north, in front and slightly to the left, a 5,000-horse-power reciprocating steam engine. This engine and its base have a total height of fifty-four feet; twenty feet of which is depressed below the floor level; the remaining thirty-four feet is elevated above the floor level. Its base occupies a space approximately thirty-five to forty-five feet. The foundations for its support cost $6,000, and its weight with electric generator is over 500 tons. The approximate value of this unit is $150,000. This engine comes from the works of the Allis-Chalmers Company.

Proceeding to the west through the central portion of Machinery Hall the visitor will see in succession the following installations: A 1,750-horse-power gas engine from Tegel, near Berlin, Germany; a 600-horse-power high-speed steam engine from Harrisburg, Pa.; a 750-horse-power medium-speed steam engine from Cincinnati, Ohio; a 1,000-horse-power slow-speed steam engine from Burlington, Iowa; a tangential water-wheel from San Francisco, Cal., operated by water forced through a pipe and nozzle at the rate of 1,200 gallons per minute and under a pressure of 300 pounds per square inch by a steam pump from Jeanesville, Pa. This great volume of water under enormous pressure will strike the buckets of the wheel, transmit its energy and fall as quietly as if poured from an ordinary basin. The water-wheel will make 900 revolutions per minute. Its speed will be regulated by a governor from Boston, Mass., and the flow of water will be measured by a meter from Providence, R. I. Next, to the west, will be found a 3,000-horse-power gas engine from Seraing, Belgium; then an 8,000-horse-power steam turbine from New York; then a 5,000-horse-power steam turbine from Pittsburg Pa., then four 3,000-horse-power reciprocating steam engines, and near to the western end of the central bay this notable line of engines will end with three eighty-horse-power exciter sets.

No one has ever seen such a line of prime movers, yet this is but one of the three lines which will be installed in the western half of Machinery Hall. The line to the north will consist of steam engines, largely of European build and drawn from the greatest works in England, France, Sweden and Germany. The line to the south will, for the main part, be made up of gas and oil engines, the products of the great machine shops of the world. All types, speeds and sizes will be shown, from the little one-half horse-power gas engine for domestic use to the great 8,000-horse-power steam turbine for the operation of lighting plants and trolley railroads.

The Belgian gas engine is also a very wonderful achievement. No one has ever seen a gas engine of anything like 3,000 horse-power. The same builders exhibited at the Paris Exposition of 1900 a gas engine of 600 horse-power, and this excited more interest and comment than any other individual item in that exposition. Here we have one with five times the capacity of the Paris engine. The unit to be installed in this exposition covers a floor space about eighty-five feet long and forty-five feet wide. Its flywheel weighs thirty-four tons, has a diameter of twenty-eight feet and its rim travels at the rate of nearly a mile and three-quarters a minute. A medium sized horse can be driven through its cylinders and its two pistons each travel ten feet at every complete stroke and each makes one hundred strokes per minute. The shipping weight of this engine is approximately 300 tons. About thirty tons of coal per day will be consumed in the generation of the gas to operate it.

At the end of the northerly line of engines and in the northwest corner of Machinery Hall will be found a French reciprocating steam engine of 1,500 horse-power, with its main shaft making 330 revolution per minute, a wonderful speed for so heavy and powerful an engine. Another peculiarity of this installation will appeal to engineers. The French engine is directly coupled to an electric generator built in Paris which operates in parallel an alternating-current arc lighting service with a generator built in Belfort, France, and directly coupled to a tandem-compound steam engine (from Mulhouse, Germany) of 1,000 horse-power and ninety-four revolutions per minute.

One hundred feet to the west of Machinery Hall will be found the "Steam, Gas and Fuels Building" which covers an area of about 100,000 square feet, and is itself an example of the most modern fireproof construction. In this building will be found great hoppers for storing the 4,000 tons reserve supply of coal and mechanical means for automatically conveying this coal from the cars to the bunkers and from the bunkers to the furnaces and gas plants. The daily consumption of coal will exceed 400 tons and the total length of the automatic conveyers lines will be about three-quarters of a mile. Here there will be found boilers to furnish steam and the gas producers to supply the gas for the operation of the engines in Machinery Hall. Briquette making, various types of mechanical stokers, force draft apparatus, water purifiers, and exhibits of items directly germane to the subject of steam generation and control will be installed in this building.

The intermural railway will be operated by four items of the Machinery Hall power plant, and it is interesting to note that the intermural railway consists of a double-track trolley road, standard gauge and standard type of open cars. The

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motor equipment and control are furnished by the General Electric Company; the brake equipment and control are furnished as an exhibit by the National Electric Company; the power plant for the operation of the road will be located in the central portion of Machinery Hall, and the prime movers in this plant are as follows:

1. A 1,500 brake-horse-power Oechelhauser system gas engine, 100 revolutions per minute, built and exhibited by A. Borsig, Tegel, Berlin, and supplied with gas from a producer plant built and exhibited by Julius Pintsch, of Berlin.

2. A 900-horse-power Corliss type steam engine, eighty-five revolutions per minute, built and exhibited by the Murray Iron Works Company, of Burlington, Iowa.

3. A 750-horse-power modified Corliss steam engine, 100 revolutions per minute, built and exhibited by the Lane & Bodley Company, of Cincinnati, Ohio.

4. A 600-horse-power four-valve steam engine, 150 revolutions per minute, built and exhibited by the Harrisburg Foundry and Machine Works, Harrisburg, Pa.

The Crocker-Wheeler Company, of Ampere, N. J., built the generators, which in every instance are directly coupled to the prime movers and deliver current at 550 volts at the switchboard.

In connection with the waterways it is interesting to note that the main one consists of a grand basin with lateral lagoons. The water is delivered into this basin from a niche in front of Festival Hall and from fountains in front of two ornate restaurant buildings which flank the Terrace of States. From these three points it flows over cascades and it is to be illuminated by electric lights placed under the lip of each step which breaks the spill. The water is to be lifted by three centrifugal pumps, built and exhibited by the Henry R. Worthington Company. Each pump is planned to deliver 30,000 gallons of water per minute against a total head and suck of 158 feet. Three induction type motors, each of 2,000-horse-power rating, are to operate the pumps. The magnitude of this feature will be better appreciated by those who recall that the total water moved in the Paris Exposition of 1900 was about 4,500 gallons per minute and at the Buffalo Exposition of 1901 about 7,000 gallons per minute, while here in this cascade feature alone we are to move 90,000 gallons per minute. The energy required for the operation of this feature equals the total energy had from the Niagara power plant by the Pan-American Exposition and the total energy availed of for illuminating the Buffalo Exposition. The secondary water system consists of Arrow Head lake. This lake is to afford an opportunity to illustrate the water dwellings and water life of the Philippines. Incidentally, it may be of interest to note that some $600,000 is to be expended on the Philippine exhibit and the result will no doubt be both entertaining and extremely instructive.

Some Data Relative to the Susquehanna River Development.

Work is rapidly progressing on the power plant at York Haven, Pa., on the Susquehanna river, which will distribute current to Baltimore, Philadelphia and other cities in this vicinity. This will be one of the largest hydroelectric developments in the country. The powerhouse is 478 feet long and fifty-one feet wide, in which are forty turbine waterwheels, of 600 horse-power each, two of which operate one 750-kilowatt generator, or a total of twenty generators, together with two turbines of 250 horse-power, each with generators for excitation.

Extending from the building to the falls is a granite wall 3,500 feet long and from twenty-eight to thirty-four feet high. It is six feet at the top and from sixteen to twenty feet at the bottom. The wall encloses a race 500 feet in width and sixteen feet in depth. To construct this wall it has required 100,000 cubic yards of masonry. This large crib dam is thirty by twenty feet wide, varying in proportion in height from eighteen to seven feet, and 3,000 feet long.

Blasting and excavating below the natural surface were done and solid rock reached for the foundations of the powerhouse. A coffer dam 500 feet in length and 240 feet in width was temporarily constructed with 45,000 bags of sand, 250,000 feet of timber and 10,000 cubic yards of stone.

Foreign Students at German Universities.

Of the 37,813 students who are at present matriculated at the twenty-one German universities, 35,082 are Germans and 2,731 foreigners, the latter being 7.2 per cent of the total number. Of these foreigners 2,299 belong to European and 432 to non-European countries. Russia is represented by 860; Austria-Hungary, 536; Switzerland, 253; Great Britain, 149; Bulgaria, 67; Roumania, 63; Greece, 56; Italy, 45; Netherlands and Servia, 45 each; France, 44; Turkey, 36; Sweden and Norway, 32; Luxemburg, 27; Belgium, 14; Spain, 11; Denmark, 10; Portugal, 3; Montenegro, 2; Lichtenstein, 1: America, 276; Asia (mostly from Japan), 133; Africa, 19; and Australia, 5. Of the foreigners, 628 study philosophy, 616 medicine, 588 mathematics and natural sciences, 351 law, 199 forestry, 146 agriculture, 124 Evangelical and 23 Catholic theology, 29 pharmacy, and 27 dentistry; 876 are matriculated at Berlin, 406 at Leipzig, 257 at Munich, 197 at Heidelberg, 146 at Halle, 128 at Freiburg, 99 at Goettingen, 79 at Jena, 75 at Königsberg, 67 at Bonn, 66 at Strassburg, 54 at Würzburg, 53 at Giessen, 51 at Marburg, 41 at Breslau, 37 at Greifswald, 30 at Tuebingen, 25 at Erlangen, 17 at Kiel, 14 at Rostock, and 13 at Münster.

Wind-Driven Generators.

For more than two years two small factories, one near Leipsic, the other near Hamburg, have been satisfactorily driven by windmills, which are also used as a means of generating electricity for lighting purposes. *Elektrotechnischer Anzeiger* states that the windmills have a diameter of five metres and five and one-half metres, respectively, and are mounted on the roof of the works. To ensure reliability the wind-wheel itself has no moving parts, the speed regulation being obtained by turning the windmill so as to vary the angle under which the wind impinges upon the sails, which are built of steel sheets. This is performed by a small auxiliary wind motor, and is said to be done so quickly and accurately that the voltage of the dynamo remains practically constant throughout the range of ordinary wind pressures. An automatic switch cuts out the battery connected in parallel with the dynamo as soon as the wind falls below a certain point. In one of the cases mentioned the battery may be divided into two parallel groups when it is necessary to utilize unusually low winds.

The filament in glow lamps gradually diminishes in diameter in consequence of the slow volatilization of the carbon, says the *Electrician*, London. According to the *Elektrotechnische Rundschau*, a German firm introduces into the glass globe certain chemical compounds with a high boiling point; these, under the influence of the temperature in the lamp bulb, slowly give off vapors containing carbon, which is deposited on the filament, thus making up to a large extent for the loss referred to above, and keeping the resistance and also the brightness of the lamp more uniform throughout its useful life.

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THE RIGHT OF WAY.

BY H. H. VREELAND.

Mr. Herbert H. Vreeland, president of the Interurban Street Railway Company, during the recent meeting of the American Street Railway Association, contributed liberally to the discussion, besides offering a paper on "The Right of Way." A part of Mr. Vreeland's discussion follows:

The necessity of approaching questions of this character from the right point of view is very important. Last winter there was a great agitation in New York city on the question of transportation. The existing facilities in the city were clogged and hampered in every way by abnormal conditions of obstruction—the aerial lines by reason of reconstruction and the surface lines by reason of subway construction, and all that went with that; and it was taken up, as a burning question, that proper facilities were not offered to the public. There were two ways to approach that state of affairs: One way was to say that the company was giving all the service it could give and doing the best it could do, and that is all that could be done, which would at once raise a controversy as to whether the company was really doing it or not. There was another way to approach the matter, and that was that the conditions that existed at that time, which surrounded the operation of the cars in the city, were conditions which were apparent to the eye of everybody, but in the rush of business had been lost sight of. It was no new point, nothing novel, absolutely none; every one knew it who saw it every day, and yet when I came out with the statement before a public meeting, that was called on this burning question, that the trouble was not that there was not sufficient service, but that the public was deprived of the use of that service by reason of the obstructions that existed on the tracks and streets, for which the railroad company could not be held responsible, and could do nothing, the matter was viewed in an entirely different way. We elaborated on that point after making a careful study of the general traffic conditions of the city, and went on to show that until there was a recognition on the part of the public authorities that the movement of thousands of citizens should be considered of greater importance than the delivery of a ton of coal or a barrel of flour, the railways were helpless to improve the condition of affairs, the matter was taken up as an almost entirely new proposition. Any number of letters were written to me at that time by persons who rode in the cars of our company on Broadway and who would say that a man with a truck of coal had held the car up for five or ten minutes, and they would all close with saying that the position which the company had taken in the matter was right. The man with the truck load of coal had been running on the tracks for the last twenty years—but the public had become so used to the condition of affairs that it did not exercise enough thought to understand that the true cause of the delay in local transportation was not any fault of the operating company but of the conditions of traffic which existed on the streets of the city and had existed all the while. The agitation resulted in strong public sentiment. The regulation of city vehicular traffic was taken up by the police authorities and by other civic bodies, in the interest of the movement of car traffic, and treated from the standpoint, not of the company, but of the public; that the public were in the cars and that no one lost his right to free movement, etc., by reason of being in a car, and while the car itself might not have the same rights as an individual who was obstructing it in the street, yet the passengers in the cars lost none of their right to free and easy passage through the city streets; that it was a question of the convenience of the few standing aside for the convenience of the many. This agitation resulted in quite a revolution which has had a lasting and improving effect all the time on the question of our transportation, viewed from this standpoint of the right of way.

It seems to me on this question of right of way and other important questions connected with our work, that they are not taken hold of in a strong enough manner; that our side of the question is not put in proper shape before the public in many instances. We are very prone to consider we know it all, and the other fellow does not know anything; that the newspaper man does not know anything when he criticises us; that the citizen who writes a letter of complaint or criticism to the company does not know anything; but we know it all. We make ourselves believe that we are carrying on our particular business better than any one else could do it; and we resent suggestions and criticisms, when we really should study every criticism which is made to see whether we are right or not and get some good out of the criticism to produce a better result. It is the one thing, in my opinion, which has created much of the antagonism that exists in the public mind and in the public press regarding matters connected with the operation of all our systems of transportation, some of the new systems as well as some of the old, the point that we think we know it all. I find when you approach any question from that standpoint that you can create not only a good deal of disturbance in the minds of others, but a good deal of disturbance in connection with the management of the property you have to do with.

I will take up another point which occurred to me as a strong point, and that is the moving of the United States mail. When you consider the rights of the many as against the rights of the few, the United States mail wagon affords one of the strongest examples. A mail wagon leaves the General Post Office in New York to go to the Grand Central Depot. It has mails destined for the Pacific coast, Honolulu, Japan, etc.—nothing local in its character whatever—yet I as a citizen of New York and you as a citizen of New York or any other city, if you happen to be in New York, must stand aside and let that mail wagon go by. The mail wagon and its contents are of no interest to us; add nothing to the comfort or convenience of our lives; there is no mail destined for our office or our houses; we have no interest in it whatever. Yet the consideration of the interests of the world, as a whole, in the movement of its mail matter is such that the consideration of the rights of the millions against the few makes it necessary that you all must go a little to one side and give the mail wagon the freedom of the streets.

We do not ask in our business for the freedom of the street in the operation of our cars, except for the operation of the cars in the interests of the general public and the quick handling of the people who are entrusted in our care. Of course, it is absolutely unnecessary, in view of the many addresses we have had on the subject of what a boon street railways have been to the United States, to go over that old ground again and say why all this should be done, except to leave the statement in this shape—that we should consider this question in a broad way and see if we can not get the general authorities, not only of one state, but of all the states, educated up to that point where they will consider this question from the standpoint of the public itself. Our regulations are just as crude with reference to municipal propositions connected with railway properties, lighting properties, etc., as are many of our rules and regulations with reference to the operation of a property. The conditions have changed so quickly in street railway operation that they have not been met at all by any change in municipal regulations; and when this question was receiving so much consideration in New York city last winter and the matter discussed very thoroughly in the newspapers, the newspaper men were surprised to find that the movement of electric cars with the millions upon millions of passengers transported every year was governed by regulations and laws away back in the sixties and seventies, and it was necessary to collate these and get them in form to present them to the city authorities to get them to see how absurd it was to regulate this vast traffic, or attempt to regulate it, by rules which had been framed for conditions which existed thirty or forty years ago. It was like an experience I had not long ago where, in looking over some questions connected with an accident, in taking up the rules and regulations of a certain company, I found that the rules and regulations were dated in July, 1872, when the property was a horse-car property with less than 100 employés, and operated about twenty cars, and that same property by consolida-

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tion had grown into a property employing more than 1,200 men, with a corresponding increase in service and all the operations of the company increased in proportion, and yet the road was operated under rules and regulations dated in 1872, telling how the men should care for the horses, etc., and nothing being said with reference to electric motors.

I am free to say that although there are certain limitations, restrictions and conditions imposed on the operation of street railways abroad, I would be willing to accept these restrictions and limitations and bear whatever loss might ensue, to gain the advantage of having proper regulations of all kinds of street traffic, and have such regulations thoroughly and intelligently enforced, such as exists abroad in the operation of the various transportation systems. The systematic manner in which regulations govern street traffic of all kinds was one of the things which appealed to me very much in looking over the conditions that existed on the other side of the water with reference to operation.

I think that the importance of a proposition of this kind may be minimized in the minds of men who have to do with the operation of lines in the smaller cities and towns; but the importance of matters of this character is emphasized when you consider that a compilation was made last winter of the laws and regulations governing the movement of all street traffic of the United States by the authorities of the city of New York to determine what was reasonable regulation. Some one may consider that this matter is of no interest to him, because of the condition which prevails in his city, where his lines are located; but you must consider these two points: First, that whatever your regulations are, when this question comes up in other sections of the country, your regulations become a part of the consideration of what is being done in other places, large or small, and the next consideration is that some of you bright young men may be operating the lines in the city of New York within the next few years and will have to face this condition yourself. The same thing is true of the franchise proposition, and franchise regulations and limitations and restrictions, which could just as well be included in this general proposition, in my mind. On this point of franchise limitations and conditions, any one who has to do with the operation of properties can not in fairness to the country as a whole consider these things as entirely of locality. To-day enquiry is being made abroad as to what we are doing in this country; and the limitations and restrictions that you may have in a weak moment accepted in securing something for your property may be a keynote and turning point on which hundreds of enterprises abroad may be stranded, and ultimately some in our own country; and without going into a discussion of the details of this matter, from the standpoint of franchise limitations, restrictions and conditions, from the standpoint of vehicular traffic and regulations, and from the standpoint of rules and regulations which govern employés of these properties throughout the country, we can not consider any one of these points as individual, but they must be considered collectively and as a part of the whole number of the railroad properties of the United States, if not of the world.

Report of the Mexico Electric Tramways, Limited.

The report of the Mexico Electric Tramways, Limited, for 1902, presented at the annual meeting of the company, states that the result of the company's operations for the past year, after charging interest on the debentures of the Compañia de Ferrocarriles del Distrito Federal de Mexico, and after payment of the three and one-half per cent guaranteed on the share capital of that company (under the terms of the lease), shows a net profit of the sum of $136,600.04, which, at the rate of exchange of eighteen and one-half pence, gives the sum of £10,529 to be carried forward to the credit of the London profit and loss account. The interest received on the debentures of the Compañia de Ferrocarriles del Distrito Federal de Mexico (held by this company) and the dividend declared by the Compañia de Ferrocarriles del Distrito Federal de Mexico on its share capital (all of which is held by this company) is then added, and after charging expenses and obligations, etc., against the same, a net balance is shown to the credit of profit and loss account of the sum of £20,260. The usual dividend of six per cent has been paid on the preference shares.

During the year under review the company issued 112,987 preference shares, completing the issue of the 500,000 preference shares authorized. One small but important addition to the electric service in the City of Mexico has been made during the past year. The total distance now operated on by electricity, under the company's system, is 116 kilometres. During the year under review 31,132,030 passengers were carried, as against 26,709,225 passengers during the previous year (1901), being an increase of 4,422,805 passengers, and the receipts amounted to $2,400,787.83, as against $2,103,174.87 in 1901, showing an increase of $297,612.96. The increase in prices of material and rise in wages, as a consequence of the lower exchange during the past year as against the previous year, may be taken, at a moderate estimate, at about twenty per cent. Traffic receipts since the beginning of January this year have shown a steady increase, and the receipts for last month reached the encouraging figure of $241,500.

A New Marine Steam Turbine.

A new form of turbine engine suitable for driving ships has been invented and patented by Mr. John Merson, of England. In this engine the steam passes radially outward through rings or vanes, expanding in its passage, and is finally exhausted into a condenser from the outside of the casing which encloses the vane discs. In the simplest form of construction a cylindrical casing is employed, having vanes on its inner end faces, and a vane disc is mounted within this casing upon a driving shaft which passes through stuffing boxes in the casing ends. Vanes on each side of the vane disc work between the rings of vanes on the casing ends. In this case the latter are stationary and the steam is admitted through a passage into the centre of the casing around the shaft.

In the second form of construction the casing is simply an enclosing chamber with plain walls. In this casing a vane disc is mounted on a central shaft and two facing discs having rings of vanes are arranged to cooperate with the vane disc, one upon each side of the latter. One of the facing vane discs is mounted on a hollow shaft, and the other is connected to the first one beyond the periphery of the central vane disc. Steam is admitted into the hollow shaft and passes into the turbine along the interior of the shaft, being distributed from the central chamber of the turbine through suitably directed passages; and after passing radially through the turbine, it is discharged from the outlet orifice at the outside of the casing. In this turbine there are no stationary vanes. The central vane disc and the two coacting facing discs are driven in opposite directions, the central shaft being thus turned in one direction and the hollow surrounding shaft in the other. Upon each of these two shafts is mounted a propeller, one being right-handed and the other left-handed.

A reverse rotation of the turbine may be produced for backing a ship by a further series of vane rings and fixed vanes on the end walls of the casing between which the outer vanes on the facing discs are adapted to work. Steam is admitted here through suitable side passages and drives the hollow shaft and its propeller backward. In either case the exhaust of the steam from the outside of the casing causes an almost complete vacuum in the other set of vanes which are not in operation, so that there is very little resistance to rotation in the non-working vanes. There is no end thrust in either direction, as the steam acts radially and equally all around the shaft.

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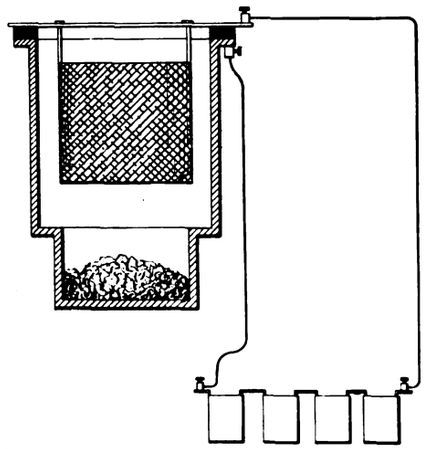
Electrical Patents.

Bror A. Bergman, a mechanical engineer, of Nyfors, Sweden, has patented in this country a new method of recovering tin from scraps of tinned iron. The electrolytic processes hitherto employed are all based on introducing the scraps, either compressed or contained in baskets, as the anode into an acid or alkaline electrolyte and by means of an electric current dissolving the tin, and depositing it on the cathode. The disadvantage connected with all these processes lies in the electrolytes soon becoming useless and requiring renewal; the acid baths, owing to dissolution of iron, which causes high tensions accompanied by greater difficulty of dissolving the tin and the depositions of an impure product on the cathode, since basic salts are deposited and iron is also precipitated when the current density increases; the alkaline electrolytes, owing to an increase of stannate of alkali in solution, probably depending on the tin being dissolved as divalent iron, but separated as a tetravalent one, so that the same quality of electricity dissolves more tin at the anode than is precipitated at the cathode, to this being added the action of the carbonic acid of the air in forming carbonate of alkali, which is likewise useless for the solution of the tin. When the percentage of stannate and carbonate of alkali is increased and that of caustic alkali decreased, the tension of the bath rises, oxygen and hydrogen are generated, the tin dissolved with greater difficulty, and the scrap iron being but imperfectly freed from tin becomes useless for smelting into high-grade iron, the electrolyte, moreover, becoming worthless and must be replaced and subsequently regenerated in some suitable manner. Briefly speaking, by anodic dissolution and cathodic precipitation it is impossible whether with acid or alkaline electrolytes to work any length of time, the point being soon reached where the process on the above grounds is spontaneously discontinued. Meantime an increasing amount of electric energy is gradually lost, owing to the secondary reactions appearing and interfering with the process. It has also been tried to arrange the tin scrap as the anode and some more positive metal—for instance, iron—as the cathode in a caustic solution, thereby forming a galvanic pair generating electricity at the same time as the tin was dissolved. This process of dissolving would, however, stop long before all the tin is removed from the iron, a current of electricity from outside sources had to be applied, and the troubles already mentioned were encountered. The consequence has been that at the present state of the art the detinned scrap iron is contaminated with some tin and fetching only a very low price in the market. The present electrolytic process for recovering tin from scraps of tinned iron, is based on an entirely different principle. According to this method, to be sure, tin is dissolved by means of caustic alkali, though in such a manner that a primary battery is formed for transforming the chemical energy developed into electric energy, and the action is strong enough to dissolve every particle of tin. In other



Method of Recovering Tin from Scraps of Tinned Iron.

words, the inventor has succeeded in arranging the apparatus in such a way that the electric energy generated is neither too weak nor too strong. He has accomplished this by introducing a depolarizing compound into the galvanic pair. Depolarizers have long been used in connection with galvanic pairs for the purpose of generating electricity, but the discovery lies in the great beneficial action of using a depolarizer in connection with detinning tin scrap in a caustic solution. The electric energy generated in this manner when the tin is dissolved into stannate of alkali is taken up by and stored in storage batteries connected with the poles of the apparatus in such a manner that the said energy may be used in the final precipitation of the tin or for any other purpose.

The Security Investment Company is the assignee of a patent granted to Charles J. Reed, of Philadelphia, Pa., on a method of treating lead plates for use in secondary batteries. The invention relates to the treatment of lead plates to form active material or material adapted to become active; and it has for its object to provide a method which will effect the formation of the material more expeditiously and of greater depth than is possible by the methods heretofore usually employed. In practising the invention, a metallic-lead plate of suitable form and dimensions is first subjected to the action of a suitable acid in gaseous condition—such, for example, as hydrochloric-acid gas—in a closed chamber or receptacle, preferably in conjunction with an oxidizing agent—such as nitric acid, nitric oxide, nitric peroxide, chlorine, or bromine—thus producing a layer of lead chloride. While it is preferred to employ an oxidizing agent in connection with gaseous hydrochloric acid for converting lead into lead chloride on account of the more rapid conversion thus produced, a less rapid conversion may be effected by the hydrochloric-acid gas alone. In order to form the active material to be utilized in secondary batteries, the lead chloride formed as above specified is reduced to spongy metallic lead either by electrochemical action or by the reducing action of metallic zinc or some other suitable reducing agent. Means for practising the invention are shown in the accompanying drawing, the signal feature of which is a sectional view, partially diagrammatic in character, of the apparatus employed. The closed chamber or receptacle 1 is formed of glass or some other material which is not chemically attacked by the gases and liquids employed in the process, and in the chamber or receptacle is placed a lead plate 2, which, as above indicated, may be of such form and dimensions as will adapt it for use as a secondary-battery electrode. Hydrochloric-acid gas is introduced into the receptacle 1 through a suitable tube or pipe 3 under sufficient pressure to fill the receptacle. This gas attacks the surface of the plate 2 and converts it into lead chloride. In order to make the converting action more rapid, an oxidizing agent—such, for example, as chlorine or one of the higher oxides of nitrogen is used, in conjunction with the hydrochloric-acid gas. The hydrochloric-acid gas may be mixed with the above-mentioned gaseous oxidizing agents before introduction into the chamber or receptacle, or the two gases may be introduced separately. If the amount of gas in the receptacle 1 at any time exceeds what is desired, it may be drawn off through pipe 3*a*. This pipe may also be utilized as an exit for air when the hydrochloric-acid gas is first introduced into the receptacle. The formation of lead chloride is greatly promoted by keeping

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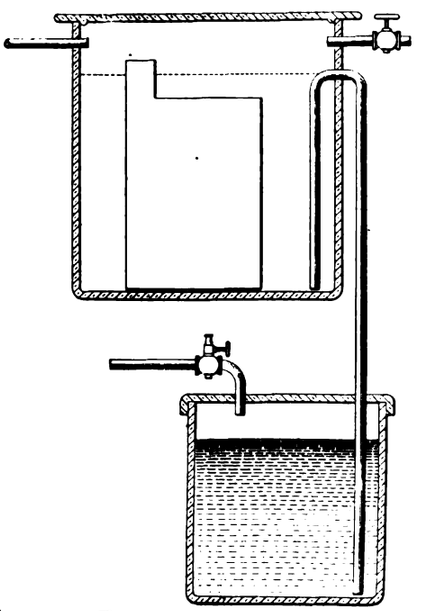
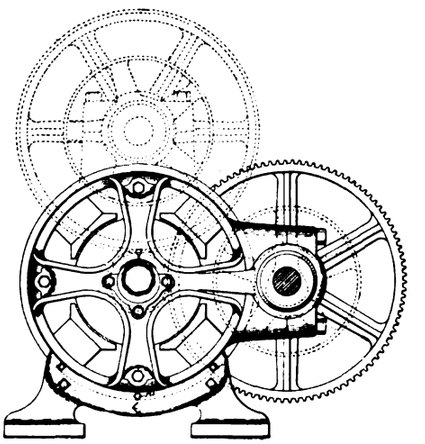
the surface of the lead plate 2 in a moist condition, this condition being brought about either by submerging the plate in water or in a solution containing either hydrochloric acid or nitric acid. If water is employed, it soon becomes a solution of hydrochloric acid by reason of the absorption of a portion of the hydrochloric-acid gas. The intervals between the applications of moistening liquid may vary from two to five hours, according to variations in the operating conditions. For the purpose of supplying water or a solution for moistening the plate 2, a receptacle 4 is shown, containing a solution 5 of a suitable character and connected to the receptacle 1 by means of a siphon-tube 6. The receptacle



METHOD OF TREATING LEAD PLATES USED IN SECONDARY BATTERY.

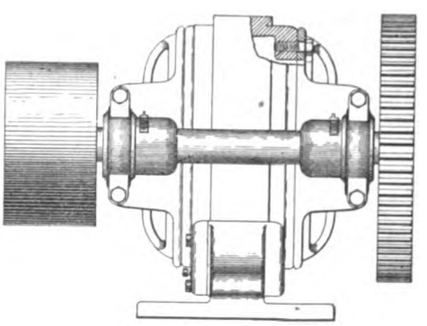
4 may also be provided with a pipe or tube 7, through which compressed air may be introduced into the receptacle. When the air is forced in through the pipe or tube 7, it obviously will force the liquid 5 through the pipe 6 into the receptacle 1, and after a sufficient amount of the liquid has been introduced into the receptacle 1 to moisten the plate 2 the compressed air may be withdrawn from the receptacle 4 through exit-tube and cock 8, and the liquid will then flow from the receptacle 1 into the receptacle 4 by the siphon action.

Norman C. Bassett, of Boston, Mass., has invented an electric motor, and has assigned the patent obtained thereon to the General Electric Company. The invention relates to back-geared motors, in which the armature-shaft carries a pinion meshing with a spur-gear on one end of the counter-shaft, which carries at its other end a belt pulley; the object being to reduce the speed of the belt pulley so that the motor can be used in driving slow-running machinery. The counter-shaft is parallel with the armature-shaft and is journaled in bearings on the frame



ELECTRIC MOTOR.

of the motor. The object of the invention is to provide a construction by means of which the counter-shaft with its spur-gear and belt pulley can be angularly shifted to any one of several positions around the periphery of the motor frame in order to adapt the motor for use in various situations. The field-magnet frame of the motor has a cylindrical periphery concentric with the armature-shaft, which shaft is journaled in bearings in two circular heads. These heads are fitted to rotate on the ends of the magnet frame and are securely clamped against the ends by screw-bolts spaced at equal distances apart on a circle concentric with the shaft. The edges of the heads are faced off to fit against the ends of the frame. On one side of each head there is a bracket or projection forming a journal bearing for the counter-shaft. Suitable caps retain this shaft in place. A separate gear is secured on one end of the counter-shaft and meshes with the pinion on the armature-shaft. The other end of the counter-shaft carries the usual belt pulley and each head carries bearings for the armature shaft, which are provided with oil wells, and furthermore, the bearings have arms by means of which they can be fastened to the head. The wells extend below their respective shafts, so as to give room for a body of oil which is carried to the journal by any suitable device, such as a ring hung thereon and dipping into the oil. When it is desired to change the counter-shaft from one side of the motor to a different position, the bolts are removed and the heads rotated a quarter turn. The bolt-holes in the head and magnet frame now coincide again, so that the bolts can thereupon be replaced. In the same way, the heads can be given another quarter turn to bring the shaft to a position diametrically opposite its original one. Every time the heads are rotated to shift the counter-shaft, the bearings in the armature and counter-shafts must be changed to keep the oil wells below the journals. The magnet frame is provided with legs, which are preferably formed on a saddle in which the frame rests. This frame has a circumferential cylindrical rib with a dovetail groove in the saddle. One side of the groove is formed by a wearing-strip backed by an angular filling-piece, both of which are clamped against the rib by a segment and fastening-screws. The strip and filling-piece can be adjusted for wear by a suitable set-screw. This construction permits the whole motor to be angularly adjusted



ELECTRIC MOTOR.

around the axis of the armature-shaft to occupy positions intermediate those provided for by shifting the counter-shaft or to take up slack in the belt driven by the pulley.

Motor-Cars as Railway Feeders.

One of the new developments on the Great Western Railway which were announced by Lord Cawdor, the chairman of the company, at the recent half-yearly meeting, came into operation on Monday last, when motor-cars were run between Helston and the Lizard. The motor cars have been built by Milnes-Daimler, and are equipped with sixteen horse-power petrol engines. They are capable of seating thirty-two passengers. If this experiment proves successful, other road services will be established as feeders to the railway between the existing stations in country districts. These vehicles will furnish links with the outlying hamlets and small towns needing improved traveling facilities. The scheme is really the outcome of the still more important development which will be inaugurated in October—that of running steam motor cars upon the railway itself, in order to meet the competition of tramway undertakings, which have reduced the company's income from short-distance fares.

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Reviews of Current Engineering and Scientific Literature.

Powerful Electromagnets.

New forms of electromagnets have been devised by MM. Camacho and de Mare, and are here described by M. E. Guarini. Camacho's magnet consists of a number of separately wound iron cylinders which slide one into the other. The different windings may be connected up in a variety of ways. When assembled, the various tubes of the electromagnet have the same polarity at corresponding ends. Similar in conception, but of greater power, is the magnet invented by M. de Mare. In this the poles are slotted and concentric coils wound in the various slots. Figures obtained by means of iron filings, with an ordinary electromagnet and that of de Mare show a much more even distribution of magnetic lines with the latter, and a table of comparative data is given, showing that with an ordinary wound magnet and one constructed by de Mare, each weighing about one kilogramme and containing equal weights of equal copper wire, for the same amount of electrical energy consumed, the carrying capacity, as measured by the author, was one kilogramme for the ordinary magnet and nine and six-tenths kilogrammes for the de Mare.—*Abstracted from the Electrician (London), August 28.*

A Process for Manufacturing Tubes of Magnesia with a Coating of Carbon for Use in Incandescent Lamps.

In order to give stability to the carbon filaments of ordinary incandescent lamps, M. de Mare gives them a core of magnesia by means of the following process: He forms a mixture of magnesia, pitch and carbon, with which, under high pressure, he produces filaments, bands, etc., of suitable diameter. These are baked in order to solidify them, and are then incinerated at a high temperature in a gas furnace, after being cut to the desired length. Then an electric current is passed through them while in contact with rarefied air. The carbon contained in the filament is burned, combustion commencing naturally at the exterior and continuing progressively toward the interior, the magnesia forming a solid covering. This treatment is continued until all the carbon is burned and a small cylindrical tube of pure magnesia remains. A hydrocarbon vapor is then admitted to the chamber and this deposits on the magnesia a covering of carbon similar to that obtained by the well-known process of flashing. These filaments have a higher resistance than those of carbon as at present used.—*Translated and abstracted from the Revue de l'Électricité (Berne), August 15.*

Electrometallurgy of Zinc.

A process of producing zinc from its ores has been developed by M. Salgùes. The ore is mixed in a closed electric furnace with an addition of fluxes and proper reducing material such as coke. The mixture is fused, which results in the formation of scoria practically free of zinc. This is drawn off and rejected, and the metal is separated either by pouring or volatilization, according to the conditions of the operation. If it is poured it is recovered under the scorium. If it is volatilized its vapors are collected in the metallic condition in a condenser. The vapors can be burned so as to form zinc-white. Ninety per cent of the zinc can be recovered in this way. It is also possible to treat blende in the same manner without roasting. When the mineral contains lead and sulphur these metals are recovered with the zinc. In 100-kilowatt furnaces the process gives an output of about five kilogrammes per kilowatt-hour. It is thought with specially adapted furnaces that two tons of zinc can be recovered per kilowatt-hour and with a preliminary heating of the materials a much better output will be secured. The process seems applicable to countries where water power is available and coal dear.—*Translated and abstracted from the Revue Pratique de l'Electricite (Paris), August 20.*

On the Asymmetry of a Mercury Break.

In making some experiments to determine the law governing the capacity of the shunted condenser necessary to stop the sparking at the break of an inductive circuit, Mr. James Edward Ives discovered that the necessary capacity varied according to the direction of the current. This phenomenon was so marked that he undertook further experiments to confirm it. The interrupter used when the action was noticed was an ordinary mercury break covered with acidulated water, contact being made with the mercury by means of an amalgamated copper wire. It was found that the action was not due to the acidulated water, nor to the metal of the contact wire, as the reaction took place with and without the water and with iron and platinum wires. It was also found that the effect was not due to the fact that in the ordinary mercury break the spark passes between a point and a plane, for by making a contact between a wire and a thread of mercury in a capillary tube, the same action resulted. It is suggested that the asymmetry may be due to some selective action of the mercury vapor generated when the spark passes, of the same nature as the Cooper Hewitt effect, or it may be due to some capacity effect such as is found in the Wehnelt interrupter.—*Abstracted from the Physical Review (New York), September.*

The Production of High Potentials from Alternating Currents.

The production of high potentials is becoming more and more important in studying many phenomena. Direct-current high potentials are generated by means of special dynamos or storage batteries, but up to this time have been limited to about 40,000 volts. By means of influence machines it is possible to reach 100,000 volts or more, but the current generated is very small. By means of induction coils, spark lengths of one metre and more are reached, yet with this apparatus exact measurements are difficult, because of the inconstant action of the interrupter. The interrupter may be discarded and an alternating current used, and this permits of the calculation of the result if the applied electromotive force follows a sine wave. Herr W. Wien has been working along this line with satisfactory results. In order to avoid the expense of a secondary with a very large number of turns, the turns in the primary coil are reduced; and that the number of turns in the primary may be made quite small, he adopted the plan of increasing the frequency of the applied electromotive force. A special alternator was built for him, giving 1,200 alternations per second at a speed of 2,000 revolutions per minute. This was driven by an eight-horse-power motor, and rated at seven kilowatts with a potential of 220 volts. This machine was connected directly to the primary of an induction apparatus with a spark-gap of forty centimetres, having only forty-three turns of

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copper wire of twenty-five square millimetres cross-section in the primary and an ordinary iron core. There was no difficulty in obtaining a strong stream of sparks across a gap thirty-eight centimetres long between two balls, with a primary current of forty-two amperes at forty volts. Much better than this could have been done, but it was not deemed advisable to risk the insulation of the secondary coil.—*Translated and abstracted from the Physikalische Zeitschrift (Leipsic), August 1.*

Aluminum Conductors for Electric Transmission Lines.

In this article Mr. Alton D. Adams gives a description of a number of important transmission lines in which aluminum is used instead of copper, and then discusses briefly the relative advantages of the two metals. Comparing wires of equal sizes and lengths, the aluminum has only sixty per cent of the conductivity of the copper. Therefore, to secure an equal conductivity, aluminum wire must have a diameter twenty-eight per cent greater than that of copper. Since copper is 3.33 times as heavy as aluminum, for equal weights the latter has 3.33 times the bulk of the former and a conductivity twice as great. The tensile strength of both copper and aluminum wire is about 33,000 pounds per square inch of section, so that for wires of equal length and resistance, the aluminum is sixty-six per cent stronger. Medium hard-drawn copper has a tensile strength of about 45,000 pounds per square inch, so that for equal resistances the aluminum wire still has the advantage. This alone would allow the poles, cross-arms and pins of the transmission line to be lighter or to be spaced further apart, but, on the other hand, the strain due to the wind would be greater with the larger aluminum wire. As the surface of the wire may be no greater than that of the poles, the increased wind strain may not be as great as the increased surface of the wire. Aluminum has a greater coefficient of expansion, and for this reason must be strung with a greater sag, but this greater sag avoids much of the vibration of the wires which is produced by the wind if they are more tightly strung. Aluminum expands between 32 and 212 degrees Fahrenheit about 0.0022 per cent; copper, under the same conditions, 0.0016 per cent. The larger diameter of the aluminum wire over an equivalent of copper has an additional advantage in that the inductance varies inversely to the diameter of the conductor employed, and the silent discharge from wire to wire is also less with larger wires.—*Abstracted from the Engineering Magazine (New York), September.*

A Question in Depreciation.

In every new undertaking the setting aside of an annual sum to cover depreciation of the plant is fit and proper for making an estimate of the returns to be expected, but depreciation should not be accepted as of universal application, as there are numerous occasions when it can not be admitted if a sound commercial estimate is to be made. Consider the case of an independent plant that has already been at work several years, and the future economy of which is to be decided upon. Enquiry need not be made into the early history of the plant or the reasons which led to its installation. It may even be granted that the installation was initially an error and that the economy secured over purchased energy will vanish if the depreciation be deducted. That it has not proved a commercial success matters nothing to the present enquiry, which is whether further working of the plant would pay better than purchasing energy. If the plant would only sell for scrap iron price, it will sell for as much if run for five or ten years more. It is there and can not be unpurchased. Obviously then, if a correct estimate is to be arrived at the plant must be taken as a free gift from a past error, and the future working costs must be calculated without depreciation. When at last the old plant can not be run for the price of purchased energy it should be stopped and sold. If plant would sell at the book value, a mistake could always be cut short by sale of plant; but plant which may be worth book value as a going item becomes scrap very quickly if an attempt is made to sell it. Under such circumstances it becomes justifiable—in fact, commercially correct—to ignore depreciation in a plant which is already at scrap price, though not at scrap value, for the work it may still perform. Another somewhat parallel argument will attach to the evaluation of the work done by a plant and the apportionment of costs. It may occur that a private electric light plant is run in connection with other plant, which can not be dispensed with. In this case, if the lighting plant were stopped the only economy would be the saving in coal, which might be less than the cost of the purchased energy. One can not get away from an accomplished fact and must not, therefore, be tied down by axioms that only properly apply before calculations on paper have been materialized in the form of plant and the money sunk past recovery except by work.—*Abstracted from the Electrical Review (London), August 28.*

The American Electrotherapeutic Association.

The thirteenth annual convention of the American Electrotherapeutic Association will be held at the Hotel Windsor, at Atlantic City, N. J., on September 22, 23 and 24.

Trains leave New York for Atlantic City at short intervals over the Pennsylvania Railroad, West Twenty-third street station.

Atlantic City is a place of great attractiveness for fall conventions, and the natural attractions, in addition to the splendid scientific programme which has been arranged, it is expected, will draw a large gathering to the sessions. There will be morning and afternoon sessions on Tuesday, Wednesday and Thursday. At each of these sessions, the reports of the committees will be heard and papers will be presented and discussed.

Clarence Edward Skinner, M. D., LL. D., is secretary of the American Electrotherapeutic Association, to whom enquiries should be directed.

The Manufacture of Incandescent Lamps.

A concession of great practical utility has recently been granted by the Mexican Government to A. Chaillet, covering the privilege of manufacturing incandescent electric lamps within the Republic. Immense quantities of such lamps are required in Mexico, and as all are imported, it will be readily seen that freight, duty, insurance and breakage, together with merchants and manufacturers' profits, greatly increase the cost of the lamp to the consumer.

The abundant water powers of Mexico furnish a cheap current for electric lighting, and new houses are invariably fitted out with electric equipment.

A company has been formed to take over Mr. Chaillet's patent and concession and to commence the manufacture of the lamps. The capital is $100,000 (Mexican), and the factory will commence with a daily output of 1,000 lamps. As this is less than the demand for the federal district alone, the output will be gradually increased in accordance with the demand.

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INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Wireless Telegraph Apparatus.

There is more interest taken in space telegraphy since its commercial utility has been assured and the practicability of the apparatus perfected than even a visionary person could give credit to.

So clear is the click on the receiver that the messages sent by the operator seldom need repeating, and if both are experts, the messages sent and received are always identical. The future usefulness of the system here described, is stated by the manufacturer to be neither doubtful nor problematical.

The transmitting machine consists of telegraph key, batteries, transmitting transformer, mounted and insulated

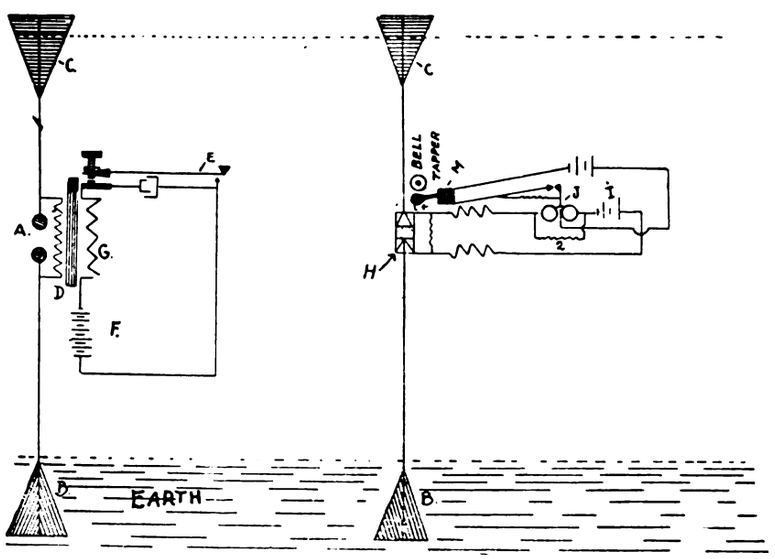

FIG. 1.—SENDING APPARATUS.

FIG. 2.—RECEIVING APPARATUS.

spark-gap, aerial capacity, ground connections and condensers; all assembled, connected and mounted on a highly finished hardwood base, so constructed that the spark-gap coil and key are the only parts exposed to view. The batteries supplying the power to the coil or transformer are placed in the base, totally concealed. All the electrical connections between the coil, key, battery and spark-gap are also connected on the under side of the base, completely concealed. The transmitting coil consists of a high-frequency transformer, specially wound with separable primary and secondary. Very high insulating material is used in its construction. The core is so constructed as to reduce to a minimum eddy currents or core loss. The condensers are treated and insulated with special prepared material, impossible to puncture. The vibrators are made with heavy platinum contacts and so constructed as to remain in constant adjustment. The coil is mounted with polished caps on each end and enclosed with a sheet of highly polished insulating material. The secondaries terminate on each end of the coil at the top of the round polished caps. The vibrators are attached directly to one end of the coil and made fast to one end of the polished cap. At this point the primary current is connected. The telegraph key is placed in the battery circuit and when opened and closed, in making the dots and dashes of the Morse code, which excites the primary of the coil or transformer, causing rapid alternating currents in the secondary, allows a discharge to take place at the spark-gap. The spark-gap is mounted on highly polished insulating pillars, which support the metallic surface, which is made adjustable. At this point, the secondary of the coil is connected and also the capacity connections for attaching to the ground and aerial connections.

The receiving apparatus consists of the following instruments and parts assembled and mounted upon a polished oak or mahogany base.

Adjustable Clark patented sealed coherers, with receiving stand and clips for supporting the coherer and making electrical connections thereby; also special wound split core relay, with one automatic tapper, condensers and shunt coils, batteries in the receiving and tapper circuit.

The batteries, shunt coils, condensers and tapper are all concealed in the base of the receiver case. The relay, coherer and stand, with binding-posts for aerial and ground connections, and the circuit switches, are the only parts visible on top of the base.

The relay is so constructed as to give the best results and is adopted and constructed specially for wireless telegraph work.

The automotic tapper is arranged to work with the least amount of current, guaranteeing high efficiency and long life for the batteries.

The complete arrangement of receiving circuit has been connected electrically in the most simple manner possible, in order to obtain the most practical results.

To communicate between two boundaries, it requires two sets of instruments, *viz.*, transmitter and receiver at each point of transmission and reception, termed stations.

Fig. 1 shows transverse section of the transmitting apparatus and transformer or sender, consisting of a modified form of the Hertz oscillator, the main feature of which is having one sphere of the spark-gap A earthed at B, and the other sphere connected to an elevated aerial capacity or vertical wire C, insulated from the earth, and the two spheres connected to the ends of the secondary winding of the transmitting transformer D.

When the key E is pressed, the current of the battery F is allowed to actuate the coil of the transformer, energizing the primary G and secondary D, which causes rapid succession of sparks to pass across the spark-gap into the vertical wire and earth.

The sudden release, caused by the spark discharge, of the electrical strain created along certain lines of electrical force through space, by the charged wire, causes some of the electrical energy to be thrown off in the form of a displacement wave in the ether, and, as a consequence, the vertical wire or capacity becomes the radiator of electrical waves.

Fig. 2 shows the receiver or responder, consisting of a coherer or adherer H, placed in a circuit containing the local cell I, the special wireless telegraph relay J. The relay is connected to work the secondary circuit, in which is placed

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automatic tapper K, also automatic recording tape and writing register M, with the proper shunts (1 and 2), for taking up excessive spark, or self-induction at these points.

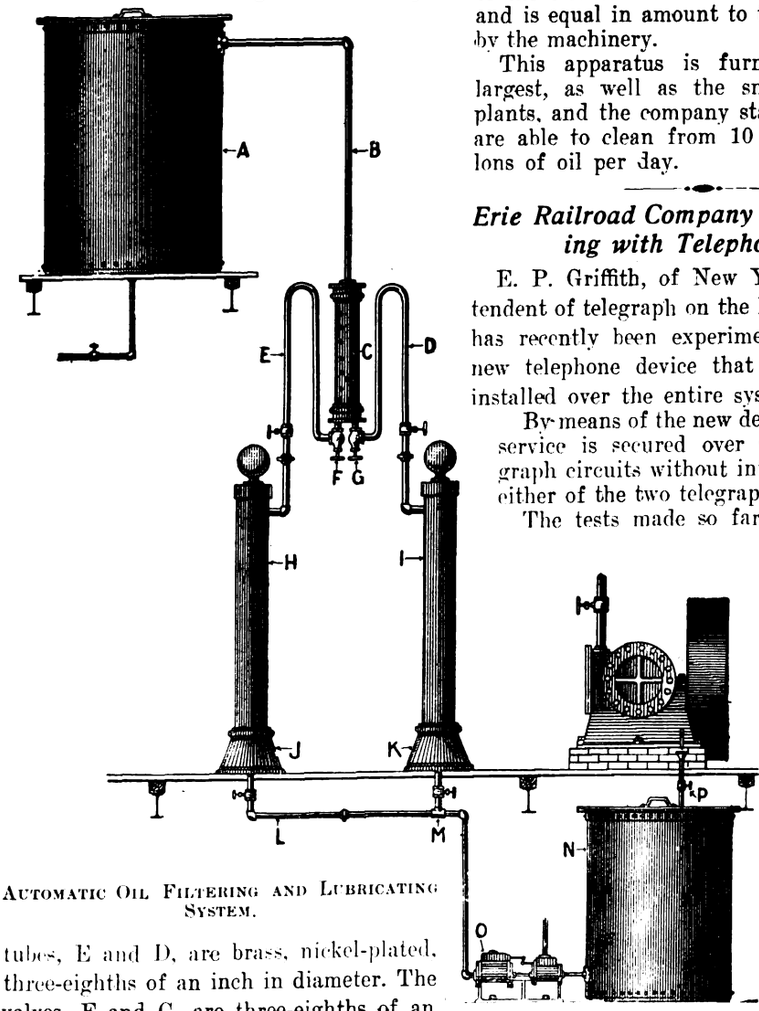
The coherer, or responder, in its normal condition, made up of numerous particles of fine filings or composition, is an imperfect conductor, and offers a very great resistance; the current of the battery can not pass through it, to actuate the instrument, but when influenced by electrical waves, cohesion or adhesion of the particles takes place, the resistance breaks down and it becomes a fairly good conductor, allowing the battery current to flow through, its resistance falling from an infinite value to between 200 and 500 ohms, thus allowing the current from the local battery to energize and work the relay, which in turn causes, automatically, a stronger current to work the tapper and automatic recorder as arranged in the secondary circuit. The decoherer taps the coherer, and in this way restores its high resistance, the results being that the responder is closed for a space of time equal to that during which the key is pressed by the operator at the transmitting station.

The apparatus described above is that manufactured by Thomas E. Clark Wireless Telegraph-Telephone Company, Detroit, Mich. Each transmitter and receiver is enclosed in a neatly finished case, made to hinge in two parts, with nickel trimmings and leather-covered handles, making them just as portable as a suit case. Dimensions of receiver case is seven and five-eighths inches in height, twenty and three-quarters inches in length and eleven inches in width. The transmitter case is twelve inches in height, fourteen and one-half inches long and eleven and one-half inches wide.

Electromagnets promise to come into common use for lifting heavy pieces of iron in factories and rolling mills. Instead of the present hooks and chains a large piece of metal is suspended above the iron or steel object to be fitted, a current is run through this, rendering it magnetic, so that it simply picks up the object and holds it until the current is turned off. A magnet weighing 350 pounds can carry a load of five tons. The time required for fastening a load to a crane by the present methods is estimated to represent one-half the cost of handling the material, so that great saving in handling material is apparent. There is a number of these electromagnets now in use at different steel plants.

An Automatic Oil Filtering and Oiling System.

The Collins Manufacturing Company, Conshohocken, Pa., has placed on the market a new form of automatic pressure oil filtering and oiling system. The operation of this system may be readily understood by referring to the accompanying drawing. The tanks, A and N, are made of galvanized steel and have a capacity of sixty gallons each. The pipe, B, is three-quarters inch brass and nickeled to the elbow. The sight-glass, C, is one and one-half inches in diameter and twelve inches long. The U-shaped



Automatic Oil Filtering and Lubricating System.

tubes, E and D, are brass, nickel-plated, three-eighths of an inch in diameter. The valves, F and G, are three-eighths of an inch, brass, nickel-plated. The filtering tubes, H and I, are twelve inches in diameter and three feet long, made of steel, electrically welded and enameled. The filtering material filling these tubes is compressed by a screw and disc not shown in the drawing. The piping from the pump is three-quarters of an inch in diameter. The pump is a duplex type and built to pump against high pressure, and is four inches by two inches by four inches.

In this system the oil is supplied to the different cups by gravity from the reservoir, A, situated in a convenient place some distance above the engine. After lubricating the bearings, the oil is carried by the pipe, P, to the tank, N, beneath the engine floor. Through this it is taken by the pump, O, and forced through pipes, M and L, to the tubes, H and I. The two bases, J and K, contain coils which are heated by the exhaust from the pump, O. This thins the oil, which is forced through the tubes, H and I, by a pump pressure of 150 to 200 pounds.

The notable feature of this system is that the oil is visible through the sight-glass, and by means of the valves, F and G, the amount of filtered oil is supplied to the elevated reservoir for distribution, and is equal in amount to that consumed by the machinery.

This apparatus is furnished to the largest, as well as the smallest, power plants, and the company states the filters are able to clean from 10 to 5,000 gallons of oil per day.

Erie Railroad Company Experimenting with Telephones.

E. P. Griffith, of New York, superintendent of telegraph on the Erie Railroad, has recently been experimenting with a new telephone device that will soon be installed over the entire system.

By means of the new device telephone service is secured over metallic telegraph circuits without interfering with either of the two telegraph wires.

The tests made so far have proved thoroughly satisfactory, it is said, and despite the vast amount of noise on the telegraph wires, conversations were easily held and voices even clearly distinguished.

Mr. Griffith states that the new system will be in general operation over the Erie in a short time.

The system is an auxiliary to the telegraph department, and will be of invaluable aid in railroad operation. It may also be used as a safety appliance in case of any possible misunderstanding as to orders.

In all probability the Erie will be the first system in the country to be thoroughly equipped with it.

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Combination Arc and Incandescent Headlight.

The Globe Electric Manufacturing Company, Cleveland, Ohio, is manufacturing a new type "Climax" combination arc and incandescent headlight for interurban railway service.

The "Climax" combination headlight

COMBINATION ARC AND INCANDESCENT HEADLIGHT.

is a two-circuit lamp, arc and incandescent. It is simple in construction, neat in appearance and light in weight, making it easy to handle. One of the features of this lamp is that it will operate on a consumption of current from one-half ampere upward, and restores the arc quickly. Each headlight is furnished with two positive plugs, and change of light is made possible by inserting either arc or incandescent positive plugs into the receptacle, or by means of a two-point switch placed in the vestibule of the car.

The lamp has double parabolic reflectors, adjustable bumpers and is made of the best material throughout. The illustration gives a good idea of the neat and simple construction of the lamp.

Stombaugh Guy Anchors.

The proper guying of poles, smoke-stacks, fences, etc., is a problem that confronts the street railway, electric light and telephone managers nearly every day—how to do it best and with the greatest economy. The accompanying illustrations show the Stombaugh guy anchor which is being generally used for this purpose all over the United States and Canada. This device can be installed in from five to fifteen minutes, depending upon the size of anchor and the nature of the ground.

In Fig. 1, Nos. 350, 500 and 600 show the three and one-half, five and six-inch rodless anchor. To use this anchor, a strand is passed through its eye and the hollow shaft of the wrench (shown as Nos. 354, 505 and 606) which is fitted to the keyed portion of the anchor. The anchor is then bored into the ground as a corkscrew into a cork, and always at the angle the guy wire is to run. These anchors are used for light, medium and heavy strains.

Nos. 351R, 502R and 603R show the three and one-half, five and six inch rod anchors which are used by those who prefer not to bury the strand. They are installed the same as the rodless, but with greater ease. These anchors are furnished with rods five-sixteenths inch, three-eighths inch, one-half inch, five-eighths inch and three-quarters inch, japanned or galvanized. The eight, ten and twelve inch (shown as 800, 1,000 and 1,200) are used for very heavy strains, such as corner turns and dead ending, or for guying large smoke-stacks.

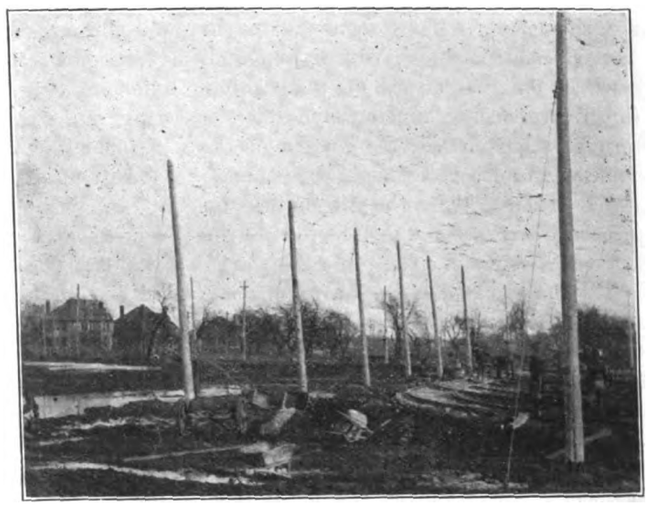

FIG. 2.—METHOD OF USING STOMBAUGH GUY ANCHORS.

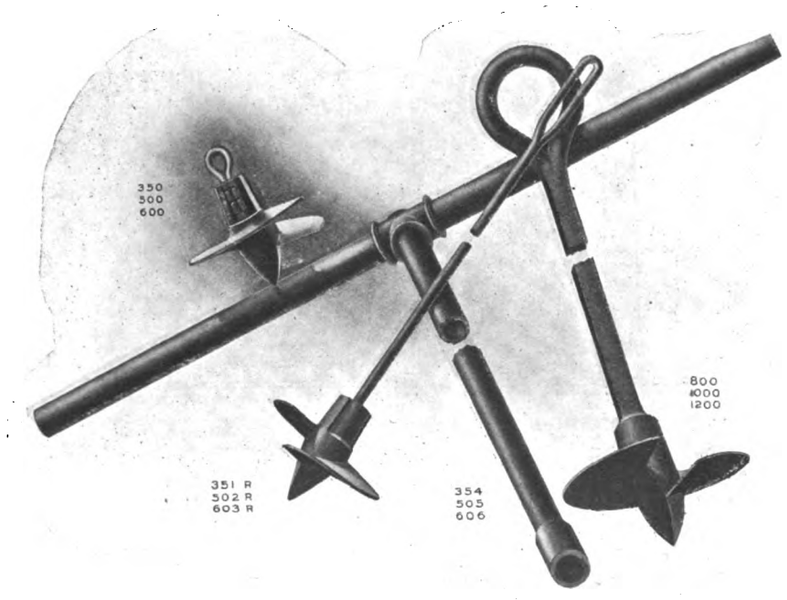

FIG. 1.—VARIOUS FORMS OF STOMBAUGH GUY ANCHORS.

Fig. 2 shows method of using the eight-inch Stombaugh guy anchor for guying poles of the East St. Louis & Suburban Railway Company, East St. Louis, Ill.

Fig. 3 shows a very heavy line of the East St. Louis & Suburban Railway Company which is dead-ended with one twelve-inch Stombaugh guy anchor bored in to its full length.

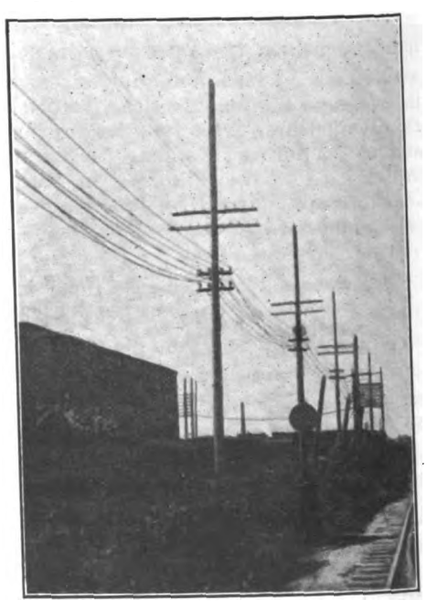

FIG. 3.—HEAVY CONSTRUCTION, EAST ST. LOUIS & SUBURBAN RAILWAY.

The data, and illustrations for this description were obtained through the courtesy of the distributing agents for this device W. N. Matthews & Bro., 1100 Carleton Building, St. Louis, Mo.

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Telephone Apparatus Under Construction.

At the Kellogg Switchboard and Supply Company's factory, Chicago, Ill., the following apparatus is in course of construction:

A straight multiple exchange equipment is being made for Cleveland, Ohio, with an immediate equipment for 7,680 lines, in eighteen sections of three positions each, with an ultimate capacity of 18,000 lines. The new Kellogg four-party selective system is to be installed in connection with this exchange, each cord circuit having a four-button indicating ringing key in addition to the regular cord equipment. This switchboard is to replace the old four-division equipment now in use in Cleveland, which was at the time it was installed nearly four times as large as the largest straight multiple board then made. The old Cleveland board is of the local battery type, and it was considered less expensive to install an entirely new equipment than to change it over to work on centralized battery.

Common battery exchanges of the latest type are being constructed for the following cities: Pasadena, Cal., 1,500 lines present equipment, mounted in a framework for 7,200 lines ultimate; McKeesport, Pa., 1,000 lines present equipment, mounted in 3,600-line framework; London, England, for Lavender Hill exchange, National Telephone Company, 800 lines present equipment; Linton, Ind., 800 lines present equipment, with 3,000 lines ultimate; St. Louis, Mo., south office, 2,520 lines present equipment, with 7,200 lines ultimate, requiring at present nine sections of three positions each; St. Louis, east office, 1,080 lines present equipment, with 7,200 lines ultimate, requiring five sections for present installation; Taunton, Mass., 300 lines present equipment, 800 lines ultimate; also four complete common battery switchboards of about four hundred lines present equipment each, for San Bernardino, Long Beach, Santa Ana and Redlands, Cal. These latter have each an ultimate capacity of 1,200 lines.

All the manually operated switchboard equipment to work in conjunction with the automatic exchange at Dayton, Ohio, and Grand Rapids, Mich., is nearly completed at the Kellogg factory. The apparatus for Dayton consists of a multiple tollboard of two sections of two positions each, also a wire chief's desk and a combined trouble clerk and information clerk's desk, each of the latter having two positions, both equipped. The Grand Rapids, Mich., equipment consists of a present equipment of nine two-position sections of multiple tollboard, and one two-position section of rural line board; also a switching section of 12,000 lines capacity equipped for 5,500 lines, and a two-position chief operator's desk, a two-position wire chief's desk and two two-position information clerks' desks.

The Lawrence-Hall Electric Company.

The Lawrence-Hall Electric Company is one of the largest commercial institutions of Cincinnati, Ohio, and represents one of the most complete storehouses for electrical supplies in the country. The

MR. F. D. LAWRENCE.

personnel of this company has been long and favorably known to the electrical trade, and the present business is the development and growth of a number of smaller operations, all of which have been ever progressive, and which have led up

MR. WILLIAM ALBERT HALL.

to a modern establishment of considerable worth.

Mr. F. D. Lawrence is president and treasurer of the company, and Mr. William Albert Hall is vice-president and secretary. Originally the business was organized under the name of the Hubbard-Hall Company, changing later on to the Hall Electrical Supply Company; and on March 1, 1903, the name was changed to the Lawrence-Hall Electric Company.

The company deals in a general line of electrical supplies, and is agent for a number of well-known manufacturers of specialties, among which may be mentioned the following: Okonite Company, New York city; Peerless Electric Company, Warren, Ohio; Osburn Flexible Conduit Company, New York city; the Phelps Company, Detroit, Mich.

Mr. F. D. Lawrence was for a number of years manager of the Standard Electric Company, of Cincinnati, Ohio, one of the largest supply houses in the West.

Mr. William Albert Hall has been in the electrical supply business for many years, as his father was an old-time electrician and inventor of a number of electrical appliances now in general use. Mr. Hall has been associated in this manner with electrical interests since early in his career, and his experience has fitted him to conduct such a business as he is now connected with with security and judgment.

Production of Coke in 1902.

During 1902 there were 69,069 coke ovens in existence in the United States as compared with 63,951 ovens in 1901. Of these 69,069, 67,124 were active and produced an average of 378.4 tons per oven. The total number in 1902 included 1,663 by-product recovery ovens, which produced 1,403,588 tons of coke, an average of 844 tons of coke per oven. The quantity of coal used in 1902 to produce 25,401,730 short tons of coke was 39,604,007 short tons as compared with 34,207,965 short tons used to produce 21,795,883 tons of coke in 1901, an increase of 5,396,042 short tons of coal in 1902 over 1901. The value of the coal consumed increased from $31,378,631 to $39,301,194. In 1901 the value of coal used in making a ton of coke was $1.44 and the average price per ton for the coke produced was $2.04, a difference of sixty cents on each ton. In 1902 the value of coal used in making a ton of coke was $1.54 and the average price per ton of coke was $2.49, a difference of ninety-five cents on each ton of coke. The quantity of coke imported in the United States in 1902 amounted to 140,488 short tons, valued at $423,775, as compared with 72,727 short tons, valued at $266,075, in 1901. The export of coke in 1902 amounted to 439,590 short tons, valued at $1,785,188, as compared with 430,450 short tons, valued at $1,561,898, in 1901.

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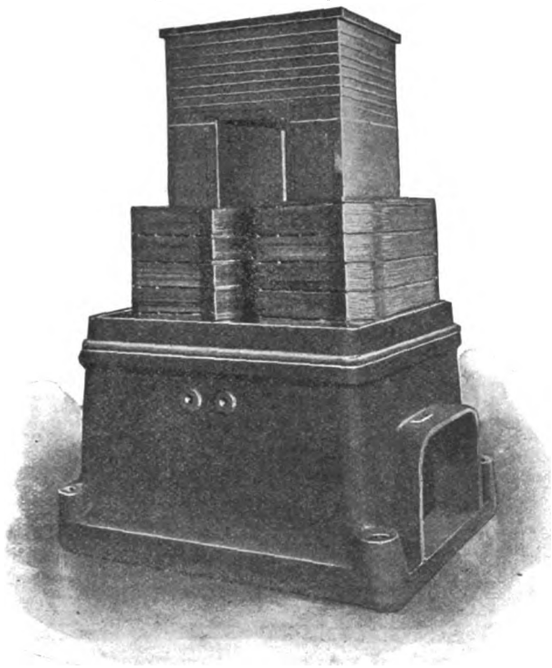
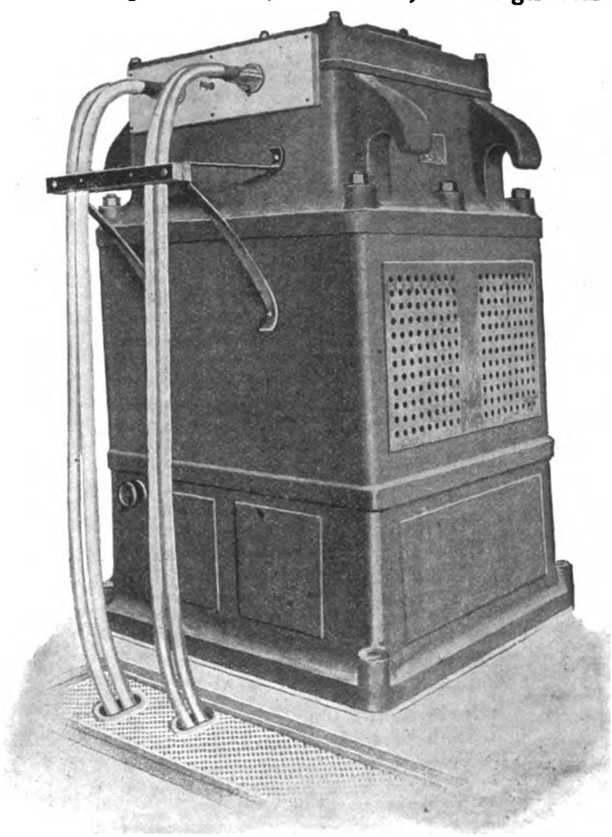
Air-Blast Transformers.

The accompanying illustrations show the assembly and complete view of Westinghouse air-blast transformers.

Westinghouse transformers of large size are manufactured in two types—oil-insulated and air-blast. The advantages of oil as an insulating medium are so great that the oil-insulated transformer is generally selected for all voltages. The air-blast transformer is, however, made in considerable quantities for those installations where this type is preferred for voltages not exceeding 3,300. The transformers shown in the accompanying illustrations are of the shell type, and their construction provides the same general features as are found in the Westinghouse oil-insulated water-cooled transformers, except that small differences in design and build are introduced where these are required by the change in the cooling medium.



ASSEMBLY OF IRON IN AIR-BLAST TRANSFORMER, SHOWING VENTILATING DUCTS IN THE IRON.



2,750-KILOWATT WESTINGHOUSE AIR-BLAST TRANSFORMER.

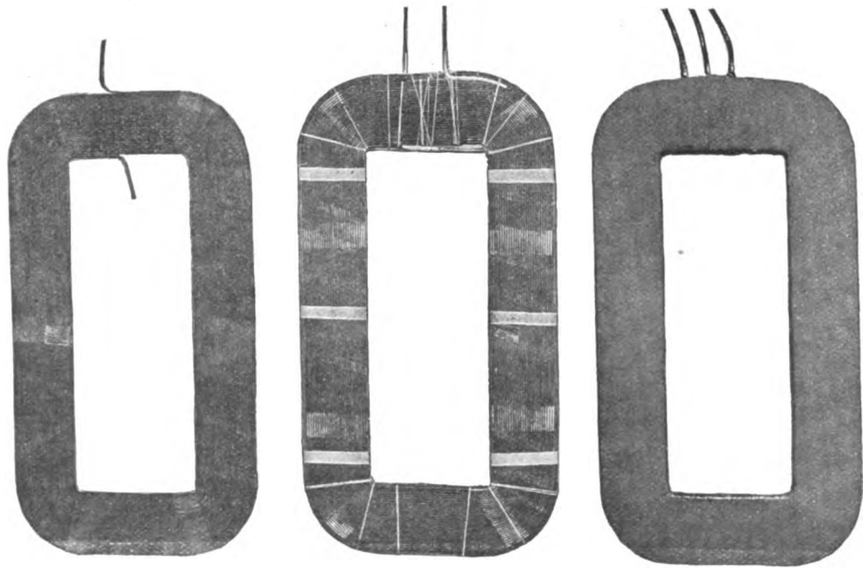


FIG. 1. FIG. 2. FIG. 3.

STEPS IN THE BUILDING OF AN AIR-BLAST TRANSFORMER COIL.

Fig. 1.—Single section of a coil. The wire is rectangular in cross-section and wound on edge.
Fig. 2.—Two single sections assembled to form complete coil.
Fig. 3.—Coil completely insulated with cable leads attached.

The capacity of the standard line of transformers ranges from 100 kilowatts to 3,000 kilowatts, for voltages from 2,200 to 33,000, and for frequencies of 7,200 and 3,000 alternations.

The method of cooling air-blast transformers is by a forced blast of air furnished by a blower. One blower generally supplies a number of transformers in the same station, and the transformers are usually placed above an air-chamber in which a pressure is maintained slightly above that of the surrounding air. The blower may deliver air directly into this chamber, or, if it is more convenient, may be located at a distance from the transformers, feeding into a conduit which leads to the air-chamber. The iron and copper are separately cooled. The air for cooling the coil passes up through the transformers between the coils, which are held apart by spacing strips, and discharges through an opening at the top of the transformer. This opening is provided with a damper for regulating the amount of air passing through the coils. The air for cooling the iron passes from the lower housing through a damper at one side of the transformer, and then horizontally through ventilating ducts spaced at frequent intervals in the iron.

In all transformers, both high and low-

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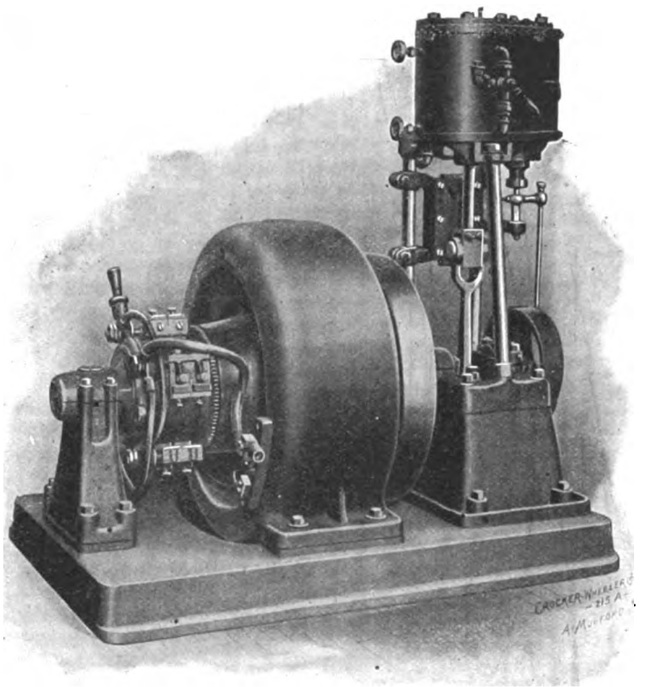
tension windings are divided into a number of flat coils. The high-tension conductor is a flat copper ribbon, wound concentrically with only one turn per layer. The layers are separated from each other by a continuous strip of a specially prepared insulating material, while the coils are insulated individually and are separated by heavy insulating barriers. Where the coil is made in two sections, these are separated by a specially treated shield having a high insulation strength. When completed, the coil is covered by a built-up moisture-proof insulation of great dielectric strength, and a strong mechanical and electrical construction is secured. The same method is employed in winding and insulating low-tension coils.

The air-blast transformers are mounted in a cast-iron housing, and the different parts of the housing are held firmly together by bolts which pass from the upper to the lower casting. These bolts also serve to clamp the iron of the transformer which rests on the lower casting. At each end of the base are panel openings which give access to the low-tension terminals. The low-tension terminals are mounted upon an iron bar (mica insulated) fastened in the lower casting. The high-tension terminals of flexible cable are brought out at the top of the transformer, although both sets of terminals may be brought out at the top or both at the bottom, as may be desired.

A Small Engine-Generator Set.

The demand for a small engine-generator set for marine purposes and use generally where compactness and low first cost are of more importance than low steam consumption and good fuel economy, has opened a most inviting field for just such an outfit as the one shown herewith. It is the outcome of an arrangement effected between the W. D. Forbes Company, of Hoboken, N. J., the builders of the engine, and the Crocker-Wheeler Company, of Ampere, N. J., whose standard open-type multipolar machine is used for the dynamo end of the unit. The set may be had in various sizes, but the particular one illustrated consists of a seven by six-inch simple engine capable of indicating twenty horse-power under 100 pounds of steam when running at 425 revolutions per minute, and a four-pole 20-D type generator having a capacity of eight kilowatts at that speed. Since illuminating is the class of service in which it will meet the most extended use, a more significant conception of its capacity may be conveyed in the statement that it is capable of lighting 140 sixteen-candle-power lamps. Nevertheless, it is remarkable for its lightness and compactness, weighing but 2,800 pounds and measuring in extreme dimensions but fifty-two and five-eighths inches long, thirty-five and one-quarter inches wide and fifty-one and three-quarters inches high.



SMALL ENGINE-GENERATOR SET.

The engine by itself weighs only 475 pounds, this extremely light weight having been secured without sacrificing strength or rigidity by employing scientifically correct lines in the design and the best grade of open-hearth steel for the forgings entering into its construction. The crank-shaft is machined from a solid forging, the crosshead and piston-rod are in one piece and there are no welds permitted in any part. The outfit has been produced with special attention to the refinements essential to satisfactory operation. For example, speed regulation is provided by a "Rites" patent inertia governor guaranteed to maintain within two and one-half per cent of constant speed, this being quite close enough to prevent the annoyance of flickering lights. Contrary to the usual custom, the governor is not combined with the flywheel, as a reference to the illustration will show. This is of advantage, for while the best location of the flywheel is between the engine and generator the governor should be where it is most accessible for adjusting. Although the figure does not show it a gravity system of lubrication is furnished with the engine whereby all moving parts are kept continuously oiled while the engine is running.

The generator is a compound-wound machine of the open type, there being not the slightest objection to its use in a case of this kind, as it may almost invariably be located where dust, moisture, combustible materials, or the usual conditions prevalent when an enclosed type of machine is demanded, do not exist. By virtue of its open construction, on the other hand, it possesses certain advantages not enjoyed by its semi-enclosed or fully enclosed prototypes. Chief among these are the availability of all of its parts for inspection and repair, and the good ventilation afforded to the armature and windings, thus preventing excessive heating even under considerable overload. The entire unit is the result of a most careful design, the component parts are of the highest class of material and the set will be found capable of a steady and reliable service under long periods of continuous full load.

A new electric flashlight has recently been erected on the island of Heligoland by the German Government. The apparatus consists of a revolving parabolic reflector, which is said to give 30,000,000 candle-power. The flashes are a tenth of a second in duration, and succeed each other every five seconds. The light has been observed at a distance of forty miles.

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CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

SPIER'S FALLS POWER PLANT AT WORK—The Hudson River Water Power Company has started the power plant at Spier's Falls, N. Y., and on September 8 began delivering power to the towns of Glens Falls, Saratoga and Ballston for lighting purposes. The company is also delivering power to the Hudson Valley Railway for running cars over fifty miles of the company's road, and is also in a position to deliver 10,000 horse-power to the General Electric Company at Schenectady, N. Y. Three generators of 5,000 horse-power each are now running, and seven more of the same capacity are to be put in operation as soon as possible. The company has contracts to furnish all of the electricity for power and lighting purposes in Troy and Albany.

PROFITABLE MUNICIPAL OWNERSHIP—The report of the Worcester (Mass.) Electric Light Company for the year ending June 30, 1903, is likely to prove an argument in favor of municipal ownership. The Worcester Electric Company paid eighteen per cent dividends on all its stock last year, an increase of ten per cent over the previous year. The company is capitalized at $600,000 of stock distributed among 164 stockholders. The annual report filed recently in Boston shows gross receipts for 1902, $251,910; for 1903, $273,981, an increase in gross receipts of $22,071. Expenses for 1902, $138,821; for 1903, $144,676, making an increase in expenses of $5,855 as against an increase in gross receipts of $22,071, leaving a net increase of $16,217. The dividends for 1902 were $40,000, and for 1903, $108,000.

$1,000,000 MORTGAGE FOR TRACTION LINE—A mortgage for $1,000,000 has been entered by the Savings and Trust Company, of Cleveland, Ohio, for the Mineola, Hempstead & Freeport Traction Company, now the New York & Long Island Traction Company, of Long Island. The loan is for the purpose of constructing, building, equipping and maintaining the traction company's lines and for the purpose of extending these. The company has a trolley road in operation from Mineola to Freeport, L. I., and will soon have the extension from Rockville Centre to the Brooklyn city line finished. A line is also operated to Queens, and new roads are contemplated to Babylon from Freeport, and lines from the north, central and southerly sections of the island into the city of New York, through traffic agreements with other lines, or over the company's own system.

HAWAIIAN ISLANDS ENGINEERING IMPROVEMENTS—It is estimated that very nearly $5,000,000 will be expended in connection with improvements at Pearl harbor, Hawaiian Islands. Three artesian wells are to be drilled, costing some $18,000. A pumping plant will entail an expenditure of $50,000, and a water-pipe system and stand-pipe are expected to cost $40,000. The same amount is to be spent in a sewerage system. Storehouses to cost $150,000 will be built, and a machine shop will be erected which will cost $150,000 for construction and equipment. A foundry will be put up at a cost of $50,000, and a yard and docks built and equipped, costing $150,000. The same sum will be spent on the construction of two wharves, and $100,000 is appropriated for dredging. An electric plant is planned, for which $150,000 is appropriated. For the purchase of tools and appliances $45,000 will be laid aside. Railroad and rolling stock will cost $100,000. The construction of the dry-docks is calculated to cost $3,250,000.

AN EXTENSIVE INTERSTATE TROLLEY SYSTEM—Plans are under way for a continuous system of trolleys from Columbus, Ohio, to Pittsburg, Pa., or from Pittsburg to Indianapolis, Ind., through Columbus. A road has recently been opened from Pittsburg to Wheeling, W. Va., and a contemplated extension to Bellaire, Ohio, is the beginning of the line connecting the cities above named. The line from Indianapolis, Ind., to Bellaire, Ohio, will be 364 miles long, and from Indianapolis to Newark, about 226 miles. The road includes Columbus and Springfield on the line, as well as Dayton. A link is to be built from Newark to Zanesville, from which point a road runs to Bellaire and to Wheeling. From Wheeling the Ohio Valley Traction Company has a road of nineteen miles in operation to Wellsburg, W. Va. A grant has been allowed this company to construct a bridge across the Ohio River at Wellsburg, to connect with Brilliant, Ohio, the terminus of the Steubenville-Mingo Electric Railway, which has had a line in operation for some time to Toronto, Ohio. Rights of way have been obtained and the survey is nearing completion for the construction of a road from Toronto to Wellsville, the terminus of the East Liverpool Street Railway, which operates to Smith's Ferry, Pa., four miles east of East Liverpool. From Smith's Ferry a survey has been completed for a road to connect with the Beaver Valley Traction lines at Vanport, Pa., which extends east, following the Ohio river beyond Rochester and Monaca. Rights of way have been secured and surveys completed by Cleveland, Pittsburg and New York capitalists for the construction of a road from Rochester to Avalon, Pa., where connections are to be made with the lines of the Pittsburg Railway Company, which has branches extending as far east as McKeesport and Wilmerding, Pa.

ELECTRIC LIGHTING.

OAKLAND, CAL.—The Suburban Lighting Company will extend its system to Fruitvale, to light the city streets.

FORSYTH, MONT.—The new electric light plant which is being established here will be in operation within ninety days.

MANKATA, MINN.—Welcome has voted to bond the village to the extent of $9,000 for a lighting plant and waterworks.

BARNESVILLE, GA.—The city council has accepted the bids for the new electric light plant and work will begin at once.

SPRINGFIELD, ILL.—Work has been commenced on the building of a large addition to the plant of the Sangamo Electric Company.

WHITHALL, ILL.—The electric light plant at Roodhouse has been purchased by C. W. Payne, of Roodhouse, and W. J. Kreider, of Jacksonville.

BELFAST, ME.—The plant of the Belfast Light and Power Company has been sold to M. Curtis Fletcher, of Boston, at the reported price of $30,000.

BENTON, WIS.—The board of trustees has let the contract for the electric light plant to David Morrow, of Galena. Work is to be completed by November 1.

DECATUR, ILL.—The main power plant for the Decatur, Springfield & St. Louis Interurban Railroad will be built at Riverton, near Springfield, at a cost of $250,000.

JOHNSTOWN, PA.—The new Rockwood Electric Company, which has a contract to furnish street lights for that town, is rapidly completing its plant, as it must be in operation by November 15.

BAY CITY, MICH.—It is learned that the Saginaw-Bay City Railway and Light Company has purchased land in Saginaw and will erect a power-house to supply the Saginaw and Bay City lines.

HOLLY, N. Y.—The Albion Power Company has purchased from George F. Lum his mill property and water rights at Clark's Mills, east of Waterport. This purchase gives the company an additional water power equal to that at Waterport.

MIDDLETOWN, N. Y.—The city has awarded a contract to the Consumers' Light and Power Company to light the streets for one year from November 1. The company's bid was $5,827.50, or $47.50 for arc lights and $9 for incandescent lights, additional lights to be furnished at the same rate.

NYACK, N. Y.—A proposition to appropriate $21,000 for a municipal lighting plant at North Tarrytown was voted down at a special election of the taxpayers. The argument against the proposition was that the village was too small to maintain such a plant, and that it would be lighted more economically by a private cor-

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poration which lights the other towns and cities of Westchester County.

GLOVERSVILLE, N. Y.—At the regular meeting of the board of trustees of the village of Fonda, the application of the Edison Electric Light and Power Company to set poles and string wires through the town was granted. The company will have the work completed by the middle of October.

FAYETTEVILLE, W. VA.—The Fayetteville town council, at a special meeting, granted E. W. Becker and associates a twenty-five-year franchise to erect and maintain an electric light and power plant within the corporate limits of the town. The company states that it will install a very complete plant.

PORTAGE, PA.—The Portage Light, Heat and Power Company, which is being promoted by H. A. Tompkins, P. F. Campbell, H. D. Hoover and J. J. McDonnell, has applied for a charter. The company will supply current to this city and to the neighboring communities, including Wilmore, Puritan, Cassandra and Jamestown.

ST. PAUL, MINN.—The electric franchise granted two years ago to F. B. Brace, G. H. Shellenberger and F. G. Genge, has been transferred to the Union Manufacturing Company. The company, which was incorporated to take over the franchise, will furnish power to factories in St. Anthony Park and light for two wards of the city.

KNOXVILLE, TENN.—The Knoxville Power Company is preparing to begin work on its dam on the Little Tennessee, in the mountains of Blount County. The company plans to generate electricity which will be sold to local manufacturing industries throughout this section. Its capital stock is $500,000, and those prominent in connection with it are General John T. Wilder and Marshal R. W. Austin.

FLINT, MICH.—The formal organization of the Flint Light and Power Company has been effected, with D. C. Wright, president, and A. G. Bishop, as secretary-treasurer. The board of directors is composed of J. J. Hurley, W. A. Paterson, Alexander McFarlan, D. C. Wright, of Flint, M. A. Brown, E. R. Knauss, of Philadelphia, E. R. Snyder, of Allentown, Pa., and J. H. Baker, of Buffalo, N. Y. The capital stock will be increased to $150,000.

DETROIT, MICH.—At the meeting of the public lighting commission, the annual report for the fiscal year ending June 30, 1903, showed that the cost of operation and maintenance had increased $21,320.35 over that of the previous year, an increase of 21.50 per cent. The increase is said to be directly due to the coal famine of last year and also to the present advance in wages. The total cost of maintenance and operation was $120,408.01, as against $99,087.16 last year. The total number of arc lamps supplied was 2,386, as compared with 2,133 the previous year.

MINEOLA, L. I.—Incorporation papers have been filed in the county clerk's office for the New York & Long Island Gas Company. The company purposes to supply electricity and gas for lighting streets, public and private buildings, etc., in cities, villages and towns throughout New York state, including the whole of Long Island, naming the towns of Hempstead, North Hempstead and Oyster Bay, in Nassau County; the villages of East Rockaway, Freeport, Rockville Centre, Lawrence and Sea Cliff, in the said county; the towns and villages of Brookhaven, Babylon, East-Hampton, Huntington, Islip, Riverhead, Shelter Island, Smithtown, Southold, Amityville, Greenport, Northport, Patchogue, Southampton and Sag Harbor, in Suffolk; the borough of Queens, city of New York; the county of Queens, the borough of Brooklyn, city of New York, and the county of Kings. The directors named for the first year are John B. Summerfield, of Arverne; Eben Jackson, of Manhattan, and Seymour K. Miller, of Brooklyn.

ELECTRICAL SECURITIES.

Although there was a more favorable report regarding the crop condition than was expected, the market did not show any inclination to rally, and the week closed with little improvement as far as activity in speculation was concerned. There is still a tendency in many quarters to look askance at even good opportunities for investment, due to the apprehension caused by the long slump in the market. On the other hand, the ability of financial interests to weather a long period of depression such as has been passed through recently has engendered a feeling of hopefulness in the stability of securities in general that works for sluggishness under conditions which at another time would cause the most apprehensive anxiety. Now that there is every opportunity for monetary relief, due to the $40,000,000 fund held by the Treasury Department, the opinion is gaining ground that it will not be necessary to touch any of this.

ELECTRICAL SECURITIES FOR THE WEEK ENDING SEPTEMBER 12.

New York:	*Closing.*
Brooklyn Rapid Transit	40½
Consolidated Gas	173¾
General Electric	162½
Kings County Electric	150
Manhattan Elevated	134¼
Metropolitan Street Railway	114¼
New York & New Jersey Telephone	148
Westinghouse Manufacturing Company	170

A quarterly dividend of one and one-half per cent on the capital stock of the Manhattan Railway Company will be paid on and after October 1, 1903, to stockholders of record at the closing of the transfer books on Friday, September 11, at 3 P. M. The transfer books will reopen on Wednesday, September 23, at 10 A. M.

The board of directors of the Western Union Telegraph Company has declared a quarterly dividend of one and one-quarter per cent upon the capital stock of the company, payable at the office of the treasurer on and after the fifteenth day of October next to shareholders of record at the close of the transfer books on the nineteenth day of September instant. For the purpose of the annual meeting of stockholders, to be held October 14, and of the dividend mentioned, the stock books will be closed at three o'clock on the afternoon of September 19 and be reopened on the morning of October 16.

The balance sheet of the Consolidated Gas Company as of June 30, 1903, shows assets of $102,518,945 and liabilities of $87,254,875, leaving a surplus of $15,264,070, as compared with a surplus of $14,095,754 on January 31, 1901. The company has been granted permission by the New York Stock Exchange to list $519,000 additional capital stock, making the total amount listed $73,437,500.

Additional assenting stock of the Westinghouse Electric and Manufacturing Company to the amount of $4,500,000 has been listed on the New York Stock Exchange, making the total amount listed $18,526,800.

A dividend of $2 per share will be paid on October 15, 1903, to holders of the stock of the General Electric Company of record at the close of business hours on Wednesday, September 16, 1903.

Boston:	*Closing.*
American Telephone and Telegraph	132½
Edison Electric Illuminating	230
Massachusetts Electric	78½
New England Telephone	124
Western Telephone and Telegraph preferred	80

Philadelphia:	*Closing.*
Electric Company of America	8½
Electric Storage Battery common	55
Electric Storage Battery preferred	55
Philadelphia Electric	6⅛
Union Traction	43⅞
United Gas Improvement	84

A dividend of 2 per cent has been declared on the stock of the United Gas Improvement Company, payable October 15. Books will close September 30 and reopen October 16.

Chicago:	*Closing.*
Chicago Telephone	122
Chicago Edison Light	145
Metropolitan Elevated preferred	55½
National Carbon common	20
National Carbon preferred	89¾
Union Traction common	5
Union Traction preferred	32

It is stated that the Chicago Telephone Company now has in use a total of 94,025 instruments, being a gain for the year ended September 1 of 24,814.

The month of August completed the first half of the Metropolitan Elevated Company's fiscal year. The gross receipts amounted to $1,006,981, an increase of $56,022 or five per cent over the similar period in 1902.

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LEGAL NOTE.

TELEPHONE "MISCONNECTIONS" AND THE LAW—The following is an interesting study on this subject, as *Case and Comment* sees it: A suit against a telephone company for the failure of a telephone to work when needed to call the fire department, in consequence of which serious damage was done by the fire that might have been prevented if the telephone had been in working order, has just been brought in Rochester, N. Y. This is probably the first suit of the kind on record. The defence is that a clause in the contract under which the telephone was placed in the building exempts the company from "all risks for misconnections, mistakes, or errors in receiving, transmitting, or delivering messages." The failure of the telephone to work is alleged, however, to be due to negligence in installing the instrument, or, rather, in the connection or joinder of the wires outside of the house, so that the ends did not remain in contact. The plaintiff claims that this negligence in connecting or joining the wires is not one of the "misconnections" referred to in the clause quoted. The question, therefore, seems to be merely one of the construction of the contract. It is, moreover, a narrow question, which is of general interest chiefly because the matter of liability of telephone companies for defects in their wires or instruments is altogether a new subject. The validity of such an exemption of the telephone company from liability can hardly be open to question—at least in the state of New York. As the courts of that state uphold express contracts, even by common carriers, to limit their liability for negligence, there can be no hope that they would hold that such a stipulation by a telephone company is not valid. The question might be somewhat less hopeless in the numerous jurisdictions which deny the validity of such stipulations by common carriers, on grounds of public policy. But that rule is clearly an exception to the general rule which permits parties to contract as they choose for exemption from liability, and even in case of railroad companies the courts have refused to extend the rule applicable to common carriers, beyond the limit of their business as carriers. In Stephen *vs.* Southern P. Co. (Cal.) 29 L. R. A. 751, in Hartford F. Ins. Co. *vs.* Chicago M. & St. P. R. Co. 30 L. R. A. 703, 70 Fed. 201, and in some other cases a stipulation by a railroad company against liability for damages to buildings of a lessee on railroad land, even if caused by the railroad company's negligence, has been sustained. On the other hand, the rule applicable to common carriers will necessarily be applied not only to telegraph, but also to telephone, companies in states where such companies are held to be common carriers. That a telegraph company is a common carrier has been held in Western U. Teleg. Co. *vs.* Call Pub. Co. (Neb.) 27 L. R. A. 622; and there are direct decisions against the validity of a stipulation for exemption from liability for negligence by such companies, in Brown *vs.* Postal Teleg. Cable Co. (N. C.) 17 L. R. A. 648, and in Gillis *vs.* Western U. Teleg. Co. (Vt.) 4 L. R. A. 611, and in some other cases. That a telephone company is a common carrier is decided in State *ex rel.* Gwynn *vs.* Citizens' Teleph. Co. (S. C.) 55 L. R. A. 139, and Nebraska Teleph. Co. *vs.* State *ex rel.* Yeiser (Neb.) 45 L. R. A. 113, but those cases did not expressly decide as to the exemption of such companies from liability for negligence. Wherever such companies are held to be common carriers the courts will doubtless apply the same rule with respect to liability for negligence that they apply in case of other common carriers.

TELEPHONE AND TELEGRAPH.

SAN DIEGO, CAL.—An independent service is to be established between San Diego and Escondido.

SENECA FALLS, N. Y.—The Home Telephone Company has decided to erect its line to Bridgeport.

CHATTANOOGA, TENN.—The Hamilton County Telephone and Power Company has been organized.

SYRACUSE, N. Y.—The Postal Telegraph Company is putting a new line through from Syracuse to Oswego.

YORK, PA.—The Cumberland Valley Railroad is constructing a telegraph line from Martinsburg to Winchester.

SALT LAKE CITY, UTAH—The Utah Independent Telephone Company will put its wires underground in the business district.

BLOOMSBURG, PA.—The Columbia County Telephone Company has been organized to build an independent telephone system in this county.

SPRINGFIELD, MASS.—The selectmen have voted to allow the Southern Berkshire Independent Telephone Company to locate poles and wires in the town.

CANANDAIGUA, N. Y.—The Interlake Telephone Company is now connected with the Gorham, Stanley, Rushville and Hall's Corners line, and also with Penn Yan.

GAS CITY, IND.—Work on the rural line of the Central Union Telephone Company, between Gas City and Upland, has been commenced, and it is hoped to have it in operation before cold weather sets in.

HOUSTON, TEX.—The city council of Seguin, Tex., has granted a franchise to the Commercial Telephone Company to erect a system of poles, wires, etc., and to conduct a telephone business in the city.

WILMINGTON, N. C.—The Inter-State Telephone Company will make extensive improvements to its system in this city beginning next month. The city will be asked for permission to place all wires underground.

TOLEDO, OHIO—The Toledo Home Telephone Company has reported a great increase in business in the last year, it has increased the number of telephones which are in use from approximately 2,500 to 7,300.

MIDDLETOWN, N. Y.—At the annual meeting of the stockholders of the Monticello Telephone Company, the following officers were elected: John D. Lyons, president; A. A. Crain, vice-president; H. F. Hilmes, secretary; George L. Hatch, treasurer.

LINCOLN, NEB.—The Beaver Crossing Telephone Company has changed its name to the Seward County Telephone Company. It has a capital of $50,000, and the incorporators are C. W. Doty, H. C. Johnson, J. P. Mayhew, Harry Coke and W. J. Organ.

NEW YORK, N. Y.—It is announced that the Police Department of New York city has contracted with the New York Telephone Company for an exclusive telephone system. The present plan calls for 661 telephones, and the expense will be between $400,000 and $500,000.

BELOIT, KAN.—The Solomon Valley Telephone Company, which succeeded W. W. Dilworth, the proprietor of the Beloit Telephone Company, now has in operation exchanges at Cawker City and Glasco, as well as toll lines reaching from Beloit and Downs to Glasco and Scottsville.

BALTIMORE, MD.—A new suburban telephone station will be established by the Maryland Telephone and Telegraph Company at Forest Park. This station will be opened to take care of the business of that company at Forest Park, Walbrook and Arlington. About $20,000 will be expended in erecting this new station.

SPRINGFIELD, OHIO—The Morning Sun Telephone Company, of Morning Sun, Preble County, Ohio, has been incorporated with a capital of $10,000, by R. H. Douglass, U. M. Cook, J. R. McCreary, S. M. Paxton and S. C. Weed. It will operate lines from Morning Sun to Oxford, Fairhaven, College Corner, Eaton and Camden.

KEOKUK, IOWA—Articles of incorporation have been filed by the Union Telephone and Telegraph Company, with its principal place of business in this city. The incorporators of the company are J. C. Hubinger, Alfred Stromberg, P. C. Burns, C. W. Stiher, Charles W. Farr, E. W. Hurst, E. B. Overshiner, Charles Messer and Henry Shafer.

HETLAND, S. D.—Work has begun on a new rural telephone line which will connect with the system at this place. The line will extend in a northwesterly direction. It is also proposed to run another line southwest from the town to be completed this fall. It will connect with a line which runs in a southeasterly direction from Lake Preston.

CONNELLSVILLE, PA.—It is announced that the Tri-State Telephone Company will build an independent line from this section to Pittsburg, and that work will be commenced in a short time. The company is also preparing to make connections with the Maryland, West Virginia & Pennsylvania Telephone Company, which will give Fayette County connections with all the towns between here and beyond Cumberland.

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ELECTRIC RAILWAYS.

SUPERIOR, WIS.—The purchase of the Kenosha Electric Railway Company by the Milwaukee Railway and Light Company is reported.

GRAND RAPIDS, MICH.—Russell B. Harrison, an Indianapolis capitalist, will build an electric road from Hammond to St. Joseph, Mich., with Kalamazoo as a terminal point ultimately.

NEW YORK, N. Y.—The storage battery cars on the Thirty-fourth street division of the Interurban street railway, New York city, have been discontinued and the open slot system put in operation.

SHEFFIELD, ILL.—The Kewanee Straight Line Electric Railroad has been incorporated with a capital stock of $15,000. It is stated that the company will construct a line from Kewanee to Annawan.

JACKSON, MICH.—Projectors are said to be working on an electric line between Saginaw and Flint. The route proposed is to parallel the Pere Marquette from Flint to Clio, thence to run due north to Frankenmuth, and thence to Bridgeport and Saginaw, with a short line from Saginaw and Frankenmuth to Vassar. Later the idea is to extend the line to Caro.

LA PORTE, IND.—Surveyors for the Chicago, Indiana & Michigan Electric Railway, projected to run from St. Joseph, Mich., to Hammond, where it will make a Chicago connection, have completed the survey of the route between Michigan City and Chesterton. It is stated that construction will begin in this state as soon as the line is staked out to Hammond, and that the Michigan end will also be commenced.

NASHVILLE, TENN.—Ground for the power-house of the proposed electric railway from Paducah to Cairo has been bought at Bandana, the central point on the contemplated route. The promoters of the enterprise are Paducah, Louisville and outside capitalists. The plan is to conduct a passenger and freight business, and an effort will be made to get the use of the tracks of the Paducah City Railway Company.

RICHMOND, VA.—The corporation commission has granted a charter to the Nelson & Albemarle Railway Company, which purposes to build an electric railway from the soapstone quarries, in Nelson, to the Southern Railway, in Albemarle, a distance of six or seven miles. The capital stock is placed at $250,000, and the incorporators are J. W. Foster, H. L. Lane, D. J. Carroll, F. V. Elsom, D. H. Pitts, J. G. Hopkins and George W. Bostwick.

PERSONAL MENTION.

MR. GEORGE W. JUDKINS has tendered his resignation as chief engineer of Los Angeles Traction Company, Los Angeles, Cal.

MR. H. H. GEARY, sales manager of the Fostoria Incandescent Lamp Company, of Fostoria, Ohio, stopped in New York en route from the South.

PROFESSOR CLARENCE T. JOHNSON, assistant chief of government irrigation investigations, has been appointed state engineer of Wyoming, Col.

MR. M. D. STRUT, for twelve years superintendent of the engineering laboratory of the Purdue University, has resigned that position to enjoy a well merited release from routine duties.

MR. ROBERT J. MASON, of Hampton, Va., has been appointed receiver for the Hampton Road Railway and Electric Company, and the Vandergrift Construction Company, of Newport News, Va.

MR. H. W. CONRY, for twelve years identified with the Santa Fe Railroad shops at Topeka, Kan., has been appointed superintendent of the engineering laboratory at Purdue University.

MR. J. A. ANDERSON, on September 22, will address the Modern Science Club, 125 South Elliott street, Brooklyn, N. Y., on the eastern power station of the Brooklyn Rapid Transit Company.

PROFESSOR J. MARK BALDWIN, of Princeton University, has been called to a new chair in psychology and philosophy in Johns Hopkins University. Professor Baldwin will immediately enter on his new duties.

MR. M. W. COOLEY, who is a member of the American Association of Civil Engineers, has been appointed general manager of the New Trinidad Lake Asphalt Company, Limited, of Port of Spain, British West Indies.

SENATOR GEORGE A. BARKER, vice-president of the American Conduit Company and whose headquarters are at Los Angeles, Cal., has been a visitor to New York recently on important business connected with the company's interests.

MR. WILLIAM S. BARSTOW, consulting electrical engineer, announces that he has removed his offices to 56 and 58 Pine street, New York city. Mr. Barstow will continue to give special attention to the engineering and development of electrical properties.

MR. L. S. STEWART, manager of the Postal Telegraph Company, Chattanooga, Tenn., has tendered his resignation, to accept the position of manager of the electrical department of the National Construction Company at Chicago, with headquarters at Chattanooga.

MR. WILLIAM MARCONI conferred with President Francis, Monday, September 7, at St. Louis, regarding the establishment of the wireless telegraph station on the exhibition ground. Mr. Marconi said, "I think it will be possible to send wireless messages from St. Louis to London with one relay and that at a coast station."

DR. WILLIAM A. NOYES, formerly professor of chemistry at Rose Polytechnic Institute, has tendered his resignation to accept the position of chief chemist of the Bureau of Standards at Washington, D. C. Dr. Noyes received his degree from Johns Hopkins University and has been at Rose Polytechnic Institute for several years.

MR. ROBERT T. E. LOZIER, secretary of the Bullock Electric Manufacturing Company, Cincinnati, Ohio, and Mr. George B. Foster, manager of the Chicago office of the Bullock Electric Manufacturing Company, were New York guests registered at the Engineers' Club last week. Mr. F. G. Bolles, of this company, is expected to return about the middle of September from a European trip.

MR. RAYMOND R. FRAZOR, consular agent at Copenhagen, Denmark, under date of August 11, 1903, stated "A well-known firm with agents in Copenhagen desires correspondence with a firm in the United States which is in a position to furnish trucks for street cars and steam cars in a country foreign both to Denmark and the United States. Trucks for passenger cars will be required for the electric lines, and trucks for passenger and freight cars for the steam railways."

MR. THOMAS A. EDISON and a party of friends on September 5 made a trip from Orange to Phillipsburg, N. J., in an automobile constructed after plans drawn by the inventor. It is stated they made the run in less time than the regular passenger train. Mr. Edison is stated to have said on arriving at Phillipsburg ahead of the train which left Orange at the same time, that mile after mile his thirty-five-horse-power automobile sped over the country roads at a mile a minute. The fact that the country trip included the climb over the Schooley's mountains makes the run all the more remarkable.

PROFESSOR BYRON BRIGGS BRACKETT has been appointed to the chair of physics and electrical engineering at the Thomas H. Clarkson Memorial School of Technology, Potsdam, N. Y. Mr. Brackett received his A. B. and A. M. from Syracuse University, and his certificate in electrical engineering and Ph. D. from Johns Hopkins University. He is an associate member of the American Institute of Electrical Engineers and a member of the American Association for the Advancement of Science. As instructor, he has been associated with Dickinson Seminary, Williamsport, Pa.; Adelhpi Academy, Brooklyn, N. Y.; Eastern High School, Washington, D. C.; electrical engineering laboratory, Johns Hopkins University, Baltimore, Md.; Union College, Schenectady, N. Y., and Rutgers College, New Brunswick, N. J., with which institution he was last connected previous to his appointment with the Clarkson School of Technology. His practical electrical engineering experience comprises the testing and inspection of all the cable manufactured for the United States Army during the Spanish-American War by the General Electric Company, Schenectady, N. Y.; a year's work with the late Professor Henry A. Rowland, of the chair of physics, Johns Hopkins University, and in the development of the Rowland printing telegraph, with considerable experience in commercial electrical testing at various times.

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INDUSTRIAL ITEMS.

THE NORTH ELECTRIC COMPANY, Cleveland, Ohio, on September 12 gave its annual picnic to its employés, at Silver Lake, Ohio. The amusements included races, baseball, dancing, bowling and boating.

DUNCAN ELECTRIC MANUFACTURING COMPANY, La Fayette, Ind., has published a new edition of its pamphlet descriptive of the Duncan integrating wattmeter for direct-current lighting and power service.

CINCINNATI ELECTRIC MOTOR COMPANY, Cincinnati, Ohio, announces that its name has been changed to the Barriett Electric Company; Mr. S. L. Barriett, president. It will expend about $50,000 for improvements.

CROCKER-WHEELER COMPANY, Ampere, N. J., has recently brought out a pamphlet which gives an instructive description of the equipment of the new locomotive and car shops of the Lake Shore & Michigan Southern Railway at Collinwood, Ohio.

THE EMPIRE ELECTRICAL SUPPLY COMPANY, Chicago, Ill., has just been incorporated with a capital stock of $10,000. This company will manufacture and deal in electrical devices. The incorporators are C. W. Farr, A. N. Barothy and C. L. Hibbard.

THE NATIONAL CARBON COMPANY, Cleveland, Ohio, has brought out an attractive circular, wherein is given data from the results of which is made the assertion, that "phenomenal" is the word which expresses the remarkable increase in the use of Columbia carbons in the past few years.

H. T. PAISTE COMPANY, Philadelphia, Pa., has about completed the general distribution of its new catalogue No. 10, which it considers practically "a dictionary of electrical supplies." There is listed besides a line of general supplies, the most recent specialties taken up. Copies of this catalogue will be sent on request.

THE SPEER CARBON COMPANY, St. Marys, Pa., has brought out an attractive circular descriptive of the Speer high-grade motor brushes. This brush, the manufacturer claims, is of uniform texture and offers a soft frictional surface. The company guarantees that the brush will not heat up under the most severe circumstances.

I. B. WILLIAMS & SONS, Dover, N. H., tanners and manufacturers of oak-tanned leather belting, rawhide and tanned lace leather, have distributed a souvenir in the form of an illustrated booklet giving the history of the international cup races and illustrations of the more prominent boats which have participated in these contests.

WESTERN ELECTRIC AND MANUFACTURING COMPANY, New York city, announces the removal of its New York sale department, Department I, the export and the general agent's office to the New Hanover Bank Building, 11 Pine street. The executive, financial and stock transfer offices will remain on the fourth floor of the Equitable Building, where they have been located since 1889.

THE FOSTORIA INCANDESCENT LAMP COMPANY, Fostoria, Ohio, has published a novel booklet which is entitled "Things About Inner Arc Globes." This gives in detail the conditions under which arc lamp globes operate and the elements of difficulty with which this service is beset. A supplement to this matter is a chapter on "A Few Points That the Trimmer Should Not Forget," and a chapter on cleaning.

THE ELECTRICAL APPLIANCE COMPANY, Chicago, Ill., has just brought out its general supply catalogue No. 20. This catalogue is a very attractive one in appearance, completeness and arrangement and is fully up to the standard of catalogues. It lists many new articles that have, it is stated, never been shown in a supply catalogue, and all out-of-date items have been eliminated. The company will send this catalogue out on request.

WAGNER ELECTRIC MANUFACTURING COMPANY, St. Louis, Mo., has recently brought out a new portable ammeter, which can be furnished with a series transformer having leads thirty feet long, and so arranged that the series transformer can be slipped over the lighting transformer leads without disturbing them in any way. A card, descriptive of this instrument and also of a polyphase wattmeter, portable or switchboard, is also being distributed.

THE INTERNATIONAL STEAM CONDENSING COMPANY, Atlanta, Ga., manufacturer of cooling towers and condensers, will be pleased to answer correspondence with regard to the equipment of engine plants for cooling towers. An elaborate series of tests made of a cooling tower at the Federal Prison, Atlanta, Ga., shows the results which have been obtained by this company's installation. This datum is valuable and the company will be pleased to mail it to any one interested.

THE VOUGHT-BERGER COMPANY, La Crosse, Wis., manufacturer of telephone switchboards and appliances, has recently placed on the market a new magneto telephone designated as No. 45. This telephone is equipped with standard Vought-Berger Bell type, solid-back, long-distance transmitter, mounted on a hollow adjustable arm with double concealed cord, bipolar receiver with concealed cord connections, silk-wound long-distance induction coil, long-lever switch hook equipped with three or four-bar series generator, or four or five-bar bridging generator; all binding-posts concealed.

THE STOW MANUFACTURING COMPANY, Binghamton, N. Y., in bulletin No. 52 describes the operation and application of Stow multi-speed motors. The speed control of this motor is a departure from that which has generally been adopted, and does away entirely with any outside apparatus, the speed control being entirely self-contained. The special advantage which the company claims for its multi-speed motor is that it requires but one voltage to operate on any speed. There is a total absence of auxiliary machines, wiring and apparatus, and at all speeds the machine operates at its full rated horse-power capacity. The speed is steady under load changes, and a high efficiency is obtained through the entire speed range. The characteristics of this motor make it specially adapted for driving individual machine tools, lathes, planers, milling machines, slotters, drills, presses, roll lathes, boring mills, printing-presses, power pumps, blowers, compressors, fans, etc.

THE AMERICAN STEEL AND WIRE COMPANY, Chicago, Ill., will be pleased to send to any one interested, upon request, a valuable booklet which has recently been published, on "Water Purification for Cities by Sulphate of Iron." This gives the details of water purification by mechanical and chemical treatment with sulphate of iron, for domestic and commercial use, and contains reports by Earnest E. Irons, bacteriologist, and James E. Campbell, chemical engineer. Sulphate of iron is one of the chemical products of the American Steel and Wire Company. To demonstrate its particular use in the purification of water, exhaustive tests have been made under the supervision of Messrs. Irons and Campbell. The waterworks system at Quincy, Ill., was selected as the plant at which to make the tests, because of the exacting conditions prevailing there, which would make favorable results all the more valuable. It was desired by the American Steel and Wire Company that the most scientific research and experiment be conducted, and nothing was omitted that would contribute to this end. The result is most favorable to the employment of sulphate of iron for the purification of water for both domestic and commercial uses. The report will be found to contain a great deal of valuable information, and should be given careful consideration by any one interested in this line of study.

THE STANDARD POLE AND TIE COMPANY, Venezuela Building, 133 Front street, New York, is introducing a cypress pole, as it introduced the juniper pole some four or five years ago. For the last half century the juniper or southern white cedar has been used in the South extensively, but the Standard Pole and Tie Company has made it a point to advertise it and thoroughly introduce it in tne North. This company recognized the superior quality of the juniper and decided to push it, with a result that it has become known throughout all the states as a standard of quality among poles. The company's best customers are the street railway companies, to whom it has sold over 100,000 in the last two years. The telephone companies and electric light companies alone, however, send enough orders to keep any small concern busy. For some time the company has been experimenting with the cypress. This like juniper, is a southern swamp growth. Both are free from butt rot, have exceedingly close grain and a remarkably small percentage of sap wood. The cypress, however, is naturally very heavy; so heavy in fact, that the company thought it impossible to use it as a pole on account of the freight. By careful tests it has been found that by girdling the tree some three weeks before it is cut, and then keeping it entirely out of the water until it has seasoned for sixty days, the weight is decreased nearly one-third. This renders the pole marketable. It is the intention of the Standard Pole and Tie Company to push the cypress pole as it has pushed the juniper and it no doubt will meet with equal success.

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ELECTRICAL REVIEW

THE PIONEER ELECTRICAL WEEKLY OF AMERICA

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CHARLES W. PRICE . . . . . PRESIDENT AND EDITOR
STEPHEN H. GODDARD . . . . . SECRETARY AND MANAGER
WM. HAND BROWNE, JR. . . . . TECHNICAL EDITOR
AINSLIE A. GRAY . . . . . ASSISTANT EDITOR

PUBLISHING OFFICE . . . . . 13-21 Park Row, New York
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CONTENTS

EDITORIAL 425, 426, 427
The Equipment of an Electric Car 425
Meeting of the American Electrochemical Society 426
Electrolysis and Technical Competency 426
The Profitable Electrification of the Manhattan Elevated Railroad 427
Shop Testing of Motors and Generators for Commercial Service—II, by Bertrand B. Abry 428
Recovery of Gold in Combination with Tellurium and Selenium 430
Laying of the New Block Island Cable 431
A New Rectifier 432
A Novel Generator 433
A New Form of Water Rheostat 433
A Practical Utilization of the Passive State of Iron, by Charles F. Burgess 434
Nitrates by Electricity 434
Electrolytic Copper Refining, by Wilder D. Bancroft 435
The Zambesi Power Scheme 437
Sir Hiram Maxim Announces a New Invention 437
Electrical Notes from Europe 438
ELECTRICAL PATENTS:
Telephone Exchange System 440
Electrical Conductor Mouldings 441
Review of Current Engineering and Scientific Literature 442
Speaking Flames 443
Notes on Some Theoretical Considerations in the Construction of Resistance Furnaces, by Francis A. J. Fitzgerald 444
Railroad Employés' Carnival 445
American Institute of Electrical Engineers 445
Fourth General Meeting of the American Electrochemical Society 446
INDUSTRIAL SECTION:
Recording Wattmeters for Alternating-Current Circuits 452
A New Form of Boiler Cleaner 453
A New Record for Wireless Telegraph 453
A New Form of Steam Trap 454
Dam to Give Chicago Power 454
Westinghouse Electric and Manufacturing Company's Balance Sheet 454
CURRENT ELECTRICAL NEWS:
Domestic and Export 455
Electrical Railways 456
Electrical Securities 457
Electric Lighting 457
Personal Mention 458
Legal Note 458
Telephone and Telegraph 459
Industrial Items 460

Reports that are well authenticated indicate that the St. Louis Exposition next year will greatly exceed any former exposition in the magnitude, diversity and novelty of electrical and mechanical and allied exhibits. It is time the exposition management should commence to let the public in general, as well as electrical, know this, if the attendance the exposition will assuredly merit is to be realized.

At a recent meeting of the Maxim Electrical Engineering Company, Sir Hiram Maxim stated that he would shortly announce an important invention which will bring forth more money than anything he had ever done. Is it possible that this invention is connected with Sir Hiram's flying machine? He has made many experiments with aeroplanes and flying machines, and his papers on this subject are of great scientific value.

THE EQUIPMENT OF AN ELECTRIC CAR.

When an accident occurs on an electric car, the immediate cause of the injury or injuries is usually the panic which arises as the passengers become alarmed and rush for the doors. The mystery surrounding all things electrical to the uninformed tends to throw them into a nervous and irresponsible condition whenever anything about the car goes wrong. As a matter of fact an electric car is, compared with other vehicles, comparatively safe, and if the public could only be brought to realize this there would be fewer accidents.

The Car Equipment.

The equipment of an electric car is very simple. The truck is fitted with one or two motors which drive the wheels through gears on the axles. To control the motors there is a resistance of iron under the car body and the two controllers, one on each platform. The controllers are merely a conveniently arranged group of switches which are so designed that the proper combinations of motors and resistance are made when the controller handle is turned. The resistance is necessary to prevent the full electrical pressure from being thrown on the motors at the start, as this would tend to start them much too quickly. The other apparatus are the trolley pole and wheel, for collecting the current from the trolley wire, the circuit-breakers or automatic switches, which open and cut off the current when the motors are overloaded, the fuses which perform the same function as the circuit-breakers and which merely supplement the latter, and the lightning arrester which provides a path from the trolley wire to the rail which can be followed, easily by a lightning discharge to the wire, but which will not be taken by the current which operates the car.

In addition there is always a lighting circuit and usually a heating circuit. These run from the trolley pole to the truck and are independent of each other and of the motor circuits. The greater part of the wiring for these circuits is concealed beneath the floor of the car and is insulated.

Possible Sources of Danger.

There are two ways in which injury might be received by passengers on an electric car. Dangers due to the motion of the car are not peculiar to electrical cars and need not be considered. First, it is conceivable that due to very bad work a bare wire might be left exposed, which might cause an electrical shock, but the probability of this is so very slight that it need not be discussed. Any danger due to lightning striking the car or wire is also small. In fact, a trolley car is really a safe refuge during a storm. The other danger is that due to a fire caused by the electrical equipment.

Danger from Fire Slight.

Where the work on the car is carried out properly there

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should be slight risk of fire, though, of course, electrical apparatus, as well as all other apparatus, is subject to derangement. But there is nothing inflammable about the electrical equipment, and about the only thing that can burn is the car body. There is no danger of an explosion which fills the car with flaming oil or gas, and in this respect the electrically lighted car is safer than cars lighted in other ways. Should the breakdown of the motors set fire to the floor of the car, there is little danger if only a panic can be prevented. A car body is not particularly inflammable, and there is likely to be more smoke than flame. The risk of injury from jumping from a moving car is greater.

Panics the Greatest Danger.

As has been said previously, the real danger in electric cars arises from the fact that a slight disturbance makes the passengers nervous, and a little smoke or the flash of a fuse starts a rush to the doors. The public will in time become used to the electrical methods of operation and then this danger will be less. They should expect to see a flash of light from the circuit-breaker at times and an occasional spurt of smoke when an overworked fuse melts. These effects are not signals of danger. Rather they are the signals that the safety devices of the cars are in order and are performing their proper functions.

THE MEETING OF THE AMERICAN ELECTROCHEMICAL SOCIETY.

The fourth general meeting of the American Electrochemical Society, which was held at Niagara Falls last week, was in every way an enjoyable and profitable affair. Although the weather on the first day was bad, the bright, cheerful days following more than made up for the depression of the first.

Interesting and Valuable Papers.

At this meeting a number of papers of value and of unusual interest was read, certain of them drawing a full and illuminating discussion. A decided advantage of the meeting was the comparatively small number of papers presented. At the two meetings preceding this there were so many papers to be read that the members became wearied and attendance fell off.

The Social Side.

The social features also were enjoyable and not overdone. Each member felt free to come and go as he pleased without in any way upsetting the plans of the local committee. The meeting was certainly a decided success.

ELECTROLYSIS AND TECHNICAL COMPETENCY.

In the issue of the ELECTRICAL REVIEW for July 5, 1902, was discussed the subject of electrolysis of buried pipes, an effect which is usually attributed to the return currents from electric railways. In the discussion the following remarks were made:

> The current in the pipe system can, by means of increasing the ground return, be diminished to any quantity desired, to the limit of the financial ability of the corporation controlling the situation, but it can never be reduced to zero in this way. The remedy is to break up the electric continuity of the piping system by insulating joints. A single insulating joint will stop more current in the piping system than many thousand dollars worth of copper laid in multiple with it, and twenty or thirty properly distributed insulating joints will reduce the current in a pipe line more than an almost infinite amount of copper would do.

Our contemporary, the *Electrical World and Engineer,* in its issue of July 19, 1902, took us to task for the suggestion embodied in this quotation in the editorial which we quote in part below. Our contemporary deprecated the "reopening" of the question of electrolysis from electric railway currents. In its opinion, the suggestion offered in the ELECTRICAL REVIEW was not worthy even of an attempt to show that it would be inadequate, so it assumed to maintain its authority by stating incorrectly what had been suggested and sneering at the author.

Although, in the opinion of our contemporary, the question of electrolysis was closed, since then several papers have been presented to engineering associations, both in this country and abroad, upon this topic; and one of these, read recently before the annual meeting of the German Electrochemical Society, which met in Mannheim, seemed to our contemporary to merit editorial comment. This comment, in the issue of August 29, we reproduce below in full, side by side with the quotation from the editorial of the previous year.

ELECTROLYSIS FROM ELECTRIC RAILWAY CURRENTS.

We regret to note that one of our electrical contemporaries has seen fit to reopen in a sensational manner the question of electrolysis from electric railway currents. Though the matter of corrosion by leakage from railway return currents was some years ago one of much concern, with the advance of the electric railway art and as a consequence of the thorough study given the subject by engineers, it is now known, even to the tyro in electric railway engineering, that in the relatively few cases in which injury from the corrosion of underground piping is apt to occur, a definite remedy is indicated by the local conditions. . . . The technical competency of the writer who would thus resuscitate a question that in the past has been so annoying to the electrical railway industry, may be gauged from the remedy proposed for the alleged great danger—the insulation of all joints of underground piping! And it is left an open question as to whether or not railway companies should bear the expense of applying this extraordinary remedy. It is not our custom to refer in criticism in these columns to our electrical contemporaries, but we must make an exception in this case in view of the serious damage that might be inflicted upon a great industry by such an ill-judged editorial utterance; for though none with any technical knowledge would give it a moment's consideration, the newspaper press is apt to accept the statements to which we refer as the opinion of one competent to speak on the subject, because they happened to appear in the columns of an electrical journal.—*E. W. and E., July 19, 1902.*

ELECTROLYSIS IN ELECTRIC RAILWAY RETURN CIRCUITS.

In a paper recently read before the annual meeting of the German Electrochemical Society in Mannheim, Mr. Gaisberg described the damage effected in the buried metal pipes of Hamburg by return currents from the street railway mains. It was stated that while lead pipes showed a fairly uniform oxidation, wrought iron pipes were deeply pitted in many places, while cast iron pipes were unaffected. An explanation which suggests itself for these observed conditions, is that wrought iron pipes are usually connected closely together by screw joints, and thus make good continuous metallic connection, while cast iron pipes are not usually closely united in metallic connection, and are thus electrically divided into a series of short lengths. Long conductors buried are naturally subjected to much greater danger from electrolysis than short conductors, because they serve to connect remote areas between which a considerable difference of electric potential may occur. Consequently wrought iron pipes are specially likely to carry return currents, and to be electrolytically disintegrated by them. On the other hand, when the difference of potential in the ground is sufficient to corrode cast iron pipes, the damage is apt to be more serious, since it repeats itself at every pipe joint.—*E. W. and E., August 29, 1903.*

We have not wasted any energy in an effort to bring these two quotations into harmony, but one can not help wondering where the technical competency comes in. The immunity of cast-iron pipes from electrolytic corrosion is now explained by the fact that these pipes are not usually closely united in metallic connection; but it was wicked a year ago to suggest the use of insulated joints to reduce corrosion! It speaks ill for our contemporary's opinion of the engineer, or for our contemporary itself, that it should state at one time that electrically poor joints may reduce electrolysis, and at another that none with any technical knowledge would give the insulation of joints for the purpose of reducing electrolysis "a moment's consideration."

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THE PROFITABLE ELECTRIFICATION OF THE MANHATTAN ELEVATED RAILROAD.

Perhaps one of the most important and far-reaching developments of electricity is the electrification of the Manhattan Elevated Railway. It is not the intention to call attention to the great relief which has been provided to the patient travelers in the city of New York, nor of the added comfort and increased speed of the electrical elevated system. It is the financial results and the effect which these financial results will have upon the general railroad situation to which attention is called.

Successful Electrification of a Steam Road.

For many years the Manhattan Elevated Railway had been successfully operated by steam locomotives. It carried its passengers with a certain degree of comfort and speed, handling numbers greater than any other similar corporation previously, and at the same time earned dividends for its stockholders. Ever since the development of electric transportation, projects and suggestions have been made to change the Manhattan from steam locomotives to electric distribution. A conservative management, backed up by reasonably satisfied and cautious stockholders, deferred the improvement until such time as the demands of the traffic exceeded the capacity of the plant when operated by steam locomotives.

The Attitude of Steam Railroad Men.

To a certain extent this is the attitude of a great many railroad managers in the United States to-day. They recognize that their patrons would be better satisfied, and as a result they would have a larger patronage, if the heavy passenger traffic lines were operated electrically. But the large investment and the necessity of earning interest on the present capitalization and on the added cost, causes them to hesitate and wait. With this attitude of a large number of railway managers, admitting the desirability of electrification, but questioning the profit-producing capacity, the report covering the workings of the Manhattan Railway for the past year, and particularly for the last quarter of the last fiscal year, the first period of complete electrification, is of extreme importance.

In detail the comparative figures of the earnings and expenses for the quarter ending June 30, 1903, compared with the corresponding period of the previous year, are as follows:

	1903.	1902.	
Gross earnings (3 months)	$3,271,787	$2,857,250	Inc. $414,537
Expenses	1,302,089	1,401,106	Dec. 99,017
Net earnings	$1,969,698	$1,456,144	Inc. $513,554
Other income	90,187	111,287	Dec. 21 100
Total income	$2,059,885	$1,567,431	Inc. $492,454
Interest and taxes	684,563	655,849	Inc. 28,714
Surplus	$1,375,322	$911,582	Inc. $463,740

An increase in gross earnings of over $400,000 with a decrease in expenses of $99,000, making a gain to the profit account of over half a million in three months, is a strikingly pleasing and desirable result. And when the cost is figured it shows that in 1902, with steam locomotives, the cost to the company was 2.24 cents per passenger, whereas in the corresponding quarter of 1903 under complete electrification the cost per passenger was reduced to 1.98 cents. When it is noted that the diminished cost was accompanied by increased train service, increased capacity, increased speed and increased comfort to each individual passenger, the results are remarkable. Of course when analyzing the results, and even when predicting, before electrification was completed, what might be expected, many of the accomplished results were self-evident.

The Importance of This Successful Electrification.

But the important point is that this desirable result has been produced here in New York city under the direct observation of the gentlemen who control the destinies of the majority of the steam railroads of the United States. These men control the purse strings of and find money for railroad corporations when it is demonstrated to them that the proposed investment will be profitable. More than anything else, these men, these New York bankers and financiers, desire profits. They recognize that to make a railroad profitable it must satisfy the demands of its patrons and must adequately serve the territory tributary. These gentlemen, however, are loath to make large expenditures and put added burdens on corporations which under existing conditions produce reasonable profits. It is natural, especially in finance, to let well enough alone. But now managers and engineers have an illustration, both of the personal satisfaction which accrues to the passenger, as a result of the electrification of steam railroads, and also an unanswerable argument in favor of the profit-producing result from the necessary investment.

Hence it is that we say, that the great and pronounced success of the electrification on the Manhattan Railway is perhaps the most important event in the development of electric transportation. It must not be forgotten that the principal bankers in the United States, including New York banks, have refrained largely from investing in the securities of electric, or so-called trolley roads. The reasons for this disinclination may be summarized as first, the rapidity with which business has developed and the consequent uncertainty as to the future; second, the conditions, local franchises, terminable rights, etc., pertaining to most electric lines; third, the tremendous financial *optimism* evinced by most trolley road promoters. Without mentioning other reasons, these three are sufficient to account for the lack of interest in trolley securities on the part of New York bankers. On the other hand a majority, if not all New York bankers, have made the bulk of their fortunes out of steam railroads. In most instances it has been made by a general study of local conditions and predicted earnings on future development. Except in rare cases this expected development has not failed. So the situation at the present time that confronts us is that railroad managements are willing to admit the desirability of electrification, the larger railroads have ample credit or finances for at least the beginning of a comprehensive scheme for electric development, and now the last argument against the investment, that of possible failure to produce profit, is removed. We may expect to see many of the large railroads follow the lead of the Long Island Railroad Company and plan and put into service continuously increasing electrical transportation plants.

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Shop Testing of Motors and Generators for Commercial Service—II.

By Bertrand B. Abry.

THE iron loss is plotted with watts as abscissæ, and generator volts as ordinates. See Fig. 3.[1] The saturation curve has for its abscissæ and ordinates, generator field current and volts.

As already mentioned, the saturation curve may start a few volts above zero, due to residual magnetism. The iron loss curve begins at zero. In general, then, we shall obtain iron loss and saturation curves as indicated in Fig. 3.

If, during the test, the excitation is carried far enough, it will be found on plotting the saturation curve that a decided bend will occur in the upper portion of the curve, indicating that the iron is becoming fully saturated. This is, of course, the so-called "knee."

3. Electromotive Force Regulation Test—The electromotive force regulation of a generator is the variation in voltage from no load to full load, the speed remaining practically constant.

For the purpose of a test, the machine may be belt-connected to a motor arranged to run at constant speed. The wiring and connections for this test are shown in Fig. 4. The load on the generator can be regulated by means of a water rheostat or any other convenient method of absorbing power. As the load is increased on the generator, it will be necessary to tighten the belt from time to time to ensure a constant generator speed. When ready to begin the test bring the generator up to speed. Then build up the generator field, adjusting the field rheostat until normal voltage on no load is obtained. Leave the rheostat at this point throughout the test. Observe the following:

Generator.			
Speed.	Amperes.	Volts.	Field Amperes.

Begin the test at zero load, increasing step by step to, say, twenty-five per cent overload.

At this point it will be well to remember that we are considering a compound-wound generator.

When the machine is tested, it is sometimes necessary to use a German silver shunt in connection with the series field. By varying the length of this shunt the field strength is decreased or increased until the desired regulation is secured. Such an adjustment provides for the proper regulation when allowance must be made for any variation in the engine speed.

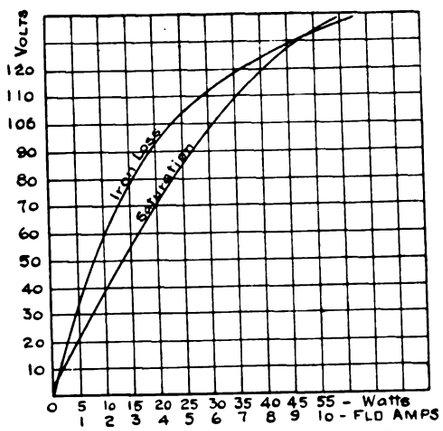

Fig. 3.—Iron Loss and Saturation Test.

Furthermore, it provides a means of increasing or decreasing the field strength due to the fact that it may be mechanically impracticable to wind the series coils of just the calculated number of turns for a given regulation. For example, the calculated series field may only require three and a fractional number of turns, but in the actual winding of the coil it may be necessary to make four complete turns. This will necessitate, then, the use of a shunt.

In a well-designed machine, after full-load conditions are reached, it will be noted that the regulation curve may become flat or possibly droop if carried farther. Likewise the field current curve. This results from the armature reaction and from the fact that any further increase in the current rapidly increases the ohmic drop and cuts down the terminal voltage. Such a decrease in the terminal voltage means a corresponding decrease in the shunt field current.

As the load is increased during the test, it should be noted whether it is necessary to shift the brushes to prevent sparking. With a well-designed machine no shifting at all or very little will suffice to insure good commutation at all loads.

In general, the regulation and field ampere curves of a compound-wound generator will appear as shown in Fig. 5. In the case of a generator these curves are plotted on an external ampere base. By "external" amperes is meant the current delivered to the line.

That automatic voltage regulation is an inherent characteristic of a compound generator, is clearly shown by the regulation curve.

A shunt-wound generator may be designed for a varying voltage with a constant load, or a constant potential with a varying load. In the latter case the results of the test should show the regulation curve a perfectly straight line. To accomplish this, hand regulation is employed, starting with the field rheostat set to give normal voltage on no load, as already explained.

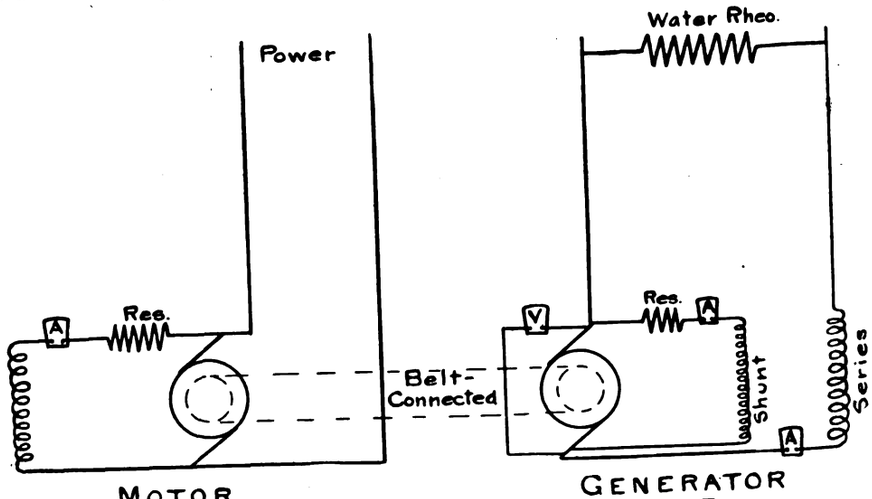

Fig. 4.—Wiring for Electromotive Force Regulation Test.

4. Calculation of Efficiency—Having determined the cold resistance, iron loss and regulation of the generator, we have sufficient data for calculating the kilowatt input and output and efficiency. The term "efficiency" is here taken to mean the "commercial efficiency" or ratio

[1] The curves shown in Figs. 3, 5 and 6 are not plotted from the performance of any machine, but merely intended to indicate the general shape and relation of such curves.

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of output of generator (in watts) to the input or mechanical horse-power (in watts) delivered to the shaft. At the beginning of the tests the cold resistance of the armature, shunt and series fields and the thermometer temperatures of these various parts were determined.

For the sake of uniformity in all tests it will be found convenient to first reduce all resistances to a 100-per-cent basis, at, say, twenty-five degrees centigrade. This

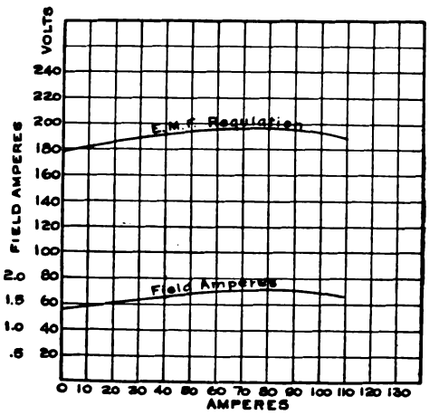

FIG. 5.—ELECTROMOTIVE-FORCE REGULATION TEST.

may be done on the assumption that an increase or decrease of one per cent from this 100-per-cent basis is equivalent to 2.5 degrees centigrade. For example, if the armature resistance as measured is .125 ohm at twenty degrees centigrade, at twenty-five degrees centigrade it will be increased two per cent and become .1275 ohm.

In calculating the efficiency of any machine intended to operate under normal conditions for a certain period each day, it would not be consistent to figure the efficiency on the basis of the cold resistances. To obtain fair results in the calculations, a resistance should be used corresponding to the temperature at which the machine is expected to run when in actual service. This may be determined by running the machine at normal load until the temperature becomes constant, and then measuring the hot resistance.

After making a great many tests on any certain class of machines, it is possible to assume a certain average per cent increase above twenty-five degrees centigrade which will closely approximate the temperature of the generator when operating under normal conditions.

If a German silver shunt is used on the machine, its resistance should also be known, but it need not be increased in the manner above mentioned, since the resistance of German silver does not change materially within the ordinary range of temperature.

After the regulation test is made, make a preliminary plot of the regulation curve and the field ampere curve, on an external ampere base, as in Fig. 5. Then, for convenience, take even values of the amperes and read off corresponding values of the voltage and field current. This voltage will be known hereafter as the terminal voltage.

Results may be tabulated as follows:

Ext. Amps.	Field Current.	Total Amps.	Term. Volts.	Total Volts.	C²R Arm. and Ser.	C²R Sh. and Rheo.	C²R Brushes.	Brush Fric.	Fric. and Windage.	Iron Loss.	Total Loss.	Output.	Input.	Efficiency.

The efficiency of course is the ratio of the output and input. The input is the sum of the losses in the machine plus the output. Hence it is necessary to determine the individual losses in the generator in order to calculate the efficiency. We have already measured the iron loss, brush friction, and friction and windage. The copper losses are calculated from the resistances (corrected) and the current at different loads.

"External amperes" is the current in

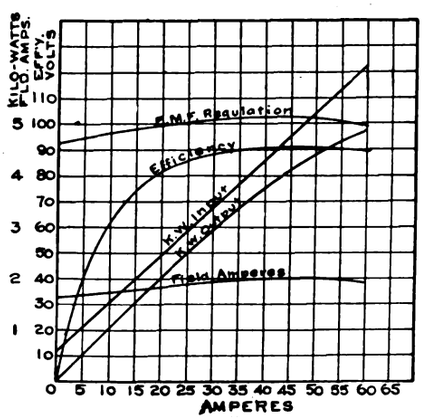

FIG. 6.—CHARACTERISTIC CURVES DIRECT-CONNECTED GENERATOR.

the external circuit, indicated by the main ammeter.

The field current column represents the shunt field amperes, indicated by the field ammeter.

"Total amperes" is, of course, the sum of the external amperes and the field current.

"Terminal volts" is the voltage at the terminals of the machine.

"Total volts" equals the sum of the terminal volts plus the drop in the machine. The drop in the machine is the sum of the drop in the brushes plus the drop in the armature and series field at the assumed average temperature. Expressed in the form of an equation, we have

Total volts = terminal volts + brush drop + total ampere X (R_a + R_s), where R_a and R_s are the corrected resistances of armature and series field respectively.

It is necessary to know the total volts in order to obtain the proper iron loss from the iron-loss curve.

The CR loss in the shunt field and rheostat (the latter being charged to the machine) is found by multiplying the field current by the corresponding voltage, taken from the regulation curve, for different loads.

The CR loss in the brushes is calculated from the brush cross-section and the total amperes flowing. That is, for a certain number of amperes per square inch of cross-section there will be a certain average drop. This may be taken as varying from one and one-quarter volts drop at ten amperes per square inch of brush cross-section to two and one-half volts drop at sixty amperes per square inch. (The current density should be taken to mean the amperes per square inch of brush cross-section on one side and the volts as the total volts drop per ampere on both sides.)

This average drop multiplied by the total amperes flowing will give the brush loss in watts.

Add the separate losses to obtain the total loss for the various loads at which the machine was run.

The watts output is the product of the terminal volts and external amperes. The watts input equals the sum of the total losses and the output. The ratio of the output and the input gives the efficiency.

In calculating the efficiency of any direct-current belted generator, the bearing friction and windage loss are charged to the machine. In testing an engine-type generator, the engine bearings are of course not available and the bearing friction can not be measured. In such cases the bearing friction and windage loss are charged to the engine.

A plot of the field amperes, electromotive force regulation, kilowatt input and output, and efficiency curves will appear in general as shown in Fig. 6.

These curves are plotted on an ampere

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output base. The kilowatt input curve represents the sum of the losses and the output. In general, it will not vary directly with the current output, since the voltage varies more or less in all but constant-potential machines where hand regulation is employed. In the case of constant-potential machines the kilowatt input will be a straight line. Before it is possible to obtain any output the losses must be supplied, hence on an output base the kilowatt input curves cross the X-axis to the left of the origin. The difference in the ordinates of the two curves at zero amperes shows the input required to supply the losses before any power is received from the machine. The greater difference in the ordinates as the kilowatt output increases, results from the increasing losses, especially the copper loss at overloads. At zero kilowatt output the efficiency is of course zero, but rises rapidly as the load increases up to about full load. After that point is reached, it will in general begin to bend downward. This is due to the decreasing ratio of the output to the input on account of greater losses.

5. Temperature Tests—In all machines for commercial use the ultimate rise in temperature above the surrounding air when running at some definite and specified load, is an important consideration and bears a close relation to the rating of the machine. To determine this temperature rise a temperature run, so-called, is made on all generators. The machine is usually run at its full rated load until a constant temperature is reached. The length of run will depend on the size and ventilation of the machine and varies from one to fifteen or twenty hours.

The commutation should be especially noted during the test. The condition of the brushes and position of the brush-holder with respect to the neutral plane will in every case affect the commutation more or less. Before beginning any test the brushes should be properly "ground in" and the tension adjusted. The brush-holder adjustment should be such with reference to the neutral plane as to give the best commutation at all loads, but the brushes should never be shifted so far forward as to cause sparking or flashing at no load. On some machines it is possible to shift the brushes forward to a position where sparking just begins on no load and full voltage and secure besides good commutation at all loads. On other machines run at no load and full voltage it may require a forward movement of, say, five bars to obtain the first evidence of sparking; but, on the other hand, when running at full load it may only be necessary to shift the brushes forward, say, three bars to obtain good commutation. Hence in such a case it would be unnecessary to shift the brush-holder to the extreme forward position. Thus, the same rule with regard to shifting of the brushes will not apply in all cases, much depending on the voltage of the machine and the voltage between bars.

During a temperature test it is customary to make observations of the current, voltage, field volts and amperes, and the speed, at least once every hour. At the conclusion of the test thermometers are placed on the commutator, armature core and windings, and the field winding. To obtain accurate results the thermometer bulbs should be covered with a little cotton waste and left in position until a maximum temperature is recorded. This may be determined by taking readings every five or ten minutes. Knowing the maximum temperature and the air temperature, the rise in temperature for the various parts of the machine may be calculated. The cold resistances obtained in the beginning are reduced to a basis of twenty-five degrees centigrade as explained above. After the temperature run the hot resistances are measured. The rise in temperature by resistance is then calculated, on the basis of 2.5 degrees centigrade for every one per cent increase in resistance.

6. Insulation Tests—The last test made on a machine is the insulation test. This is usually made just after the temperature run while the machine is hot. The insulation of all machines will usually be weaker after their first run and while still hot than at almost any other time. If there are any weak points in the insulation they will generally show up under such conditions. The usual test on a direct-current machine is between windings and ground, and the test voltage varies from 1,200 to 3,500 volts alternating current according to the rated voltage of the machine itself. It is well to call attention to the fact that in all such tests, especially where high voltages are used, great care should be taken to protect both the operator and the apparatus from injury.

(To be continued.)

Calorie is the name given the unit of heat measurement. In chemistry the heat unit is the quantity of heat required to raise a gramme of water from zero degree centigrade (freezing point Fahrenheit) to one degree centigrade.

Recovery of Gold in Combination with Tellurium and Selenium.

In compliance with a personal letter dated June 29 from the chief of the Bureau of Foreign Commerce, asking for a special report in regard to the most effective process known and practised in Germany for recovering gold from ores containing also tellurium and selenium, Consul-General Frank H. Mason, Berlin, Germany, makes the following report:

Tellurium, which has been known as a primitive element for more than a century, and selenium, which is of more recent discovery, are distinguished in metallurgy as metals which combine chemically with gold.

The extraction of gold from telluride and selenic ores is therefore one of the most difficult problems in practical metallurgy. The discovery in recent times of extensive deposits of telluride-gold ores in Western Australia and the United States—notably at Cripple Creek, Col.—has given special importance to this subject, and it has been found on investigation that, so far as can be ascertained, the most improved and effective method known in this country is one perfected and practised by the London & Hamburg Gold Recovery Company, which has extensive reduction works at Hamburg, with offices at 20 Frauenthal in that city. This company works the telluride-selenic ores from Western Australia.

Of the process itself it has only been possible to ascertain that it is partially patented and partially held as a secret which the specifications of the patent do not disclose. What is known is that by this process telluride and selenic ores containing gold are pulverized and digested in a solution of cyanide of potash and cyanide of bromium, in proportions of seventy-five per cent of the former to twenty-five per cent of the latter. The method by which the gold is precipitated from the solution is part of the carefully guarded secret concerning which no information can be obtained, but it is certain that the process recovers ninety-five to ninety-six per cent of the gold contained in the ores, and this proportion is often as high as ninety-seven or even ninety-eight per cent.

The company, while naturally refusing to disclose further details of its perfected method, will be willing at any time to make tests of American ores and give exact reports of results. Samples of ore for this purpose should contain not less than 200 pounds.

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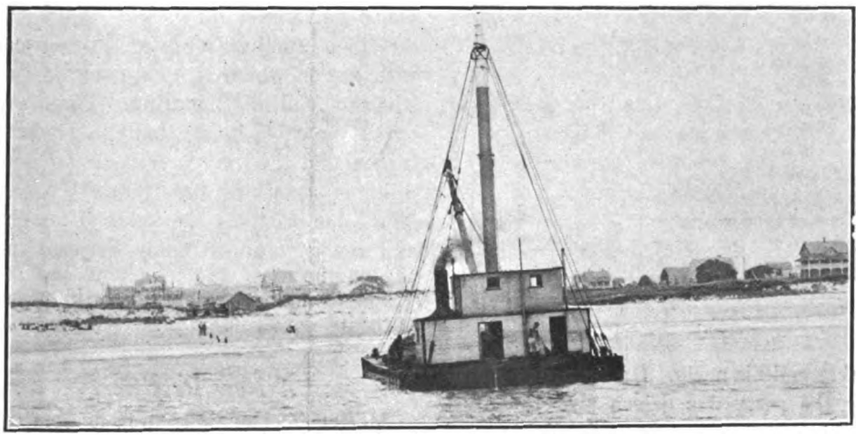
Laying the New Block Island Cable.

THE United States Weather Bureau has just finished laying a new cable connecting Block Island with the mainland at Matunuck Beach, Rhode Island. This cable is the property of the United States Weather Bureau, and will be used jointly by the telegraph service of the Weather Bureau, the Western Union Telegraph Company and the Providence Telephone Company. Telephonic communication has been cut for some time between the mainland and Block Island, but this will be resumed with the operation of the new cable.

The work was carried out under the direct supervision of Mr. Ellis B. Baker, president and general manager of the Baker Supply and Construction Company. In the party that accompanied him on the tug during the cable laying were Mr. J. H. Robinson, of Washington, D. C., chief inspector of cables for the United States Weather Bureau; Mr. George T. Manson, general superintendent of the Okonite Company; Mr. J. W. Ladd, of New Haven, superintendent of construction for the Southern New England Telephone Company, and Mr. S. B. Murray, of Brooklyn, N. Y. Mr. R. D. Blish, the cable foreman of the construction company, was on the lighter during the trip, in charge of the paying out of the cable; and Mr. H. Christian, of Newport, superintendent of construction for the Providence Telephone Company, joined the party at Matunuck Beach, where the land end of the cable was connected.

Mr. Baker and the others in his party arrived in New London early Saturday morning and were met at the wharf by the tug Alert, which took them down the harbor to the Scott company's wharf, where the lighter was tied up. Owing to the inclement weather conditions the tug and the lighter could not reach Matunuck Beach until 11.30 o'clock.



BEACHING THE LIGHTER.

PULLING THE CABLE UP THE BEACH.

The work of laying the eleven miles of heavy cable consumed rather more time than had been expected, for on the passage from the mainland to the island there was a strong head wind and head tide which made the progress of the lighter slow, and the work of getting the cable ends ashore at both terminals was cumbersome. The operation of laying the cable was done by the Baker Supply and Construction Company, of New York, for the Okonite Company, of New York, manufacturer of the cable. A tug and large lighter, and a large crew of workmen were necessary for the completion of the work. The works of the Okonite Company is at Passaic, N. J., and the cable was conveyed by flat cars from Passaic to Jersey City, where it was loaded on the lighter for transportation. The lighter, in tow of the tug Alert, left Jersey City at five o'clock on the afternoon of Thursday, September 3, arriving at New London, Conn., at eleven o'clock, Friday morning, September 4. Both tug and lighter are the property of the T. A. Scott Wrecking Company, of New London, and were chartered for the occasion by the construction company.

PAYING OUT THE THIRD MILE.

Landing the cable was accomplished with some difficulty, as there is considerable shoal water for a great distance from the beach, and it was with difficulty that the lighter was kept from grounding in getting it near enough to make a convenient landing of the heavy cable. However, the lighter was brought within 300 or 400 feet of the beach, and a medium-sized hawser sent ashore is a small boat. A tackle was made fast to a pole just above the beach, and the cable end secured to the hawser, when the signal was given to haul away. The point where the cable lands at Matunuck Beach is the end of a line of poles which lead down to this point just below a road which runs along the front of the beach.

Besides the regular cable force a number of the residents of the Matunuck summer colony lent their aid, and the cable was safely hauled to the pole, where it was made fast.

An iron cable box was attached to the pole, and the end of the cable brought up and wound around the pole. The

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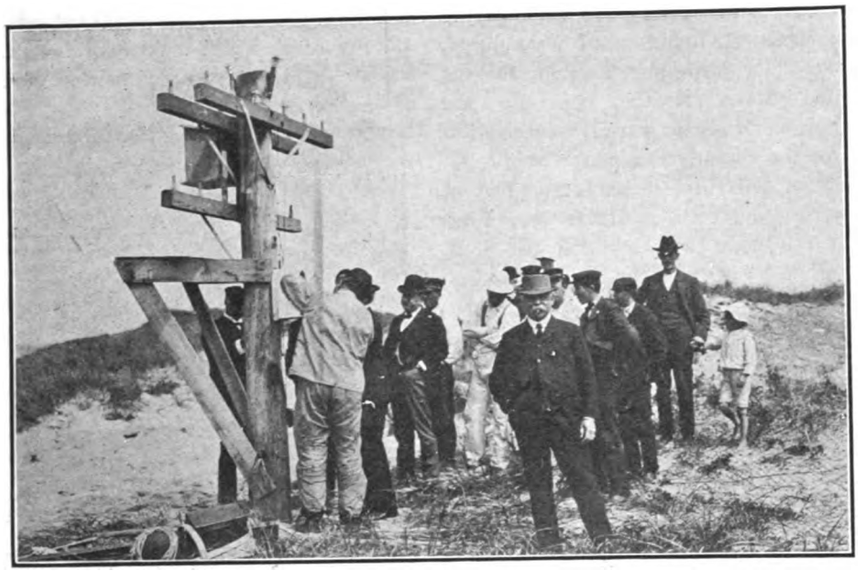
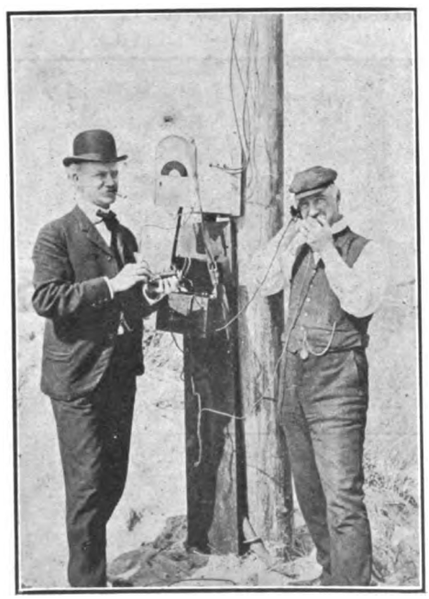
ends of the wires were then carried into the cable box and secured ready for connection with the land wires. The cable layers then returned to the tug and the lighter and prepared to start off on the run to Block Island. About two hours were spent in landing and securing the cable at Matunuck Beach, the greater part of the time being consumed in getting the lighter as near as possible to the beach.



TESTING THE CABLE AT BLOCK ISLAND.

The tug got under way with the lighter at 1.40 P. M., with the 100 tons of cable piled up in great coils on the deck of the lighter. These coils were slowly unwound and paid out over the stern as the lighter moved to the southward. The cable crew stood about and manipulated the coils so that every tangle and twist was straightened out as the cable was paid out. The cable was hauled up from the pile on the deck through two large blocks on the derrick-boom, and then passed down through a run with a brake attachment arranged at the stern, paying into the water. The weight of the cable caused it to sink beneath the surface a very few feet astern, and was all the power that was necessary to keep it uncoiling from the lighter as the vessel moved ahead.

The first mile of the cable was paid out in twenty-five minutes, the second mile in half an hour, and the third in twenty-five minutes. After the first three miles the progress was a little faster, and the ten miles to Block Island were covered in a little under four hours. The tug and lighter arrived at Sandy Point, the northernmost tip of Block Island, where the landing was to be made, at 5.30 o'clock. The landing was made in much the same manner as at Matunuck Beach, the lighter going as far in shore as was safe. The remainder of the cable was hauled ashore and work was postponed for the night, the tug and lighter putting in at New Harbor at 8.30 P. M., and landing Mr. Baker and his party. On Saturday morning the party was driven over to Sandy Point, and the crew from the lighter and the life-saving station crew pulled the cable up and made the proper connections at the Block Island cable box. There were about 300 feet left over, and this was coiled up and buried under the sand where it could be easily reached in case of further need. The three land wires were already strung as far as the beach, and the cable box and land connections were made and the cable was tested and found to be in working order.



TESTING BY TELEGRAPH AND TELEPHONE AT MATUNUCK BEACH.

The cable will be buried at each end from the cable box pole to a point beyond the low tide line.

The cable cost about $20,000, and the Providence Telephone Company will use two of the three wires by special arrangement with the government. The cable is made up of three conductors, each composed of seven strands of No. 22 copper wire twisted together and insulated with "Okonite" compound. The three covered wires are bound with jute, over which is a layer of "Manson" tape and another layer of jute. This is wound with twelve No. 3 galvanized iron wires coated with tar, then another layer of jute covered with tar on which is a covering of soapstone to facilitate handling. The diameter of the cable is one and three-quarters inches, and the total weight of the eleven miles is something over 200,000 pounds. The cable occupied six weeks in making, and the government cable inspector and the engineers of the telephone and telegraph companies were greatly pleased with its construction and manipulation.

A New Rectifier.

Messrs. Siemens Brothers & Company, of Westminster, London, S. W., England, are introducing a type of rectifier for transforming alternating into direct current. The apparatus is known as Koch's rectifier, and consists of a vibratory synchronous interrupter resembling in external appearance the polarized relay constructed for heavy currents and quick action. If a polarized interrupter is excited by an alternating current of any ordinary periodicity its armature will vibrate synchronously with the phase of the current. Owing to the self-induction of the coils of the interrupter, hysteresis of the iron and the inertia of the armature, the phase of the armature lags behind the phase of the current. Contact may, however, be rendered sparkless by putting in series with the coils of the interrupter a condenser of such capacity as not only to neutralize the self-induction of the coils, but bring the phase of the exciting current in advance of that of the main current. This counteracts the hysteresis of the iron and the inertia of the armature, and brings the latter in phase with the main current. A pulsating intermittent current is delivered, in which the makes and breaks can be made to occur at the zero points. To make the rectified current serviceable for charging accumulators, the magnets on the inter-

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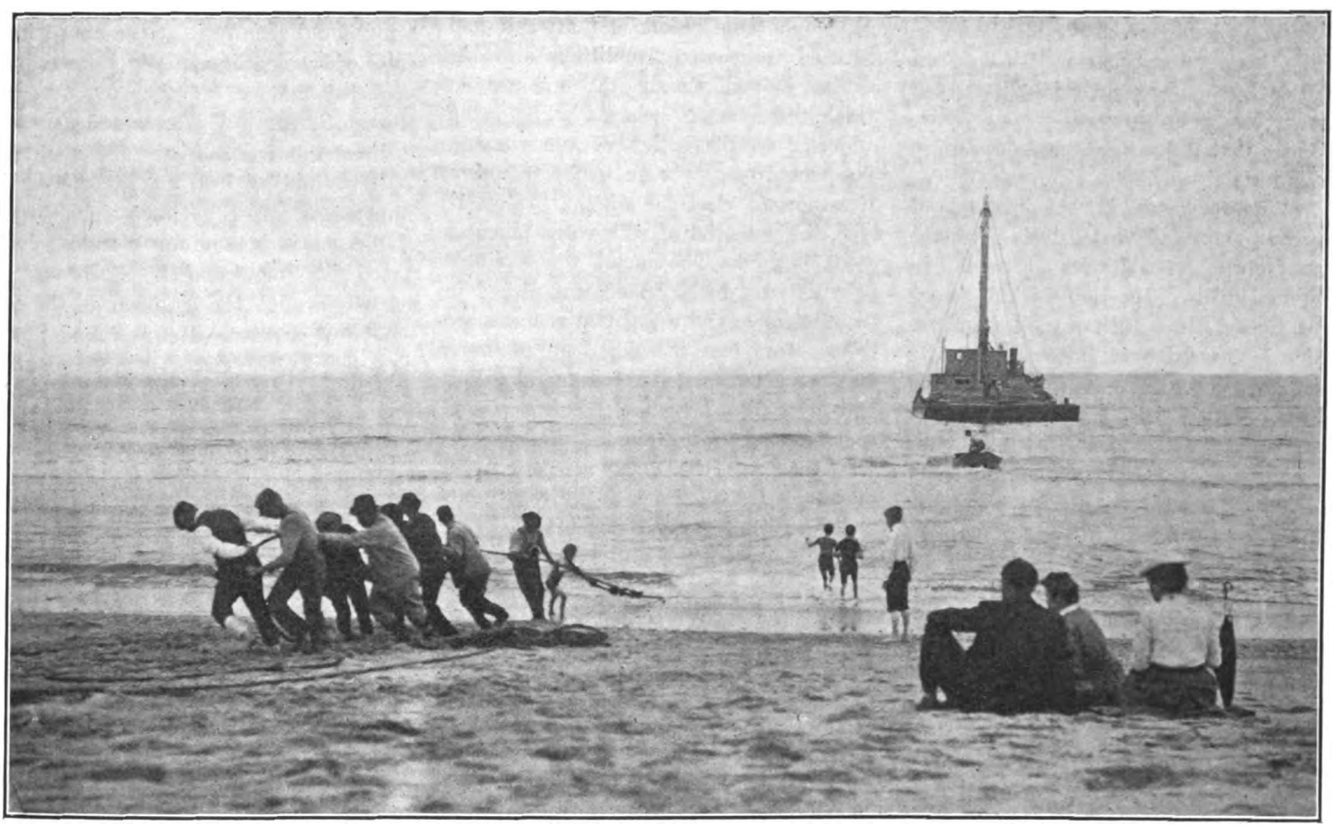
rupter must be provided with a second winding so connected to the battery that the voltage of the latter opposes the current induced by the charging impulses. If this secondary winding is properly proportioned, only the excess voltage closes the contact against the potential of the battery, and an entirely automatic adjustment of the interrupter for all battery voltages is obtained. To avoid troublesome tuning, a condenser of relatively small capacity is used, and the excessive lead is connected by placing in the circuit a coil of variable inductance. The interrupter can be made sparkless by adjusting the position of the coil of this bobbin, and it maintains its sparklessness under considerable fluctuation of potential in the alternating circuit. If the potential of the battery approximates the mean potential of the alternating current, the closed period is very short compared with the open period, and the armature has a very jerky motion, liable to cause interruptions. This is remedied by placing a choking coil to moderate the inductance between the alternator and the apparatus. This has practically no effect on the weak current flowing in the exciting circuit, but causes a displacement of the phase during the period of load, and therefore a lengthening of the charging impulses with respect to time. The efficiency of the apparatus is said to be the greater the nearer the potential of the battery equals the mean potential of the alternating current.

A Novel Generator.

According to an ingenious German invention, electricity is generated by forcing liquids, such as solutions of potassium or sodium alum, under high pressure, and at a great velocity, through magnetic fields. In the specially designed apparatus the field magnet has a single coil wound upon a cast-iron core, which is formed with a number of arms, projecting alternately from its two sides, and terminating in wrought-iron bolts, which produce magnetic fields. The bolts are supported in copper blocks, each of which has two passages opening at the front and back respectively. The solution forced in through a pipe enters the front passage in the first block and is conducted to the first magnetic field, where it cuts the lines of force at right angles, thereby generating a current which is carried off by suitably disposed copper conductors, which are all connected in series. After leaving the first magnetic field the liquid flows through an insulating grating in the frame to the next magnetic field, and so on round the machine until it leaves by a pipe. The insulating gratings are provided in order to prevent the formation of whirl currents in the frame of the apparatus.—*Kuhlow's German Trade Review, September.*

A New Form of Water Rheostat.

A convenient type of water rheostat has been designed by M. Wolliscroft, which avoids some of the inconveniences of this type of apparatus. The rheostat consists of a cast-iron drum which holds the electrolyte, the cast-iron plate swinging on insulated trunnions so that it can be lowered into or raised clear of the electrolyte. This plate is moved by a handle attached to one trunnion, and on it is mounted the open-circuit release mechanism. Within the supports of the drum is arranged an overload circuit-breaker which acts by short-circuiting the open-circuit release magnet. The movable part of the rheostat is placed so as normally to hold the circuit open. When the motor is to be started, the starting handle is pressed down, gradually releasing the resistance, until the apparatus is short-circuited automatically by a contact attached to the trunnions. In case of overload or a break in the field circuit of the motor, the releasing gear opens and the resistance is gradually increased until finally the circuit is opened.



LANDING THE CABLE AT MATUNUCK BEACH, RHODE ISLAND.

Cable despatches from Berlin, Germany, state that on September 18, the experimental electric car made a speed of 106 miles an hour on the Marienfelde-Zossen military railroad.

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A PRACTICAL UTILIZATION OF THE PASSIVE STATE OF IRON.[1]

BY CHARLES F. BURGESS.

In what may be considered the ancient literature of electrochemistry the fact was pointed out that iron and steel may be made to assume that peculiar condition known as the passive state by employing the material as an anode in suitable electrolytes. Among such solutions are sodium nitrate and various other soluble nitrates.

Upon assuming the passive condition, the iron no longer becomes attacked by the anode products, oxygen being liberated, and the metal acting toward the solution as would an anode of platinum. While this peculiar behavior of iron, when used as an anode material, has been known for many years, it is only quite recently that it has been made use of in an industrial way.

An improvement in the method of brazing employed extensively in the manufacture of bicycles consists in dipping bodily a portion of the frame to be brazed into a bath of melted spelter, which is covered by a suitable flux. By this operation not only is the brazing effected within the joints, but a thin layer of brass adheres to the outer walls of the tubing, so that it becomes necessary to remove this layer in preparing the frames for receiving a coating of enamel.

An attempt was made to employ an electrolytic stripping process for removing this brass, but, upon trying a great many electrolytes, it was found that the iron itself tended to corrode much more readily than did the copper which enters into the constitution of the brazing spelter; and the problem resolved itself into finding a solution which would dissolve the copper, but in which the iron would not corrode.

Iron has a position considerably above copper in the electrochemical series of elements, and where two different metals are in contact the natural tendency is for the more electropositive one to go into solution with the greater ease. The idea presented itself of making the iron more electronegative than the copper by causing it to assume the passive state, and upon using the sodium nitrate solution in which this state could be developed it was found that the brass could be completely removed and the iron left intact.

This method of electrolytic stripping was installed and operated with success in various factories, and is now an important adjunct to the dip-brazing method. This same electrolytic stripping process may be applied equally well in removing silver, lead, tin and other metals more electronegative than iron from an iron surface. Nickel can not be removed in this way, however, since nickel, as well as the iron, assumes the electronegative or passive state.

In some correspondence with the Patent Office it was claimed that while the iron might assume a passive condition, becoming coated with a resistant film of iron oxide, it could not be considered as becoming electronegative. For the purpose of determining this question, some measurements of single potentials were made upon iron before and after it had assumed its passive condition, and the results showed clearly the manner in which these metals behaved while being subjected to the action of the current. The measurements were made by means of a normal electrode of the "calomel" type, the potential of which was taken as — 0.56 volt. The metal whose single potential was to be tested was placed in the electrolyte and the potential measured before applying an electrical pressure, and also after currents of different values had been caused to flow. It was found that up to a certain limit the single potential varied in accordance with the current density. These values at different current densities were determined by a specially constructed switch, which broke the current and immediately connected the electrode with the normal electrode circuit for an instant, long enough to determine the direction of the movement of the meniscus of a capillary electrometer used as a zero potentiometer instrument.

It was noted that the single potential of iron immersed in a sodium nitrate solution before the current passed was in the neighborhood of + 0.2 volt. In other words, a potential was set up toward the solution in the same direction, but of less magnitude than would be produced by zinc. By causing the current to pass from the iron electrode, however, this potential quickly became negative, and increased rapidly in negative value until potential as high as — 2 volts could be obtained under certain conditions. This potential of iron, when in the passive condition, is considerably higher than the single potential of platinum, and consequently in this condition may be considered as electronegative to that metal. Its potential is approximately equal to that of the peroxide plate of the lead storage battery.

Copper, on the other hand, does not change its contact electromotive force in anywhere near the same degree. The maximum electromotive force of copper was — 0.65 volt, and iron may readily be made much more electronegative than this value.

It was found that the iron did not assume the passive condition when used in sodium nitrate solution freshly prepared, but that this condition was developed after the current had flowed for some time. This fact led to the conclusion that the solution underwent some chemical change which was favorable to the passive state.

In removing brass from iron, the current should remove it at the approximate rate of one gramme per ampere-hour, provided that all of the current enters the solution from the brass and none of it utilizes the iron as an anode surface. A brass and an iron anode, each having dimensions of 1 by 2.75 inches, were immersed in a sodium nitrate solution to test the requirement. Each was connected through the ammeter to the same source of current. It was found that on first closing the circuit almost all of the current passed through the iron anode, but after operating for a few seconds the iron became passive, after which the brass took all of the current, the amount passing through ammeter being so small as to be hardly detected. By using very high-current densities, however, the iron may begin to conduct a small portion of the current, thus causing a liberation of oxygen on the iron surface. From these tests it was shown that the current has a high efficiency in the removal of the brass, and a practical trial has demonstrated that a small percentage only is wasted by flowing from the iron surface, provided the solution be maintained in good working condition and the applied electrical pressure be kept within suitable limits.

[1] Abstract of a paper read at the fourth general meeting of the American Electrochemical Society, Niagara Falls, N. Y., September 18, 1903.

Nitrates by Electricity.

There is now being made in the Canton Vaud an interesting attempt to utilize the nitrogen of the air for purposes of industry and commerce. Electricity is the active agent in the new process, of which the inventor is M. Ami Chessex, and the shareholders of the Motor Power Company, of the Grande Eaw, have, it is stated, ratified a contract with the Nitric Acid Manufacturing Company, of Fribourg, for the experimental manufacture of nitric acid under practical conditions by the process.

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ELECTROLYTIC COPPER REFINING.[1]

BY WILDER D. BANCROFT.

In determining the best conditions for the electrolytic refining of copper, we must consider the cost of the power necessary to precipitate a tank-full of copper under different current densities and at different temperatures; the cost of heating the tank; the deterioration of the electrolyte; the interest charge on the copper in the tank; the cost of pumping, and the quality of the copper deposited. Good adherent copper can be obtained at almost any current density, provided the rate of circulation be sufficient. The question of the cost of pumping has not been taken up, and is supposed to remain constant while the conditions are varied. The watt-hours necessary to precipitate a gramme of copper increase with increasing current density, and decrease with rising temperature. The cost of heating increases with rising temperature, and the interest charge on the copper in the tank decreases with increasing current density. With increasing current density, we have to strike a balance between the increasing power and the decreasing interest charge. With rising temperature, we have to strike a balance between the decreasing cost of power and the increasing cost of heating. The object of this paper is to furnish data bearing on these points. Two of my students, Messrs. Schwab and Baum, have heretofore determined the relation between voltage, current density and temperature for pure copper plates set a definite distance apart in four solutions. By expressing the voltages in terms of the voltage at twenty degrees, the effect of the distance between the plates is eliminated, and the percentage variations hold for any set of plates in the same solution. Data have been obtained showing the relations between current efficiency, current density and temperature for pure copper plates in four different solutions. These experiments were necessary because Foerster and Seidel[2] had found a marked falling off of the current efficiency above fifty degrees. These runs also give the degree of neutralization of the acid by copper. Incidentally, some experiments have been made on the effect of iron salts. The cost of heating tanks similar to those used by the Baltimore Copper Company has been determined, and Messrs. Schwag and Baum have calculated the variation of the cost with varying conditions of temperature and current density for the case of all power costing at the rate of $20 per horse-power-year, and for the case in which steam heating costs only one-thirtieth of electrical heating.

[1] Abstract of a paper read at the fourth general meeting of the American Electrochemical Society, Niagara Falls, N. Y., September 18, 1903.

[2] Zeit. anorg. Chem. 14, 138 (1897).

TEST NO. 1.

The object of this test was to determine the variation of voltage with variation of temperature, current density and solution. In commercial copper refining two standard solutions are used, each solution containing sixteen per cent copper sulphate crystals. The refineries using the Hayden system make up their electrolyte to contain also six per cent sulphuric acid, while the plants operating with the multiple system use a nine per cent acid solution. It has been claimed that the addition of a small quantity of sodium chloride produces a more coherent form of copper at the higher current densities. Experiments were therefore made with the following solutions:

SOLUTION A.

16 per cent $CuSO_4 5H_2O$ and 9 per cent sulphuric acid.

SOLUTION B.

16 per cent $CuSO_4 5H_2O$ and 6 per cent sulphuric acid.

SOLUTION C.

Solution A + sodium chloride (1 : 2,000,000 of solution).

SOLUTION D.

Solution B + sodium chloride (1 : 2,000,000 of solution).

Pure copper plates, five centimetres wide and dipping ten centimetres into the solution, were used as electrodes, one cathode and two anodes. The plates were held one centimetre apart, and arrangements were made for efficient stirring. The four solutions were placed in four beakers, and the measurements made under practically the same conditions by means of Weston instruments which had been compared with a standard. The four beakers stood in a large water bath.

The voltage required to obtain a given current density is materially less with the nine per cent acid solution than with the six per cent acid solution. The addition of sodium chloride to the solution increases the voltage at the lower temperatures, while the effect is scarcely noticeable at the higher temperatures.

TEST NO. 2—CURRENT EFFICIENCY RUN.

The object of this test was to determine the variations of the current efficiency when operating with the different electrolytic solutions at varying temperatures and different current densities. Heretofore it has been claimed that the current efficiency drops off rapidly when working at temperatures above fifty degrees centigrade. It was to verify the correctness or prove the incorrectness of this claim that this test was made.

The apparatus used in this test was practically the same as was used in the voltage test (test No. 1), with the addition of a copper voltameter run in series with the four other cells.

The electrolytes used for this run were the same as those of the voltage run, *viz.*: Solutions A, B, C and D.

This test showed that the current efficiencies for temperatures below seventy degrees centigrade fall off but very little, and are practically 100 per cent. Even at a temperature of ninety degrees centigrade and a high current density of four amp/qdm, the efficiency runs as high as ninety-eight per cent and ninety-nine per cent for the nine per cent and six per cent solutions, respectively, while a current density of one amp/qdm gives an efficiency of ninety per cent and ninety-one per cent.[1] Between fifty and seventy degrees, the efficiency in some cases runs a trifle above 100 per cent. This is no doubt due to the formation of cuprous sulphate in small quantities in the electrolyte.

The deterioration of solution is proportional to the ratio of anode loss to cathode gain, since pure copper plates were used and there was no sediment or copper scrap on the bottom of the beakers. The solution deteriorates more rapidly at the higher temperatures and at the lower current densities. This deterioration of solution probably more than offsets the advantage of decrease in voltage which the higher temperatures give, but only when operating at the lower current densities. The ratio of anode loss to cathode gain, when operating at seventy degrees centigrade and four amp/qdm, is hardly any higher than this ratio for operating temperatures between twenty degrees and fifty degrees.

EFFECT OF IRON IN ELECTROLYTE.

Frequent statements have been made that the presence of iron in the electrolytic solutions cuts down the current efficiency. To investigate this, solutions containing iron were electrolyzed between

[1] While this result is apparently in flat contradiction with that of Foerster and Seidel, this is not really the case. These authors find forty-seven per cent efficiency with 0.3 amp qdm and eighty-three per cent efficiency with one amp qdm at 100 degrees, while we find, at ninety degrees, ninety-one per cent efficiency with one amp qdm and ninety-nine per cent efficiency with four amp qdm. The highest current density of Foerster and Seidel is our lowest. Since no refinery in this country runs at as low a current density as one amp qdm (except perhaps the Calumet and Hecla), the conclusions of Foerster and Seidel are not applicable to American practice.

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weighed copper electrodes at a temperature of forty-five degrees centigrade and a current density of two amp/qdm, with a voltameter in series. The results obtained show that there is no falling off in the current efficiency. After the test the precipitate on the cathode was dissolved in nitric acid, and the solution was tested for iron. None was found, thus demonstrating that iron was not precipitated from the solution.

TEST NO. 3—RADIATION RUN.

One of the important items in electrolytic copper refining is the cost of maintaining the electrolytes in the vats at operating temperature. To form some idea of the relative costs of operating at various temperatures was the object of this test.

The vats in a plant using the Hayden system are nine feet long, two feet wide and two and one-half feet deep, and are filled with copper plates one-half inch apart. Accordingly, there was constructed a small tank out of one-half-inch stock, with the inside dimensions of nine by two by two and one-half inches, and filled it with copper plates one-half inch apart. The joints of the tank, as well as the inside, were lined with tar, thus effectually preventing leaks.

As a means of heating up the tank, a platinum coil was placed on the bottom, and connections brought out to binding-posts on the sides of the tank. Next the tank was filled up with electrolytic solution (solution A), and its temperature brought up to near the boiling point by passing an alternating current through the platinum coil. When the solution had reached a temperature of about ninety-five degrees centigrade the current was turned off and the run started.

A standard thermometer was placed in the electrolyte, and readings of its temperature taken at varying intervals of time, until the temperature had dropped to about forty degrees centigrade. Two radiation runs of this sort were made—the first with the tank uncovered, and the second with a cover over the top.

The tank was again heated up to ninety degrees centigrade, and the current so adjusted that the temperature of the solution was maintained constant. The power required to overcome radiation at ninety degrees was determined both for covered and uncovered tanks. The power required at several different temperatures was computed for both covered and uncovered tanks, and the data are given in the following table.

CONSTANT TEMPERATURES—POWER DATA.

Tank Covered.				Tank Uncovered.			
Temperature Degrees.	Watts.	Temperature Degrees.	Watts.	Temperature Degrees.	Watts.	Temperature Degrees.	Watts.
90	44.0	65	25.2	90	145.0	65	42.0
85	40.1	60	21.7	85	118.0	60	34.4
80	36.6	55	18.8	80	90.4	55	26.4
75	33.5	50	14.5	75	67.3	50	20.6
70	28.8	..	....	70	50.6	..	....

Since the radiation of any two similar bodies is directly proportional to the area of their radiating surfaces, these values of power as determined for the small tank can be easily translated to figures for a tank of commercial size by multiplying by 100.

COMMERCIAL TEST.

In this test an attempt was made to duplicate commercial conditions in the precipitation of electrolytic copper. Through the courtesy of the Baltimore Copper Company several hundred pounds of their commercial anode plates were obtained.

As the current efficiency could not be computed from the results of this run on account of a short-circuit which occurred, an extra determination was made with a commercial anode, using the current-efficiency apparatus previously described. This run was made at forty-five degrees centigrade and a current density of two amp/qdm. From the current efficiency obtained, it is clear that the impurities in the anode do not cut down the current efficiency to any great extent. The current efficiency of commercial tanks does not reach this high figure, probably due to leakage of the current through the slimes on the bottom.

CALCULATIONS FOR COST OF REFINING.

Basis—One tank, inside dimensions two by two and one-half by nine feet. Outside dimensions taken as 29 by 34 by 16,000 square inches. Ratio of radiating surface of small experimental tank to commercial tank is about 1 to 100.

SOLUTION D.

The basis for the following figures on the cost of production are as follows:

One tank, containing 130 electrodes of two plates each.

Weight of copper per tank = 5,700 pounds.

Value of copper per tank = $800.

Cost of power = $20 per horse-power year.

Plant temperature = twenty degrees centigrade.

The calculation is made on the basis that the heating of the electrolyte is done by means of the electric current. In such cases, where the cost of heating the solution is greater than the cost of precipitating the copper, we have taken as the figures of cost the former, and *vice versa*, since, in precipitating the copper, the energy is consumed simply in overcoming the resistance of the electrolyte, and thereby heating it. The following table gives the results of the calculations.

COST OF REFINING TANK OF COPPER.

Amp/qdm.	Temperature Degrees.	K. W.-Hours to Deposit.	Cost to Deposit.	K. W.-Hours to Heat.	Cost to Heat.	Interest on Copper.	Total Cost.
1	20	390	$1.195	000	$0.00	$2.975	$4.17
1	50	196	0.601	793	2.425	2.975	5.40
1	70	153	0.468	1,550	4.755	2.975	7.73
1	90	134	0.411	2,360	7.205	2.975	10.18
2	20	608	1.86	000	0.00	1.487	3.35
2	50	362	1.11	396	1.21	1.487	2.70
2	70	274	0.84	775	2.38	1.487	3.87
2	90	233	0.71	1,180	3.60	1.487	5.09
3	20	795	2.43	000	0.00	0.99	3.42
3	50	519	1.59	264	0.81	0.99	2.58
3	70	400	1 22	517	1.58	0.99	2.57
3	90	341	1.04	787	2.40	0.99	3.39
4	20	1,000	3.06	000	0.00	0.74	3.80
4	50	647	1.98	198	0.61	0.74	2.72
4	70	519	1.59	388	1.19	0.74	2.33
4	90	433	1.33	590	1.80	0.74	2.54

While these figures are based on experiments with the series system, it is probable that the conclusions to be drawn would apply equally well to the multiple system.

Exception may be taken to these estimates of the cost on the ground that, in practice, the solutions are heated by

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steam coils, and that this costs less than electrical heating. To meet this objection, the results have been calculated on the basis of electrical power at $20 per horse-power-year, and steam heating at one-thirtieth the price of electrical heating. The data for the two calculations are given in the table, and show cost per ton of copper instead of per tank.

COST PER TON OF COPPER.

Amp/qdm.	Temperature Degrees.	Cost 20—20.	Cost 20/30.
1	20	$1.46	$1.46
1	50	1.89	1.28
1	70	2.78	1.25
1	90	3.57	1.27
2	20	1.17	1.17
2	50	0.95	0.91
2	70	1.36	0.83
2	90	1.79	0.80
3	20	1.20	1.20
3	50	0.91	0.91
3	70	0.90	0 78
3	90	1.19	0.72
4	20	1.33	1.33
4	50	0.95	0.95
4	70	0.82	0.82
4	90	0.89	0.89

It must be kept in mind that these estimated costs do not include the cost of labor, and are based on the assumption of 100 per cent current efficiency.

CONCLUSION.

Summing up the results obtained for the different runs, it is now possible to draw conclusions as to what are the most financially economical conditions under which to refine copper electrolytically.

Two sets of curves were plotted, one showing the relation between the cost to precipitate a ton of copper and the operating temperature, the second set showing the relation between the cost to precipitate a ton of copper and the operating current density. From these curves, it is evident that to operate at a temperature of ninety degrees and a low-current density is entirely out of the question, not only on account of the cost of power to heat the solution and precipitate the copper, but also on account of the deterioration of solution, which takes place very rapidly under these conditions. At this high temperature and the higher current densities, the cost rapidly approaches a minimum, but here also the deterioration probably more than offsets the advantage of reduced cost of power. To operate at twenty degrees centigrade is not so costly as would seem at first thought. The cost is maximum at the lowest and the highest current densities, reaching a minimum between two and one-quarter and two and one-half amp/qdm.

At fifty degrees it would not be economical to operate at one amp/qdm, but the cost drops off very rapidly between one and two amperes. At the higher current densities the cost fluctuates but very little, reaching a minimum at about two and one-half amp/qdm.

The result at seventy degrees seems the most satisfactory, and it is at this temperature that we shall get the best results. Although the cost runs very high at this temperature for a current density of one amp/qdm, it begins to drop off very rapidly as the current density increases, until it assumes a practically constant value at the higher current densities. Between 3.5 and 3.75 amp/qdm would be the best current density for obtaining economical results, for at this density no extra power would be required to heat the solution. Operating at this current density, and with the tanks covered, the current alone would be sufficient to heat the electrolyte to over eighty degrees. In order to secure a good circulation, essential for a good deposit with high-current densities, the present method of pumping could be retained.

The lower the cost of heating, the greater the advantage of a high temperature. Lowering the rate of interest decreases the advantage of a high-current density. With covered tanks, it will be possible for men to work in the tank room even with the electrolyte at seventy degrees.

If we compare the cost of working under so-called standard conditions of open tanks, a current density of fourteen amp/sq ft and a temperature of fifty degrees with the cost of working with covered tanks at seventy degrees and a current density of 3.5 amp/qdm (31.5 amp/sq ft), the saving by the latter method will be very close to a dollar a ton of refined copper when all power is figured at $20 per horse-power-year.

Therefore, in order to operate a plant most economically, copper should be refined electrolytically under these conditions:

1. Covered tanks.
2. Current density 3.5 amp/qdm.
3. Temperature seventy degrees.

The Zambesi Power Scheme.

The African Concessions Syndicate, which was organized to exploit the possibilities of the Victoria Falls, on the Zambesi, has issued a report describing the work so far accomplished. These falls are over 400 feet high, and their power is estimated at 35,000,000 in the wet season, while that of Niagara is 7,000,000 horsepower. The railway has now been completed to within seventy miles of the falls, and will reach them before the end of next March. It is believed that it will be practicable to carry the electrical energ generated at the falls economically as far as the Rand, and it is hoped to work by means of it a large portion of the South African railway mileage, as well as to supply the power in the gold mines. American estimates are that with conditions similar to those in Rhodesia it will be possible to convey the current 330 miles and deliver it there at a cost of $22 per kilowatt per year, the load being on the whole twenty-four hours of the day. Within a radius of 300 miles of the falls there are important gold fields, coal fields, copper fields and about 900 miles of railways, while a transmission of 600 miles would take in the whole of the South African gold fields. The site of the falls is said to be healthy throughout the year, and the whole region is thought to be more richly endowed in mineral wealth, including copper, iron, gold and coal, than any similar area on the surface of the globe. At present only preliminary survey work is in progress, but it is expected to complete this very shortly, and work will then be begun on the building of a hydroelectric generating station much on the lines of that at Niagara Falls.

Sir Hiram Maxim Announces a New Invention.

Sir Hiram Maxim stated at a meeting of the Maxim Electrical and Engineering Company, of London, on September 14, that he will shortly announce an important invention which will bring forth more money than anything he has ever done, not excepting his automatic gun. He added that he was putting thousands of pounds into the invention, the character of which he will not divulge until all the patents are secured. The president of the company announced that the company had the patent for a new boiler, made entirely of steel, which was more economical in working and cheaper than anything of the kind now on the market.

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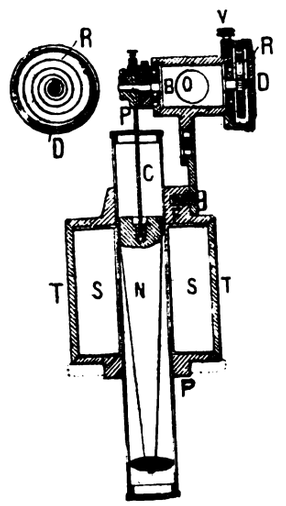
Electrical Notes from Europe.

From Our Special Correspondent.

THE De Dion Company, of Paris, has recently brought out a compact generating set which consists of a petrol motor of its standard type with some slight modifications, and direct-coupled to a small four-pole dynamo of five kilowatts. The motor makes 1,500 revolutions per minute and is almost entirely enclosed by the field casting. One of the principal novelties of this apparatus is a new electromagnetic regulator which is operated by the main circuit and acts upon the supply valve of the petrol motor. It varies the motor speed at each instant so as to give a constant voltage at the dynamo terminals under varing loads. The use of a regulator upon the petrol motor dispenses with a rheostat or compound winding. This device, which is shown in the diagram, consists of a solenoid S which acts upon a core N of conical form. The core works up and down inside of a tube which serves as a guide. To provide a stronger field with a given current, the magnetic circuit is closed by the soft iron end-pieces FF and the outer tube T around the solenoid. This arrangement also protects the device from the influence of the surrounding field. The upper end of the solenoid is attached by a chain C and a pulley P to the end of the revolving valve B which is fixed on the carbureter of the motor. The opening O of the valve is placed in the passage which brings the explosive mixture from the carbureter to the motor. Under these conditions the movement of rotation which is communicated to the pulley P by the core N will have the effect of closing more or less the passage of gas to the motor. A spiral spring R, mounted on the other side of the revolving valve, is fixed at its outer end to a screw-cap D so that the tension of the spring can be regulated by turning the cap, thus changing the sensitiveness of the regulator. The ends of the solenoid are connected to the main terminals of the dynamo which is shunt wound. When the motor starts the dynamo becomes excited and the voltage soon comes up to the normal value. If there is no load on the dynamo the motor will tend to race, but as soon as the normal voltage is exceeded, the core N of the solenoid is pulled down and by its action on the pulley it closes more or less the valve which supplies the motor, thus reducing its speed until the voltage of the dynamo resumes its normal value. When a load is thrown on the dynamo the speed of the petrol motor tends to slacken up and the voltage is lowered. In this case the core rises and allows the spring R to open the admission valve and increase the motor speed. In practice the electric governor follows all the variations of load and the voltage always remains constant. Its action is very rapid and the regulation is made in less than five seconds in passing suddenly from no load to full load or *vice versa*. The variations of voltage are kept below three volts. As to the energy which is consumed by the governor, it is stated to be about five watts and is thus almost negligible. The



DE DION GENERATING SET VOLTAGE REGULATOR.

new group is especially adapted for charging storage batteries, as there is no danger from a varying voltage and the battery can not be deteriorated by an overcharge or a too heavy current. It is only necessary to regulate the governor once for all to suit the given case.

One of the questions which was considered by the last automobile congress held at Paris was the standardizing of accumulator cells for electromobiles and also those which are used for producing the ignition spark for the petrol motors of automobiles. The congress appointed a committee of leading scientists and engineers as well as automobile constructors, who are to consider the question and make a report in October. The committee find that at least two dimensions of the cell can be standardized, namely, the width and the height, which correspond with the dimensions of the plate, while the length corresponding to the number of plates will doubtless remain variable. In this way all the accumulator boxes for electromobiles will have the same height and width and only the length will vary. The size of plate which seems best adapted for the purpose and is proposed by the committee is 112 millimetres wide and 270 millimetres high. The want of a standard accumulator cell has long been felt and it will be of great convenience. Another question which was taken up by the committee relates to the small accumulators for use with gasoline motors. A few years ago nearly all the makers constructed these cells on a uniform size, but at present there is but little uniformity, especially as a smaller type of cells had to be made for the new motor-bicycles. It is now proposed to standardize this type of accumulator cell and to use the standard plate of 112 millimetres wide, which will be cut down in length so as to make a smaller cell for the igniters. In this case the cell, which will be made of celluloid or similar material, will be 107 millimetres long and eighty millimetres wide. For motor-bicycles the cells will be made just half of the former size so that two of them, side by side, will occupy the standard space. It is also proposed to standardize the screw-threads of sparking plugs so that these will always be interchangeable. This will be easier to carry out, as at present nearly all the constructors use a uniform screw-thread which is that of the De Dion plug, having a diameter of eighteen millimetres with a pitch of 1.5. Another piece to be standardized is the contact plug for charging automobile batteries, so that vehicles can fit their plugs into any charging station which is found en route. At present the plugs have different forms. Some have two separate plugs and in others the two are united by an insulating cross-piece and have different diameters so as not to invert the poles. A very good form which was presented to the congress is that of two concentric pieces which fit into a single socket, and it is proposed to adopt it as standard. This form is now made by the Clemançon company. It has an interior cylinder corresponding to the positive pole, surrounded by a brass tube for the negative. The plug thus formed is provided with a two-strand cable, at present made in two sizes for thirty and fifty amperes.

The two sets of storage battery

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which have been lately installed by the Edison Company, of Milan, are no doubt the largest batteries in Europe. The first battery, which is used for the tramway system, consists of 260 cells of the Tudor pattern, giving 3,500 amperes on an hour's discharge or 6,000 amperes on a short discharge. The cells in working order weigh 4,840 pounds each and are made up of twelve positive and thirteen negative plates. They measure eight feet four inches long, thirty-two inches wide and forty-one inches high. The battery is disposed in six rows of cells, using copper connectors of twenty-five square centimetres section. It is designed as a reserve in case the generating station of Paderno should cease to work, and can furnish 2,000 kilowatts for one hour. During this time it can operate the whole of the Milan tramway system, which uses 300 cars. The second battery is used for the lighting circuit in parallel with the dynamos. It contains four series of seventy-eight cells, or 312 in all. The cells are of the same size as the former, but each contains thirty-three plates instead of twenty-five. The battery will give a discharge of 20,000 amperes during one hour. Under ordinary circumstances its power is rated at 3,000 kilowatts, but it will give as high as 4,000 kilowatts on a short discharge.

An interesting experiment on the use of graphite in connection with oil for lubricating machines has been carried out in Germany. The addition of a small amount of graphite to the oil seems to be a decided advantage. The experiments were carried out upon locomotives of the Saxony railroads. The usual lubricating oil was mixed with a small percentage of a very pure graphite in the form of small and very thin scales. In the case of journal boxes, these were filled up with waste which had been saturated with the mixture of oil and graphite and also with a little tallow, and the waste was strongly compressed upon the journals. In the case of oilers for other parts of the mechanism, they are filled with the oil and graphite mixture. The consumption of graphite is very small, only 200 grammes for a run of 5,000 miles. The experiments have proved so successful that it is now proposed to use the mixture exclusively. Where ordinary lubricating oil is used at the rate of twenty-two grammes per kilometre the new mixture requires only ten grammes.

The Italian Government is now maturing the extensive wireless telegraphy projects which were mentioned in a recent note. Upon consultation with Signor Marconi it has been decided to proceed with the construction of fourteen wireless telegraphy stations at different points of the peninsula and also in Sicily and Sardinia. These stations will practically cover the whole country. The three stations which now exist comprise that of Mt. Mario, near Rome, a station on the Island of Palmaria, opposite the Gulf of Spezzia, and the Maddalena station in Sardinia. Of the fourteen new stations which are to complete the Italian system, may be mentioned that of Cape Mele, near Genoa, one on the Island of Ponza, opposite the port of Gaëta. An important post will be erected on the Island of Pantelleria which will cover the strait between Sicily and the north coast of Africa, connecting the eastern and western parts of the Mediterranean. This station can thus easily communicate with the African coast. The Island of St. Antioco will have a station at its southern point, the Cape of Sperone, while two others will be placed on Cape Spartivento and Cape Carbonara. On the east coast there will be a station near Venice, at the hido, and another at Mt. Cornaro, near Ancona. The Island of Sardinia is to be covered by four stations. These stations have been chosen at the proper distance apart so as to cover the whole of the peninsula and the islands. It is expected that each station will be able to cover a radius of 200 miles. The current is to be furnished by storage batteries. Marconi himself is to have the active supervision of all the stations and will select the best apparatus for the purpose. Nearly all the points chosen have been already used for semaphore signal stations, and thus it will not be necessary to erect special buildings. Preparations are now being made for erecting the main central station at Rome, which will be provided with extra powerful apparatus so as to be able to communicate with a second station in South America.

Some rather curious phenomena have been observed in the case of dielectrics by two German scientists Kiessling and Walter. They use a hard rubber tube containing an internal rod which serves as one electrode of a high-tension discharge. The other electrode is placed near the outside of the tube. When the outer electrode is near the end of the tube the discharge takes place between the two and the spark passes around the end of the tube without piercing it. If the end of the tube is placed in an oil bath so as to stop this discharge, the spark passes through the tube and pierces it. In this case it is observed that the point of rupture is always at the surface of the liquid. They brought out the same phenomenon in a still more striking way in a second experiment. A plate of glass is placed between two electrodes of a high-tension discharge and if a drop of candle grease is placed on the glass the discharge passes through it more easily than before. The hole which is formed by the discharge is always found at the edge of the drop. If the drop is scratched with a fine point or a small hole is made in it, the discharge has a tendency to pierce the glass at this point. In one case the experimenters used a sheet of ebonite 4.2 millimetres thick, with a fifty-centimetre spark. The discharge could not pass through the plate, but when a drop of stearine was placed upon it the plate was pierced through the wax by a spark of only twenty-five centimetres.

The organizing committee of the Paris Automobile Exposition has already issued the prospectus of the sixth annual Exposition Internationale de l'Automobile du Cycle et des Sports, held in the Grand Palais from the tenth to the twenty-fifth of December. Electrical features will be well represented, as last year, by electromobiles of French and other makes, storage batteries and primary batteries for ignition, also the new method of magneto ignition. The organization, as before, is in the hands of the Automobile Club of France, with the cooperation of the Chambre Syndicale du Cycle et de l'Automobile, the Chambre Syndicale de l'Automobile and the Syndicate of Automobile Constructors. The exhibits are divided into fifteen classes; the first class includes automobiles of all kinds and all vehicles of mechanical make. Only the constructors are admitted to this category. Firms representing foreign makes are admitted only on condition that they exhibit the vehicles of the makes they represent. Class No. 3 provides for exhibitors representing the various makes for which they are the selling agents. Class No. 6 comprises motors for automobiles and boats, also accumulators. Class No. 9 provides for automobile boats, either petrol or electric. Class No. 11, which includes various applications of alcohol for fuel and lighting, will no doubt bring out as interesting a collection of apparatus as last year. Inventions in connection with automobiles, etc., form another class, and a separate class is devoted to publications and photography.

C. L. DURAND.

Paris, September 12.

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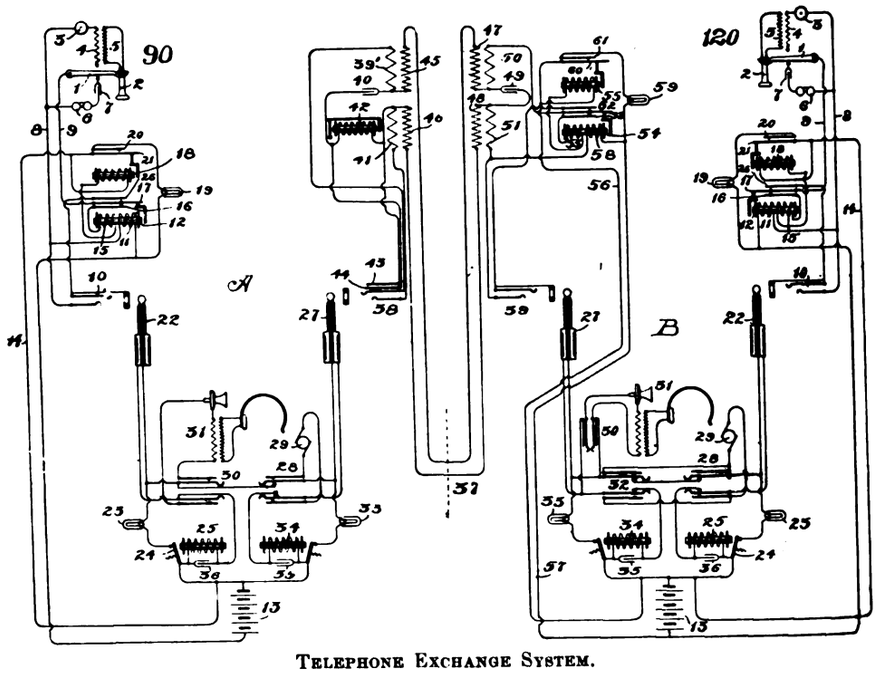
Electrical Patents.

Stromberg-Carlson Telephone Manufacturing Company, of Rochester, N. Y., has obtained control of a patent recently issued to Mr. William M. Davis, of Chicago, Ill., on a telephone exchange system, wherein subscribers whose lines extend to different telephone exchanges may be connected through the agency of trunk lines. The invention has for its specific objects—first, the provision of improved means whereby the operators of different exchanges may signal each other over those conductors employed in effecting a complete connection between subscribers connected with the exchange, thereby dispensing with special conductors that have been generally employed hitherto for the purpose of establishing signal connection between the operators, and second, the provision of means whereby repeating coils may be employed in the trunk line for the purpose of propagating voice currents from one substation to another, in combination with means whereby the common battery employed in the system may not be short-circuited by reason of inductively related closed circuits forming links in the telephonic circuit. While this latter feature of the invention is particularly adaptable for use in connection with repeating coils contained in trunk lines, the invention is not limited to this adaption thereof. The invention can be more readily explained by reference to the accompanying drawing, in which are illustrated two telephone exchanges adapted for union by a trunk line. A subscriber's station No. 90 is connected with the telephone exchange A and a subscriber's station 120 is connected to a telephone exchange B. At each of the telephone substations there is illustrated a gravity switch hook 1, a receiver 2, that may be supported thereby, a transmitter 3, an induction coil having the primary 4, adapted for inclusion in circuit with the telephone line upon the elevation of the switch hook, a secondary 5 included in closed circuit with the telephone receiver, a signal receiver 6, and a condenser 7 included in the signaling branch. When the switch hook occupies its depressed position, the signal receiver is cut into circuit and the telephonic apparatus is rendered inoperative. When the receiver is removed from the switch hook the switch hook is elevated to open the signaling branch containing bell 6 and condenser 7 and to close circuit through the telephonic apparatus. The substations are connected with the exchange by telephone lines, the limbs 8 and 9 of each being connected with the short and long-line springs of the spring-jacks 10 at the exchanges. The limb 8 of each telephone line is continued through the helix 11 of a relay 12 and is connected with one pole of a common battery 13, the remaining pole of this common battery having connection by way of the conductor 14 with one terminal of the second helix 15 of the relay 12. The remaining terminal of the helix 15 is in the form of a contact spring 16, normally engaging a contact carried by the spring 17, which spring constitutes the normal terminal of the limb 9. When the limbs 8 and 9 are conductively united at a substation 90 or 120, circuit from the battery 13 finds passage through both of the helices 11 and 15, which by being differentially wound do not cause the operation of the relay 12 when thus both included in circuit. There is also included in circuit with the conductor 14 and the helix 15 the winding of a line indicator 18, having a single helix which energizes its core when circuit through the battery 13 is completed upon the elevation of a corresponding telephone switch hook. The signaling magnet 18 preferably presents a signal through the agency of a small incandescent lamp 19, whose circuit is completed as terminals 20 and 21 are engaged upon the energization of magnet 18. The operator in response to the signal conveyed by the lamp 19 inserts a plug 22 into the calling subscriber's jack, thereby including the helix 11 in a momentary closed circuit that contains the tip of the inserted plug, the clearing-out indicating lamp or other signal 23 corresponding to the subscriber whose jack is engaged by the plug 22, the armature 24 of the signal-controlling magnet 25 corresponding to the signal 23, the battery 13, the helix 11, and the short-line spring of the spring-jack 10 engaging the tip of the inserted plug. The spring 17 is thereupon moved from its normal contact to its alternate contact 26, thereby opening the circuit, including the helix 15, and permanently connecting the short-line spring to the battery through the helix 11. It is understood, of course, that the short-circuit momentarily maintained through the lamp 23 causes the coil 11 to exert a greater magnetizing effect upon the core than the differential coil 15, whereby the said relay may be operated. The helix of magnet 18 and the coil 15 of the relay are at the same time cut out of circuit, as the continuity of its circuit depends upon the engagement of the parts 16 and 17. In addition to the plugs 22 there are also provided the plugs 27 united by tip and sleeve strands. There is provided at the board A a ringing key 28 for including the calling generator 29 in bridge of the telephone lines and a listening key 30 for including the operator's telephone appliance 31 in the telephone circuit. Similar keys 28 and 30 are also provided at board B, there being also illustrated at this board a second ringing key 32, so that the generator 29 at this board may be included in circuit with one or the other of the plugs 22 and 27. There is also preferably provided in connection with each cord circuit an added super-



TELEPHONE EXCHANGE SYSTEM.

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visory signal 33, provided with a controlling electromagnet 34. The magnets 25 and 34 are included in series in the cord circuits, being shunted by condensers 35, 36, included serially in the same cord strands. Having generally described a particular telephone exchange system with which the invention is particularly adapted, the salient features of the improved trunking system will be disclosed. The exchanges A and B may have telephone lines connected therewith united through the agency of said trunk lines, as the trunk line 37 illustrates. This trunk line terminates in the long and short line springs of the spring-jack 38, that are adapted for engagement with the terminal of a plug, and in similar contact springs of a spring-jack 39 at the board or exchange B. The trunk line is made up of three inductively related sections. The first section includes the short and long-line springs of the spring-jack 38, the primary helix 39′, condenser 40, and the primary helix 41. When the trunk-line jack 38 is not engaged with the plug, this first section of the trunk line includes the drop or indicating magnet 42, which is thus normally in condition to be operated from the board B. When the jack 38, however, is engaged by a plug, the helix of its magnet is short-circuited by the engagement of terminals 43, 44 of its helix, by which adjustment it is rendered unresponsive to alternating currents, while its impedance is removed from the trunk-line circuit. The second or middle section of the trunk line is in the form of a local circuit that is closed telephonically. This telephonically closed second or middle section of the trunk line includes secondary coils 45 and 46 in inductive relation with the primaries 39′ and 41 and secondary coils 47 and 48. This middle section also includes the condenser 40, that is common to the first and second sections of the trunk line, and the condenser 49, that is common to the second and third sections of the trunk line, said condensers serving to telephonically close said sections. This third section of the trunk circuit also includes the primary coils 50 and 51 in inductive relation with the secondaries 47 and 48. There is included normally in this third section of the trunk line a circuit-changing spring 52, the helix 53 of a relay 54, the helix of a signal-controlling magnet 55, the conductor 56, the battery 13 at the exchange B, the conductor 57, and the helix 58, that is differentially wound with respect to the helix 53, which arrangement is preserved as long as the jack 39 is not engaged by a plug. This association of the signal-controlling relay 54 and the signal-presenting magnet 55 constitutes one feature of the invention. By this arrangement, assuming that subscriber No. 90 is calling subscriber No. 120, a signal is transmitted to the B operator upon a simple insertion of the A operator's calling-plug in the trunking-jack through the agency of the cord-circuit instrumentalities at the exchange A, which result is secured because the sides of the circuit extending from the calling-operator's exchange to the board B are metallically continuous. If the plug 22 is not inserted in spring-jack 10, the circuit at station A may be closed by the closure of the operator's listening-key, the circuit then including the operator's talking set instead of the apparatus at substation 90. This signal thus automatically transferred through the agency of apparatus at board A is manifested in the signal 59, it being assumed that the relay 54 is not operated, owing to the differential arrangement of its windings. This signal 59 is preferably in the form of a small incandescent lamp and is included in a local circuit that is established by the armature of the magnet 55, which effects the closure of the switch parts 60 and 61, constituting terminals of the circuit, including the lamp 59. The operator at the board B in response to the signal presented by the device 59 inserts a plug 27 into the jack 39, thereby momentarily establishing a local circuit that includes the tip of the inserted plug, the supervisory circuit 33, the armature of the magnet 34, the battery 13, the helix 58, and the short-line spring of the jack 39 in engagement with the said tip. The momentary closure of the circuit causes an increase in the strength of the magnetism due to the winding 58 over that produced by the winding 53, whereupon the armature of the relay 54 is attracted, moving the contact spring 62 from its normal contact anvil, thereby opening the circuit including the helix 53. By the disconnection between the spring 62 and its normal contact anvil the magnet 55 is thrown out of circuit, restoring the signal 59. The spring 62 when elevated engages its alternate contact anvil, thereby effecting a direct-connection between the primary 50 and the long-line spring of the spring-jack 39, thus placing the third section of the trunk line in condition to afford telephonic communication between the calling and called subscribers. The condensers 40 and 49 prevent the short-circuiting of the batteries 13 and 13, which would otherwise take place if the second section of the trunk line were placed in a metallically closed circuit. The condenser 49 by furnishing sufficient impedance to the low-frequency calling current serves to permit the passage of sufficient current from the calling generator 29 at the board B (assuming now that subscriber No. 120 is the calling subscriber and that the operator at the A board is to be signaled) to effect the operation of the drop 42. This signaling current may be traced from one terminal of the generator 29 to the tip of the plug 27, inserted within the jack 39, the short-line spring of this jack, the primary 51, the secondary 48, the secondary 46, the said magnet 42, the condenser 40, the secondary 45, the secondary 47 and the primary 50, the long-line spring of the spring-jack 39, the sleeve of the inserted plug 27 to the remaining terminal of the generator. The condenser 49 taking the place of a metallic continuation of the second section of the trunk line prevents the current from the generator 29 at the exchange B from being short-circuited, forcing the same through magnet 42.

It is well known that electric conductor mouldings as usually constructed are provided with longitudinally extending grooves, together with a cover strip which is fastened to the moulding after

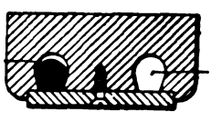

FIG. 1.—MOULDING CLEAT.

the conductors have been seated in the grooves. In practice it is difficult to place the conductors in the grooves and retain them until the application of the cover strip. This is especially true when the mouldings are employed on ceilings, the tendency being for the conductors

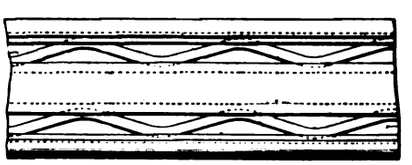

FIG. 2.—MOULDING CLEAT.

to drop out of the grooves before the workman completes the insertion throughout the length of the strip. Mr. Sidney M. Burk, of Philadelphia, Pa., has been granted a patent on a novel construction of moulding, wherein the conductors will be held securely in place. In one form of construction, the grooves in the moulding are dove-tailed, or, in other words, have their inner portions enlarged, as shown in Fig. 1, while the open mouths are contracted so as to be slightly less in width than the diameter of the conductor. Therefore, when such conductor is forced into the groove, it will maintain its position therein. In another form the conductor may be made smaller and twisted or corrugated so that its opposite edges will engage in the enlarged portion of the groove as shown in Fig. 2, and be held by the overhanging walls thereof.

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Reviews of Current Engineering and Scientific Literature.

Electrically Driven Mining Plants.

In this article Mr. G. Hooghwinkel discusses the advantages of electrically operated mining machinery, particularly drills, as compared with compressed air-operated machinery. Compressed air machinery is expensive to lay down and expensive to keep up, and as a medium of transport is most cumbersome and inefficient. The disadvantages of the air drill are deafening noise of the exhaust air, no power to draw back the drill from jambs in the boring hole, large amount of power required (about four times that required with the electrical drill), and large amount of space required. As an advantage, it is sometimes stated that the exhaust air may be used in ventilating the face after an explosion, but the air from several drills is about one-tenth of the amount required for clearing away the smoke of the lamps and dynamite and for a sufficient supply of oxygen, and this amount is supplied at an exaggerated cost. Electrical drills are of the rotating as well as the percussion type. They have none of these disadvantages, but have some qualities which recommend them for such work as quick tunneling and where there is not much room. Their use also permits the use of a few electric lamps in the working face. Drills are operated by one or two-horse-power motors and are about thirty per cent cheaper in first cost than an air drill. The first electric drills were operated by solenoids acting upon an iron core, but these heated rapidly and were unsatisfactory. A successful type of drill now used is operated by means of a motor which drives a crank, the latter transmitting motion to the drill by means of buffer springs. The drills require small power, give variable length of stroke, and are not injured by sudden removal of resistance. The motors can also be used to drive a rotating drill. After firing the shots, the motor may be used to drive a small ventilating fan. The author recommends the use of 120 volts, three-phase current, driving induction motors for this work.—*Abstracted from the Electrician (London), August 28.*

Tests of Electric Traction by Simple Alternating Currents.

A single-phase alternating-current motor for traction purposes is being developed by Dr. Georges Finzi, of the house of Brioschi, Finzi & Company, Milan, Italy. Dr. Finzi has been experimenting with the series motor for use on alternating circuits since 1896 and has built and tested several machines, the latest of which has a capacity of about twenty-five kilowatts. This motor has laminated fields and is supplied with current at 180 volts, eighty cycles per second. Much pains has been expended in overcoming sparking at the commutator, and now this difficulty has been met satisfactorily. The air-gap is relatively large, the field winding has been carefully proportioned to the armature, and resistances are used in the connections of the armature windings to the commutator. This motor has been tested in the shop, and last June on a tramway line six kilometres long at Milan. Current is supplied to the line at 570 volts, and was reduced on the car by means of an autotransformer which also allowed voltage regulation to be used. The car weighed nine tons, and there were grades of 2.7 per cent. The speed was forty-five kilometres per hour. The operation of the car under these conditions is compared with that of a similar car on the same line equipped with the standard direct-current motors, and it is stated that these tests show a higher efficiency for the alternating motor, as compared with the direct-current motor, part of which was due to the voltage regulation which was used with the former equipment. Shop tests of the motor gave characteristics very similar to the direct-current motor. The efficiency varied with the load and voltage applied, and under the best conditions was about seventy-eight per cent at a speed of 600 turns per minute and a voltage of 140. The power-factor is low at low speeds, but increases both with the speed and with the voltage until at 1,200 revolutions per minute and 140 volts it was 0.96.—*Translated and abstracted from L'Industrie Electrique (Paris), August 25.*

Friction Between Iron and Wood.

Wooden brakes on iron wheels are in wide use, particularly in hoisting machinery in mines, but there is such a wide variation in the figure used for the coefficient of resistance in designing this machinery that Professor L. Klein, of Hanover, was requested to investigate the subject. His brake pulleys were driven by a small Pelton wheel worked under a constant head. The diameter of the pulley was 15.75 inches, and the brake locks were attached to a lever, from the end of which weights were suspended. The machine having been carefully calibrated, tests were made of various kinds of wood, by varying the speed, varying the pressure and varying the surface of the brake. As a rule, the wood fibre was parallel to the pulley face, though tests were made both with the grain across the pulley face and with it end on. The brake wheels were of wrought iron and cast iron, both smooth and rough. The braking effect is much smaller with the rough pulley and the values fluctuated more than with the smooth pulley. Rough pulleys wear the wood badly. Beech and oak suffered more than poplar, elm and willow on rough pulleys. The former woods proved more efficient, probably because the charred particles smoothed out the rough spots. Elm, poplar and willow were not charred. Poplar was found to be the best brake block material. It gives high friction and is little sensitive to oil. Carefully finished and cleaned wrought iron is a better pulley material than rough wrought iron or cast iron. It was found that, within limits, the speed and pressure did not affect the friction coefficient. Many hundreds of tests were made, a few of the results of which are given in tables from which the following values are taken: The coefficients of friction on a smooth wiped wrought-iron pulley, with the fibre parallel to the face, were, for beech, 0.53; for oak, 0.51; for poplar, 0.65; for elm, 0.60, and for willow, 0.63. —*Abstracted from Engineering (London), August 21.*

Electrical Resistance of Hydraulic Cement.

Although mortars and cements have a considerable resistance when dry, this property is greatly affected by humidity, so that it is impossible to consider these materials, under ordinary conditions, as insulators. M. R. Feret has carried out some interesting experiments upon the change of resistance of various cement mortars, particularly investigating the change of the resistance with time. The first work was carried out on blocks of cement four centimetres square and sixteen centimetres long. These had been allowed to set for a day after mixing, and had then been kept in water for a number of years. The samples consisted

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of both Portland and Roman cement mixed with various proportions of sand. The blocks were clamped in a frame between plates of copper, and the resistance was determined by means of a high-resistance voltmeter. During the test the samples of cement were placed in an oven and gradually dried. The sample consisting of pure Portland cement after one hour showed a resistance of over 1,000,000 ohms. The other samples showed a lower resistance, but this gradually rose to the figure given, the time required increasing with the increase in the proportion of sand. The samples of Roman cement showed in general a higher resistance and a more gradual change with time. Experiments were then made to determine the change of resistance of samples during setting. For this purpose the various mixtures of cement and sand were placed in small boxes lined with oiled paper and in contact with terminal plates of copper. During the setting process the resistance rose gradually without showing any sudden changes. This work was repeated by pouring the mixtures into glass tubes placed in a vertical position in order to avoid any errors which might be introduced by a layer of water collecting upon the surface of the samples when placed horizontally. In this case the resistance of the various samples changed slightly for a time and then suddenly increased, the curves showing a decided knee. It is suggested that these knees may indicate definite steps in the hardening of cements, and the process of setting may be somewhat analogous to the cooling of steel.—*Translated and abstracted from l'Electricien (Paris), September 5.*

Compensation of Asynchronous Motors.

Mr. H. S. Meyer has here brought together some notes on the advantages and disadvantages of the compensated asynchronous motor, as compared with the simple induction motor. The advantages claimed for the compensated induction motor are unity power-factor at all loads, greater overload capacity and higher all-around efficiency. It is practically impossible to obtain unity power-factor at all loads, because this would necessitate continually shifting the brushes and changing the exciting voltage by hand. While the power-factor curve of the compensated motor is flat, it is not a straight line, and a power-factor of 0.99 means a fourteen per cent wattless current. Although the power-factor is increased by compensation, it is not thought that the advantage gained outweighs all the disadvantages introduced thereby. As regards the greater overload capacity of compensated motors, it must be admitted that the rotor flux, on which the overload capacity is chiefly dependent, will be larger in the compensated motor. However, at overloads leakage will be present and the difference will not be so marked. The advantage of greater overload capacity due to the larger rotor flux would in most practical cases be only apparent, since the output of the motor is almost entirely limited by the efficiency and the heating, and in these points the compensated motor can hardly give increased figures compared with the standard type. It is claimed that compensation allows certain modifications which cheapen the design, such as increasing the air-gap, fewer slots on the motor, and a smaller diameter and greater length of the motor; but the author thinks that these are of only secondary importance. The increase in efficiency due to compensation will be reduced by the commutator losses, both electrical and mechanical. The commutator is thought to be a decided disadvantage, as it will be very difficult in practice to avoid sparking, particularly when starting or in regulating for speed. Reference is made to Heyland's latest recommendation of a device for lifting the brushes off the commutator during starting, and replacing them when running, at the same time lifting the brushes from the slip rings. This suggestion seems to indicate that there is difficulty in starting the compensated motor. In Mr. Meyer's opinion there are hardly any practical cases where the compensated induction motor would be preferable to the ordinary induction motor; and as long as the commutator is not used for improving either the starting conditions or for obtaining a more efficient speed regulation, it will find no field in alternating-current motors.—*Abstracted from the Electrician (London), September 4.*

The Largest Storage Battery in Canada.

In a description of the power plant of the Ottawa (Can.) electric railway, Mr. John Murphy gives some particulars of what is said to be the largest storage battery in Canada. This consists of 288 cells of the Electric Storage Battery Company's latest improved chloride accumulators. The elements of the battery are contained in lead-lined wooden tanks which have been made large enough to permit of a fifty per cent increase in the number of plates and in the output of the battery. Each tank now contains twenty-five type G plates, but there is space in each for thirty-nine plates. The tanks rest upon porcelain insulators supported by well-seasoned pine stringers, water-proofed, and which, in turn, are separated from the concrete floor by vitrified bricks. The maximum discharge and charge rates of the battery are 1,000 amperes and 300 amperes, respectively, enabling the battery to take care of load variations amounting to 1,350 amperes. Before the battery was installed, when the necessity for increasing the plant arose, three propositions were considered: An increase of the present water power installation, the addition of a steam-driven generator, or the battery installation. The latter course was decided upon because it would improve immediately the service by maintaining a constant voltage at the power-house, irrespective of load changes, and for the further reason that it would prolong the life of the hydraulic plant, not only by relieving the water-wheels and gates from jars caused by sudden variations in load, but because it would also act as an addition to the plant, as it can be charged during hours of light load and discharged during the peak hours. Up to the time the battery was installed the water-wheels and the generator voltage had been controlled by hand, but not with entire satisfaction. When the battery was installed the voltage was increased from 550 to 600, and it now remains constant, irrespective of the conditions of the load. The batteries are charged by a differentially wound motor-driven booster which maintains a constant load on the generator. The water-wheel gates are not moved at all for speed regulation, but are set so as to make the generator carry the average load.—*Abstracted from the Canadian Electrical News (Toronto), September.*

Speaking Flames.

Some time ago Simon, Duddell and others exhibited electric arcs which could speak or act as telephone receivers when they were properly connected to a microphone. Now two Russians show how to make an ordinary flame speak. Wires from poles of the secondary circuit of an induction coil are led to insulated Bunsen burners, paraffin lamps, or short candle ends. A microphone and battery are placed in a shunt to the primary circuit of the coil. On speaking to the microphone the flame repeats the sound, although it is thirty yards from the microphone. The effect is better when two flames are employed, a pole of the secondary coil being connected to each and a third wire connecting the two flames.

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NOTE ON SOME THEORETICAL CONSIDERATIONS IN THE CONSTRUCTION OF RESISTANCE FURNACES.[1]

BY FRANCIS A. J. FITZGERALD.

Electric furnaces are usually divided into two great classes—arc furnaces and resistance furnaces. The latter class may be divided into two sub-classes—furnaces in which the current passes through the whole charge and those in which the current passes along a definite path or paths, thus localizing the heat. It is to the latter type that this paper will chiefly apply, although some reference may be made to the former. An apology for this paper seems necessary, since to those who have done much work of this kind the considerations presented will appear to be obvious and elementary. But it is believed that those who have had little experience in the construction of furnaces may find here some suggestions that will be of assistance in furnace design.

Of the various electric furnaces that have been developed, those due to Mr. E. G. Acheson present unusual interest, because they cover a considerable range of temperature and involve certain conditions as to accurate temperature regulation.

Graphite Furnace—In this furnace the highest temperature attainable is desired. The carbonaceous material, anthracite coal, coke, etc., is placed in a trough-like furnace, and through the centre of the charge is a series of carbon rods connecting the furnace terminals. Anthracite coal, the raw material usually employed, is practically a non-conductor of electricity, and at first the current passes through the core of carbon rods. The heat generated in the core converts the surrounding coal into graphite, which then becomes a conductor and heats another layer of coal, and so on till the process is complete. This furnace belongs to both sub-classes of the resistance type.

Electrode Furnace—The furnace belongs to the first sub-class, but is peculiar in that the heat is mainly generated outside the article under treatment. In the most general case the electrodes to be converted into graphite are arranged in piles, and the spaces between the latter filled with granular carbon. Since the resistivity of the granular carbon mass is much greater than that of the electrodes, most of the heat energy will be developed in the former. The advantage of this type of furnace is that it permits of treating a large mass of low-resistance material without using currents of excessive amperage.

Carborundum Furnace—Carborundum is a substance that is decomposed at the temperature of the graphite furnace, hence in its manufacture careful temperature regulation is necessary. The charge, consisting of sand and coke, in the form of powder, is put in the box-like furnace, and through its centre passes a conducting core, which may consist of carbon in a granular form, or of carbon rods, connecting the terminals of the furnace. The current is confined to the core, raising it to a high temperature, and the heat generated is conducted into the surrounding mixture, converting it into carborundum. If the temperature of the furnace is too high, the carborundum is decomposed and the silicon vaporized.

Furnaces for Moderately High Temperatures—This is the latest of Acheson's patents, and is of great interest. In the outer zone of the carborundum furnace, just outside the crystalline silicon carbide, is a thin layer of an amorphous substance, known as "white stuff." It is an intermediate product in the formation of carborundum, and the temperatures between which it is formed and decomposed apparently lie near one another. For this reason its manufacture, or that of like compounds, involves serious difficulties, and it was to overcome these that Acheson invented this furnace. The furnace is of the same general form as that used in the manufacture of carborundum, but it contains several cores, which are "definitely spaced with relation to each other at distances largely determined by the heat conductivity of the charge, the duration of the operation and the superior and inferior temperature limits of the operation."[1]

In all of the furnaces described above there is one common characteristic—the electrical resistance is a variable quantity, and after any furnace is started there are no means of adjusting internal conditions so as to effect regulation in this respect. In general, the resistance of these furnaces is high at the beginning of a run and low at the end; therefore, means of varying the voltage at the furnace terminals must be used. If the furnace resistance at the beginning of a run is R, at the end of the run r, the maximum voltage attainable E, the minimum voltage e and the maximum watts W, then the following equations must hold:

$$R = \frac{E^2}{W} \qquad (1)$$

$$r < \frac{e^2}{W} \qquad (2)$$

The application of these equations to the various furnaces considered is obvious. The resistance of the furnace may be varied by altering the dimensions of the core or that part of the furnace which acts as an electrical conductor. Later we shall see that there are limits to the variations that can be made in this respect on account of other considerations; but the resistivity of a mass of carbon granules varies with the size of the latter, and further variation may be obtained by the judicious choice of different forms of carbon, which themselves have different resistivities. By taking advantage of this, any desirable variations in the resistance of the furnace may be obtained. The case of the electrode furnace is a special one, the adjusting of the resistance being obtained, to a certain extent, by the spacing between the piles of electrodes.

If a cylinder is kept at a constant temperature, θ_1, and is surrounded by a heat-conducting material, then the quantity of heat, Q, passing from the cylinder into the surrounding material per second is given by the equation

$$Q = 2\pi\rho_1 LK(\theta_1 - \theta_2)$$

where ρ_1 is the radius of the cylinder, L its length, θ_2 the temperature of the surface of the material in contact with the cylinder and K is a constant. Then

$$\theta_1 - \theta_2 = \frac{Q}{2\pi\rho_1 LK}$$

Now, if θ_2 is a constant and a certain quantity of heat, Q, is developed in the cylinder, then, in order that θ_1 may be kept constant, $\rho_1 L$ must have a definite value. If the cylinder is a conductor heated by a current of W watts, then

$$\frac{W}{\rho_1 L} = \text{constant} \qquad (3)$$

If the material surrounding the cylinder is in the form of a second cylinder, coaxial with the first, then if ρ_2 is the radius of the second cylinder, K[1] the heat conductivity of the material of which it is composed and θ_3 the temperature of its outer surface, it may be shown[1] that

$$Q = \frac{2\pi LK^1(\theta_2 - \theta_3)}{\log\frac{\rho_2}{\rho_1}} \qquad (4)$$

Next let it be assumed that the outer cylinder is surrounded by a material hav-

[1] A paper read at the fourth general meeting of the American Electrochemical Society, Niagara Falls, N. Y., September 17, 1903.

[1] United States patent 738,631, March 24, 1903.

[1] In this case the isothermal surfaces about the cylinder are a series of coaxial cylinders, and the lines of flow of the heat form tubes of flow having the shape of wedges, with their edges lying parallel to the axis of the cylinder. Planes parallel to the axis of the cylinder will cut off from the wedges rectangles of equal length, having widths proportional to their distances from the axis; therefore, the heat passing through unit area of the rectangles will be inversely proportional to their dis-

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ing a heat conductivity k, and that a certain amount of heat is absorbed at the outer surface of the cylinder, then applying equation (4) to an isothermal surface, outside the cylinder, having a temperature θ_4 and a radius ρ_3, the quantity of heat passing from the cylinder to the isothermal surface per second is

$$q = \frac{2\pi L k (\theta_3 - \theta_4)}{\log \frac{\rho_3}{\rho_2}}$$

or if $\rho_3 - \rho_2 = t$, and t is very small,

$$q = 2\pi L k (\theta_3 - \theta_4) \frac{\rho_2}{t} \qquad (5)$$

In using the results obtained from these calculations, it must be remembered that they only apply approximately, representing as they do hypothetical conditions and involving various assumptions that are not rigorously correct. Keeping this in mind, the various furnaces described may be considered.

Graphite Furnace—The furnace having been designed so as to fulfil the conditions of equations (1) and (2), it remains only to apply equation (5). The heat developed in the furnace is used in various ways—in raising the temperature of the furnace charge; in effecting chemical changes; in vaporizing substances other than carbon; in supplying heat lost by radiation. With the exception of the last, all these items represent useful work. The last item is represented in equation (5), and, leaving all other losses out of consideration, the efficiency of the furnace is given by the equation

$$\text{Efficiency} = \frac{Q - q}{Q} \qquad (6)$$

In order, therefore, to make q as small as possible, K and $\theta_3 - \theta_4$ should be small. The important point to observe, however, is that a furnace may be made indefinitely large so far as equations (1) and (2) are concerned, but equation (5) sets a limit, since q varies directly as the product of L and ρ_2.

Electrode Furnace—The equations apply to this furnace in a similar way to the previous one.

Carborundum Furnace—Applying equation (4): ρ_1 is the radius of the core, or the inside of the carborundum cylinder, θ_2 the temperature of that surface, ρ_2 the radius and θ_3 the temperature of the outside surface of the carborundum cylinder, while K^1 is the conductivity of the crystalline mass. The equation may be written

$$\log \frac{\rho_2}{\rho_1} = \frac{2\pi LK^1 (\theta_2 - \theta_3)}{Q}$$

In order, therefore, to make the maximum amount of carborundum around the core, K^1 must be as great as possible. This can be best accomplished by having the mixture surrounding the core of high density, for then the crystal mass formed will also be dense. $\theta_2 - \theta_3$ should also be as large as possible, but θ_3 is a constant, the temperature just below that of the formation of carborundum; therefore, θ_2 should be as large as possible. But θ_2 can not be indefinitely increased, for above a certain temperature carborundum is decomposed. Hence equation (3) applies here, for the value of ρ_1 L must be such that the core temperature shall be just less than that which will ensure the decomposition of carborundum.

Finally, in considering the outside of the carborundum cylinder, equation (5) is used. As before, k and $\theta_3 - \theta_4$ must be kept as small as possible. Nothing can be done to diminish k, as the material outside the carborundum must of necessity consist of the mixture of sand and coke. Fortunately, the mixture has a very low heat conductivity. $\theta_3 - \theta_4$, however, may be kept small by leaving a good thickness of unchanged mixture outside the carborundum. It will be observed that since the value of ρ_2 increases with the length of the run, a point will finally be reached where q is equal to Q in equation (6); or, in other words, the efficiency of the furnace continually diminishes as the length of the run increases, and a point is at length reached where no more carborundum is made. In order to work efficiently, the run must be stopped long before that point is reached.

Furnaces for Moderately High Temperatures—Here the conditions are similar to those in the carborundum furnace, but more complicated, as there is a multiplicity of cores. However, the theoretical considerations that have been discussed will still prove useful in giving a general idea of the furnace design.

In no case that has been considered can the various fundamental equations be rigorously applied, for, as has been pointed out already, these involve numerous assumptions that do not represent the actual conditions, and take no account of certain conditions that are invariably present. Nevertheless, it will be found that keeping the theoretical considerations in view is a great help in the building of furnaces, and prevents waste of time in experimenting with designs that can not possibly be satisfactory.

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tances from the axis. The equation from the flow of heat is

$$\frac{d\theta}{d\rho} = \frac{a}{\rho}$$

where a is a constant; hence

$$\theta = -a \log \rho + b$$

then at the inner and outer surfaces of the second cylinder

$$\theta_2 = -a \log \rho_1 + b$$
$$\theta_3 = -a \log \rho_2 + b$$

so that

$$a = \frac{\theta_2 - \theta_3}{\log \frac{\rho_2}{\rho_1}}$$

The quantity of heat passing through the cylinder per second is

$$Q = -2\pi\rho LK^1 \frac{d\theta}{d\rho}$$
$$= 2\pi LK^1 a$$
$$= \frac{2\pi LK^1 (\theta_2 - \theta_3)}{\log \frac{\rho_2}{\rho_1}}$$

American Institute of Electrical Engineers.

The September announcement of the American Institute of Electrical Engineers contains an attractive programme for the first meeting of the fall session, Friday, September 25. The following papers are announced.

"An Efficient High-Pressure Water Power Transmission Plant," by George J. Henry, Jr., associate, engineer Pelton Water Wheel Company, and Joseph N. Le Conte, associate, instructor of mechanical engineering University of California.

"Electric Motors for Centrifugal Pumps and Fans," by August J. Bowie, Jr., associate, engineer electric department Union Iron Works, San Francisco, Cal.

"A Suggested Hydraulic Unit," by Ralph L. Montagu, associate, consulting engineer, Oroville, Cal.

The new meeting place of the Institute is the New York Academy of Medicine, 17 West Forty-third street.

Railroad Employes' Carnival.

The employés of the Brooklyn Rapid Transit Company held their annual seaside outing at Luna Park, Coney Island, this year, on September 14, 15, 16, 17 and 18. The returns from the sale of tickets for this outing go into the treasury of the employés' association which gives relief to the members or families of members who may be in distress. The management of Luna Park, Messrs. Thompson & Dundy, inaugurated a series of additional attractions on Labor Day, September 7, and these were thoroughly enjoyed by the participants in the railroad employés outing.

Luna Park has become renowned for the extent and variety of its attractions. The use of electricity is one of the most significant features of this collection of entertainments. The park covers twenty-two acres and cost $1,500,000. There are 224,000 incandescent electric lamps used, and the current for these is supplied by the Brooklyn Edison Company from the regular service mains. The park is scheduled to close on October 1. At present and up to the closing of the park a series of Indian summer carnivals will be undertaken.

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Fourth General Meeting of the American Electrochemical Society.

THE fourth general meeting of the American Electrochemical Society was held at Niagara Falls, N. Y., September 17, 18 and 19. The meeting was well attended, there being 136 members and guests registered. The weather for the first day was exceedingly disagreeable, making traveling uncomfortable, but the remainder of the week was bright and cool.

The meeting of the board of directors was held at nine o'clock on Thursday, September 17, and the general meeting of the society was called to order by President Richards in the auditorium of the Cataract House at 10.30 A. M. In opening the meeting, President Richards spoke of the successful year the society had had, stating that there were now 600 members, thirty-five having been elected during the month. The report of the treasurer showed that the treasury was in a flourishing condition, having a surplus of $2,000. President Richards also stated that the executive committee had arranged with the Faraday Society, of England, for an exchange of transactions. The members of the American Electrochemical Society will receive free of cost the monthly issues of the *Electrochemist and Metallurgist,* and in return the members of the Faraday Society will receive the yearly transactions of the American Electrochemical Society free. Although this will entail considerable expense upon the society, there will be no increase in dues. It was further announced that the board of directors had taken action authorizing the establishment of local sections, at which monthly meetings may be held. Regulations governing the organization of these sections will be drawn up. The first application for a local section was made on behalf of the University of Wisconsin by Professor C. F. Burgess, the second application being made by the New York members for a section in New York city.

Mr. F. A. J. Fitzgerald, of Niagara Falls, N. Y., was then called upon for his paper on "Some Theoretical Considerations of Resistance Furnaces." This paper will be found in full on other pages of this issue. Mr. Fitzgerald described the several types of electric furnace and presented formulæ for calculating the design of any of these when the constants of the material used are known.

The discussion was opened by Professor C. F. Burgess, of the University of Wisconsin, Madison, Wis., who asked what the power-factor of these large furnaces is.

In reply, Mr. Fitzgerald said that, in general, the power-factor is not unity, due to the very heavy currents used and the inductance of the leading-in cables and bus-bars.

Mr. Alfred H. Cowles, of Cleveland, Ohio, asked whether in the use of these furnaces a suboxide of silicon had ever been identified. He said that in 1885 he was working with an experimental furnace and made carborundum. He noticed that a yellow substance was formed beyond the carborundum crystals, and thinking it might be a suboxide of silicon, he submitted some to an analyst, who advised him that this was the case.

Mr. Fitzgerald said that he had many analyses of the "white stuff" formed in the carborundum furnace, but had never found the suboxide of silicon.

In reply to a question regarding the units and constants of his equations, Mr. Fitzgerald replied that the equations he had worked out were not applied except roughly; that they were intended merely as guides in the construction of furnaces, and did not have much value except in a relative way. In working out these equations too many points had necessarily been omitted.

Mr. Cowles asked whether in the carborundum furnace the carborundum itself conducted. He had made an experiment to determine this, constructing a furnace in which the bottom could be dropped out, carrying with it the graphite core. The furnace was put into action, and after the current had been passing for some time the bottom was drawn out with the graphite core, but the current taken by the furnace fell only one-third. This seemed to him to show that the carborundum conducted. He had also fused carborundum by passing a current through it.

Mr. Fitzgerald thought that carborundum was practically a non-conductor. In constructing this furnace the core is built up of granular carbon which changes throughout the process, the resistance varying with it. However, carborundum will conduct when hot.

Professor C. F. Burgess stated that he had made some conductivity measurements of carborundum, and had found it to be a poor conductor compared with carbon.

Mr. Marcus Ruthenburg, of Philadelphia, Pa., then read his paper entitled "Advances in Electrometallurgy of Iron Production." At the last meeting of the society he had presented a paper upon the electrometallurgy of iron, and the figures which he then gave for the power consumption had been criticised both in the discussion and by the technical press. The paper now presented was to give further figures showing what had been accomplished. While the blast furnace was a highly economical device for accomplishing its end, some classes of ore may now be more cheaply reduced to metal by other means, making a product whose analysis can not be produced in a blast furnace at all. Given a magnetic ore carrying gangue, silver and phosphorus in prohibitive quantity for making good steel economically, such ores find no market tributary to the blast furnace.

In last year's paper he made the assertion that "the work of the electric furnace was performed upon a ton of ore with something less than 500 kilowatt-hours of energy."

Upon this basis one of the members accorded him an efficiency of eighty-three per cent, which he followed up by saying it was impossible. In truth at that time he was doing ten per cent better than that, or an efficiency, according to his figures, of 91.3 per cent. To-day he is doing the same, but better work, with one-half the kilowatt-hours reported last year. Three problems have presented themselves for solution, in the conduct of his work; first, the power required to agglomerate and heat sufficiently for subsequent reduction; second, the regulation of the size of the agglomerated particles; and third, the amount of reduction of the agglomerated material.

The status of those three problems today is that a ton of ore is being agglomerated with an expenditure of about 250 kilowatt-hours.

The size of the product is under perfect control.

The reduction is being made absolute. Inasmuch as the only function of the electric current is to agglomerate the dusty particles into coherent masses without binder or flux, and to convey a sufficient quantity of heat to the ore in the soaking pit, to permit the reducing agents to perform their functions, it will be readily comprehended that the heat and current losses due to maintaining a molten mass are lacking.

In reply to the question of Mr. C. J. Reed, as to the basis for calculations of

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efficiency, Mr. Ruthenburg stated that he makes no calculations of efficiency. He knows the power taken and the cost, he uses electrical measuring instruments, and his recording wattmeter gives him at any time the energy taken by the furnace. The iron ore, after it leaves the rolls, where it is fused, is reduced by hot carbon monoxide at a comparatively low temperature. He stated further that he uses only magnetic ore containing a small amount of sulphur, which is practically all eliminated. The phosphorus is removed in a magnetic concentrator. He gets with this process a ninety-two per cent reduction. The reduction is made in a magnetic field, the magnets being covered with carbon to prevent the ore welding to them. The ore, after being fused, falls into the soaking pit with not more than five per cent of the oxide present, which is eliminated by the carbon monoxide. The sulphur is eliminated by mixing a proper proportion of the sulphides with the oxides. The sulphur reacts with the oxygen, forming sulphur dioxide, atmospheric oxygen not being used. The reaction takes place purely between the two salts of iron.

Mr. Cowles said that the same reaction takes place with lead, sulphur being eliminated in this way. He had examined Mr. Ruthenburg's furnace and he thought that the temperature of the material in the soaking pit was a little higher than that of molten copper. As copper melts at about 1,100 degrees centigrade, Mr. Cowles put the temperature of the material in the soaking pit at 1,200 degrees centigrade.

Replying to a question of Mr. F. M. Beckett, of Niagara Falls, Mr. Ruthenburg said that the sulphur is not eliminated by his process when carbon is present. It is very essential to maintain a correct temperature if the reaction is to be successful. Mr. Beckett said that he had done much experimental work on an electric furnace for producing iron, but it had not been able to eliminate the sulphur. He worked up to 2,000 degrees centigrade, and had come to the conclusion that the reaction mentioned above does not take place.

Mr. Ruthenburg stated that he was producing metallic iron by his process, free of sulphur—that is to say, that the sulphur did not show upon test.

President Richards explained that Mr. Ruthenburg was working with magnetic ore which contains little sulphur. He said that his calculation of the efficiency of the Ruthenburg furnace had been based upon an assumption of a higher temperature. If the temperature given by Mr. Cowles is correct, the efficiency, as calculated, would have to be reduced in proportion. The process may be successful as now proposed, but it can hardly be used as a preparation for the blast furnace.

Mr. Ruthenburg stated that he still contemplated the application of his process as a preliminary treatment for certain ores which will warrant the expense. The cost at present is about sixty-two and one-half cents per ton, and this can be borne in sections where coal is cheap.

President Richards stated that the electric furnace would have a large place in the metallurgy of iron and steel in the future. When processes have been developed, this will probably be the largest branch of metallurgy.

Professor C. F. Burgess then presented a paper entitled "The Practical Utilization of the Passive State of Iron," an abstract of which will be found on another page of this issue. The first session then adjourned.

During the afternoon visits were made to the power-houses and certain electrochemical plants. The Niagara research laboratories were thrown open to the society. The present building is being fitted up with appliances for all kinds of electrochemical and electrometallurgical work. Companies or individuals who desire to carry out research along electrochemical lines will be able to rent space and power, and use the machinery which is being installed.

The works of the Electric Lead Reduction Company were also visited, and the new type of cell, which was later described by the inventor, Dr. P. J. Salom, was shown in operation.

In the evening a very enjoyable smoker was held under the auspices of the local committee at the Cataract House, at which an excellent musical programme was rendered.

FRIDAY, SEPTEMBER 18.

Friday morning the second session was called to order by President Richards at 10 o'clock.

Mr. Ivar Juel Moltke-Hansen, of Perth Amboy, N. J., presented a paper entitled "An Experiment in the Electrolytic Determination of the Basicity of Acids." Electrolytic methods of determining the basicity of acids are of the highest value in many cases where complex acids of doubtful basicity are in question. The author has applied the electrolytic method to the different metaphosphoric acids. The method used in making the conductivity measurements is due to Kohlrausch, in which a Wheatstone bridge is made use of, but an alternating current and a telephone replace the usual battery and galvanometer. In carrying out the work it was found that the conductivity of the water influenced the results considerably, so that it was necessary to make up a solution from one sample of water and use this throughout the entire work. Solutions of various percentages were prepared and their conductivities measured. These determinations of the conductivity of the solutions show the acid to be dimetaphosphotic acid, according to Ostwald's law, and that it has the following formula:

$$(NH_4PO_3)_2\,2H_2O$$

Work has also been started to determine the rapidity of the migration of the ions for this salt, but these determinations have not yet been completed.

A paper was presented by Dr. W. H. Walker, of Boston, Mass., entitled "The Electrometallurgy of Gold." Dr. Walker first sketched briefly the various electrolytic methods which have been developed for the extraction of gold from its ores. While these processes are in use in various places, none of them has been eminently successful, principally because it is necessary to handle large quantities of ore. In all of these the gold is first dissolved in a solution—usually potassium cyanide—and is then deposited on another metal. While carrying out some experimental work on these methods, an apparatus was set up in which the ore was laid on a plate of aluminum, and the cathode plate suspended above it in solution. It happened that the connections became reversed, so that the lower plate carrying the ore became the cathode. When this was discovered and the plate examined, it was found that gold in the metallic form had been precipitated upon the aluminum plate, presumably by cathodic reduction. Further work along this line showed that it was possible to precipitate the gold in this way on various metals, and plates were shown on which the metallic gold could be seen clearly. The action was thought to be a reduction of the telluride of gold by means of the hydrogen set free at the cathode. The author stated that, although successful as a laboratory experiment, this method could not be applied commercially because in it it is essential that every particle of gold ore be brought into intimate contact with the cathode plate.

A paper was presented by Dr. Wilder D. Bancroft, of Cornell University, Ithaca, N. Y., entitled "Electrolytic Copper Refining," this being illustrated

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by lantern slides. An abstract of Dr. Bancroft's paper will be found on another page of this issue. Dr. Bancroft describes a long series of experiments undertaken to determine the best conditions of electrolyte and current density for use in copper refining processes. The result of this work indicates that in order to operate a plant most economically copper should be refined electrolytically in covered tanks with a current of three and one-half amperes per square decimetre at a temperature of seventy degrees Fahrenheit.

A communication to the discussion of this paper from Mr. Lawrence Addicks, of Perth Amboy, N. J., was read by President Richards. According to Mr. Addicks, Dr. Bancroft has not considered all the effects which enter into copper refining. While good adherent copper can be obtained at almost any density, if the rate of circulation is sufficient, in the latter point we are limited to a slow rate of circulation; otherwise a turbid solution results. Insufficient circulation means poor deposition and necessitates frequent renewal of cathode sheets to maintain the current efficient, and entails a corresponding increase in labor cost. The Anaconda plant, with a density of ten and one-half amperes per square foot, draws copper every thirty-five days; the Great Falls plant, with forty amperes per square foot, every two days. He thought that Dr. Bancroft should have considered the labor cost. He had compared the figures given by him for the influence of differences of concentration in producing counter-electromotive force, and found that these agreed very satisfactorily with the figures obtained on a large scale. The work on temperature coefficients is very complete. He thought that recommendations regarding covering the tanks would not meet with much favor, as it is difficult, even with open tanks, to obtain thorough inspection. The application of covering would be simpler in the case of series tanks than for multiple. In making calculations of cost the question of interest on the metals tied up arises. Many refineries are not charged with this interest at all, the owner of the copper allowing so many days gratis for the refining; but every refiner is charged with interest and depreciation on his plant, and figures for this were not taken into account. These changes, he thought, would revolutionize the cost tables. While Dr. Bancroft has furnished some valuable data, and for some refineries his conclusions are true, Mr. Addicks protested against their application to every plant that can obtain power for $20 a horse-power-year, and raised the question of how many refineries are obtaining power for that figure.

A communication was received from Mr. Benjamin Magnus, of Anaconda, Mont., and was read by President Richards. Mr. Magnus's experience has been that the ampere efficiency depends entirely upon mechanical conditions. If the tank is kept free of most local short-circuits, it is easy to attain a desirable maximum ampere efficiency. A good efficiency in practice is ninety-five per cent, and while he has succeeded in raising it to ninety-seven and one-half, the extra labor was not saved by the extra saving in power. Dr. Bancroft states that the solution deteriorates more rapidly at the higher temperature and at the lower current densities. This Mr. Addicks has found to be true for high temperatures, but not for low current densities. At Anaconda, where the current density is low, they have been using the same electrolyte continuously for many years. At other plants where the current density is sixty per cent higher, it is found necessary to renew part of the electrolyte quite frequently. He questioned whether the green color of the solution was due to the presence of ferrous arsenate, as stated by Dr. Bancroft, and was more inclined to attribute it to an impoverishing of the solution. High current densities cut down the interest on copper tied up and the cost on investment for plant. Although Dr. Bancroft states that the number of men employed does not vary with the current density, as a matter of fact, plants having high current densities usually have higher labor costs per ton of copper. In regard to using covered tanks, a casual inspection would soon convince a visitor of the objection to this practice. The communication concludes with a statment of the conditions at the Anaconda refinery. The current density is 10.5 amperes per square foot, the temperature of the electrolyte is 100 degrees Fahrenheit and the circulation of the electrolyte is three gallons per minute. Under these conditions the chemical action in the tank is one per cent greater than the electrolytic action, and the voltage per tank is 0.23 volt. In order to keep the solution constant day by day, the extra copper taken up by the solution, due to the one per cent greater chemical action, is taken out by means of a tank which has insoluble anodes. The cost of operating this tank is at least eight times the cost of operating a regular depositing tank. (The voltage being two.) Most electrolytic plants use exhaust steam for heating the electrolyte, but even if they used live steam, which cost $80 per horse-power-year, the cost of heating the electrolyte per ton of copper produced would only be from sixteen to thirty-five cents; and if they raised the temperature of their solution to seventy degrees centigrade and raised the current density to 31.5 amperes, the excess chemical action would be so great that to free the electrolyte from copper, by means of tanks having insoluble anodes, would cost so much that the saving of power due to warmer solutions would be more than offset.

Mr. W. McA. Johnson described some work which he had carried out on nickel, similar to that of Dr. Bancroft. He thought that the change in resistance mentioned in the paper was due to the deposit of slime on the anode cells, as well as to the change in concentration. To prevent an uneven deposit on the cathode he had found that a vertical plate of slate, placed against the bottom of the cathode, was very effective. The return of scrap copper is not a linear function of the current density, but increases rapidly. This might more than make up for the saving due to high current density. The regeneration of the electrolyte also increases at a greater rate than the current density. He suggested that the research be extended to an examination into the behavior of the impurities contained in the anodes.

Replying to the discussion, Dr. Bancroft said that he did not agree with Mr. Addicks that it was impossible to get pure copper at a high current density. "The Anaconda copper is supposed to be good." Mr. Addicks says interest is not to be charged, while Mr. Magnus thinks it is. An analysis of the solution showed the presence of both arsenic and iron, though he would not claim that the two were in combination. He did not think that regeneration at seventy degrees would cost more than at fifty degrees, the temperature now in general use; nor does the depreciation of the plant figure largely. He had found that the increase of resistance due to the slimes on the anode was smaller than he had anticipated. It was found that the conductivity of the solution could be brought back to the normal by adding acid. As regards the feasibility of using covers on the tank, it is merely a question of whether the saving was worth while. At sixty degrees a saving of thirty-seven per cent could be effected, while at fifty degrees a saving of fifty per cent could be effected by adding covers, no other change being required.

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A paper by Oliver W. Brown, of the University of Wisconsin, Madison, Wis., entitled "The Efficiency of the Nickle-Plating Tank," was read by Mr. Johnson. An ideal electroplating cell is one which operates at a current efficiency of one hundred per cent, has a low resistance, and which requires but a low electromotive force. With a current efficiency of one hundred per cent no change in the condition of the electrolyte will occur. The nickel-plating cell, as at present used, is notably inefficient when viewed from this standpoint. To operate a nickel-plating cell at maximum efficiency, the electromotive force required to send a current through would be only that necessary to overcome the resistance of the electrolyte. There is, however, a counter-electromotive force amounting in some cases to over two volts. The author described a series of experiments which he had carried out with a view of determining the variation of the counter-electromotive force, using for this purpose a slightly acid nickel ammonia sulphate solution. From the results of the work it is shown that satisfactory operation of a nickel-plating solution depends to a large extent upon the character of the anode employed. The presence of copper is advantageous to a certain extent, and it is likely that certain other impurities may assist. Rolled nickel or electrolytic nickel anodes are unsatisfactory. A study of the total polarization pressure, while not as definite in the indications as a study of the individual electromotive forces at the electrolyte, will serve as a means for determining whether the cell is operating properly. When the polarization goes much above 0.75 volt, the assumption that the anode is not corroding properly is justified, and, on the other hand, if the polarization is below 0.70 volt, the efficiency at the anode is as high as can be obtained. For measuring this polarization a voltmeter only is needed, readings being taken while the current is flowing and immediately after opening the circuit.

Discussing this paper, Mr. Johnson doubted if the ordinary plater would be willing to install the expensive apparatus necessary for measuring single electrode potentials. He thought that not enough analyses of the electrolyte had been made in the work described.

Professor C. F. Burgess said that while analytical data was desirable, time had not been available for obtaining this, and, moreover, it was beyond the scope of the paper. As to measuring the electrode potentials, all that was necessary was a calomel cell and a capillary potentiometer, neither of which was expensive nor too delicate for practical use.

President Richards suggested that the impurities might be of assistance in keeping the percentage of nickel in solution up to normal on account of the local action. In this suggestion Mr. Rudolf Gahl did not agree.

Dr. Pedro G. Salom, of Philadelphia, Pa., described the new type of electrolytic cell. In a previous paper he had described his cathodic reduction process for obtaining lead from galena and the cell developed for this purpose. With the old type of cell 10,000 units would have been required for an output of ten tons per day. To overcome the disadvantages of this cell—which were, of course, the small output for the large capital outlay and space required—he had developed a new type of cell which was described and illustrated. In the old type of cell a current density of twelve amperes per square foot had been used. In the new type, by spreading the ore in a very thin layer, he was able to increase the current density to thirty amperes per square foot, and he hoped soon to reach sixty without reducing the efficiency, which he said was now sixty per cent. The time of treatment has been reduced from five days to an hour and a half. The new cell, which measures four and one-half feet, consists of a flat circular dish of lead; which composes the cathode. This is revolved by means of a pawl and ratchet, making one complete revolution in an hour and a half. Above this are suspended the anodes, consisting of horizontal flat bars arranged in a series of compartments, the number of bars being greatest at that part of the cell where the ore enters, and lowest where the treatment is completed. The ore is fed in at present by hand, and is carried by the motion of the cathode slowly around under the anode bars. The electrolyte is sulphuric acid. Hydrogen sulphide is given off, and this is caught and converted into sulphuric acid. The lead sponge is taken out after it has completed the run. It is then washed to remove impurities. At present the sponge is being roasted to convert it into lead oxide. After roasting it is ground and dried and is then ready for the market. The present equipment consists of seventeen cells in one row. In the complete equipment there will be thirty-four cells in each unit. One hundred cells will have a capacity of ten tons per day. Samples of the products of the process were exhibited. These included sponge lead, sulphuric acid, oxides of lead, and chrome yellow.

A paper by Dr. C. Hambuechen, entitled "The Electrolysis of Sodium Hydroxide by Alternating Current," was read by Professor C. F. Burgess. It is well known that aluminum in certain solutions possesses to a marked degree the property of readily permitting the passage of current toward it, and interposing a higher resistance to the flow of current in the opposite direction. This property has been made use of in an electrolytic rectifier, using aluminum and iron electrodes in fused sodium nitrate. It was found also that aluminum could be used in a like manner in various other fused electrolytes, one of which is sodium hydroxide. While aluminum is actively corroded by sodium hydroxide in the presence of water, it is almost completely stable in contact with the fused salt. Advantage has been taken of this property of aluminum to make use of alternating currents for the production of metallic sodium from fused caustic soda. Salt is fused in an aluminum vessel. Within this is placed an aluminum electrode surrounded by an iron electrode. Between the two is a diaphragm also of aluminum. This is perforated so as to allow the circulation of the electrolyte and passage of the current. After some time globules of fused sodium appeared on the surface. It was found that careful regulation of the temperature was necessary to produce a large yield, but other than this the cell required no attention. At the end of the run the aluminum electrode showed almost no corrosion. A run was made to determine the amount of corrosion, and it was found that an electrode one and one-half inches long and one-half inch in diameter lost about one-half of a gramme with a run of fifty ampere-hours. Sodium, after being liberated, rose to the surface of the liquid and was prevented from diffusing over to the cathode by means of the aluminum diaphragm. A porcelain sleeve surrounding the aluminum electrode prevented short-circuiting between this and the diaphragm. To determine the effectiveness of the aluminum in preventing the current flowing from it to the electrolyte, current and pressure curves were obtained by means of the Blondel oscillograph. These curves were shown. The portion of the curve below the axis represents a leakage current due possibly to small particles of sodium adhering to the electrode, and to a small leakage which naturally takes place in such a cell. This portion of the curve represents energy loss, unless its heating action is useful in maintaining the cell at the proper temperature. The portion of the curve above the axis represents the useful current. From measurements of these areas the

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efficiency was found to be about seventy-three per cent. The alternating-current electromotive-force wave had a peaked form, but previous measurements showed that a sinusoidal or flatter wave-form gave a higher efficiency. The same method of operating an electrolytic cell might be applied in obtaining various electrolytic products other than sodium. While the current efficiency is less than if a direct current be employed, this loss may be partially balanced through avoiding losses of the synchronous converter, and this loss may be useful in heating the cell.

President Richards then presented a paper prepared by himself and Mr. W. S. Landis, entitled "The Electrolysis of Water." This is the second paper on this subject, the previous one having been presented at the last meeting of the society. The type of cell described in the first paper was very inconvenient due to its great length, but by reducing the cross-section of the cell they have been able to obtain the desired high resistance with a much shorter tube. The cell now used consists of a capillary tube connecting the two vessels in which are placed the platinum electrodes. It was found that the size of the electrodes affected the readings very greatly. When these were small polarization took place rapidly. The area finally adopted was approximately twenty-five square centimetres to each electrode. Solutions of sulphuric acid of various concentrations were measured, the results of measurements being shown in tabular form and in curves. It was found that the current flow followed almost exactly Ohm's law up to three volts, beyond which point the readings were not carried. The resistance of the cell is very high, being about 284,000 ohms for a one-tenth per cent solution. In measuring the current flow, polarization was corrected for by taking the readings at a definite time after closing the circuit. After obtaining the reading the circuit was then opened and the polarization current read after the same time had elapsed as in the first reading. This time was generally seven seconds, as that allowed the instruments to become steady. The sum of these two readings was then taken as the true value, as it was found that this method gave a constant flow, independent of the time elapsing after closing the circuit. Although no gas was given off at the electrodes during this work, gas will be given off at either pole if the electrode there be small, although there may be no gas appearing at the other. It is suggested that this method of measuring resistances might be useful in place of the Kohlrausch method.

After the reading of this paper the meeting was adjourned.

The afternoon was spent in making visits to the various establishments at Niagara Falls, and in the evening a dance and reception were tendered to the visiting members of the society by the local members.

SATURDAY, SEPTEMBER 19.

Saturday morning the third session was called to order by the president at 9.30.

Mr. F. Lidbury, of Niagara Falls, N. Y., presented a paper on "The Supposed Electrolysis of Water Vapor." This described some researches which he had carried out upon the electrolytic action of sparks when passed through a water vapor. The apparatus consisted of an arrangement of glass tubes and the current of vapor was made to pass by means of a condenser. The gases from the neighborhood of the anode and cathode and from the middle of the tube are collected after exploding by means of an electric spark, and a residue of gas was left which corresponded approximately to what should have been produced by a voltameter. The conclusion was reached that in the partial decomposition of water vapor by the electric discharge, the hydrogen and oxygen liberated tend to separate and to take up different positions in the tube, the hydrogen collecting at both anode and cathode and the oxygen in the middle of the tube. In all cases there was a large excess of both hydrogen and oxygen in the discharge tube over that simultaneously obtained from the voltameter. At present there is too little data for the construction of a satisfactory theory to explain the results obtained, but Thomson has brought forth evidence which points to the possibility that a hydrogen ion may carry either a positive or a negative charge. He observed that a capillary tube containing hydrogen, on the passage of a spark, gave spectra at the anode and cathode in which the relative brightness of the lines differ. An assumption of this kind might explain the unexpected behavior of hydrogen as explained above.

A communication from Dr. E. A. Byrnes, of Washington, D. C., entitled "A Note on Metallic Diaphragms," was read by Mr. C. P. Townsend, New York city. The diaphragm was constructed of magnetite. This material, mixed with Portland cement, had been used in melting sodium hydroxide in 1896. It was found that it made a satisfactory diaphragm for aqueous solutions of caustic alkalies when crushed and contained within wooden partitions. It did not act as a bipolar electrode.

Dr. E. F. Roeber, of Philadelphia, Pa., then read a paper entitled "The Theoretical Properties of Free Ions in Solutions." This paper formed the introduction to a discussion of the electrolytic dissociation theory which followed it. Dr. Roeber discussed the theory generally. He said that those who objected to the dissociation theory did not look at the matter in the proper light. The theory, as developed, should be considered merely as a mechanical analogy which assisted the mind in forming a conception of what was taking place in an electrolyte. Viewed in this light the theory had done a great amount of good, and while there were many phenomena which were not explained by it, still its value as a tool is too great for it to be discarded. The proper view to take was that the dissociation theory is only a model to give a concrete conception of electrolytic action.

Dr. Bancroft then opened the discussion by stating what had been accomplished by the dissociation theory, and he gave a long list of the phenomena explained by it. When proposed, it had taken the chemical world by storm. More recently two lines of work had been followed out. One set of investigators are searching for results to uphold the theory, the others looking for its limitations. Both sides have accumulated a great mass of evidence. Against the theory it may be urged that it only applies to infinitely dilute solutions, such as are never obtainable practically, and it applies only to aqueous solutions. He believed that the theory would hold until another and better one was brought forward, and pointed out that abnormal molecular weights may be explained by the heat of solution or some other corrective term, and as a matter of fact we do not know that any dissociation really takes place.

Professor Carhart said that the theory had proved to be a very useful working hypothesis. It had led to many discoveries and facts, and until it has been disproved it must be retained as useful. However, the objections to it can not be ignored and some of these are serious. He thought that the term "electrolytic dissociation" was unfortunate. It should be merely the "dissociation theory," as dissociation of a salt is supposed to take place upon passing into solution. An important point involved is that of the question of energy. The theory was not well sustained by quantitative work. It

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is now going through changes and it is not to be disposed of yet, although it has been worked too hard.

President Richards asked where the energy causing dissociation comes from. This was not explained by the theory. He thought that ionization is a change of state of the materials as a compound. He then discussed the heat of ionization and suggested that this was merely the heat of condensation of vapor. A calculation of this latter point seemed to show agreement with the suggestion.

Mr. W. S. Weedon, of Schenectady, N. Y., said that while ionization might not mean complete separation of the ionization, the state of the compound in solution must differ from the usual chemical state.

Mr. Cowles stated that in studying the energy relations the energy of the whole mass—solvent and solute—should be considered collectively.

President Richards thought that no energy was lost or gained during ionization, and was asked by Dr. Carhart what, then, was the change? He replied that he did not know.

A paper by Mr. Reed, entitled "Berthelot's Law Relative to the Electromotive Forces of Cells Based on the Reciprocal Action of Saline Solutions and Soluble Electrolytes," was read, and, on motion of Mr. Hering, a vote of thanks was tendered to the local committee, to the Niagara research laboratories, to the National Battery Company, of Buffalo, N. Y., to the Niagara Falls Power Company, and to the Niagara Hydraulic and Manufacturing Company, these companies having extended invitations to the society to visit their establishments. The convention then adjourned.

During the afternoon a number of the members of the society visited the plant of the National Battery Company, at Buffalo, and others took a trip to Niagara-on-the-Lake, Youngstown and Port Niagara, by boat and trolley.

There was a good attendance of 136 members and guests out of a membership of about 600. Among those in attendance were the following:

Joseph W. Richards, Bethlehem, Pa.; C. J. Reed, P. G. Salom, Carl Hering, Philadelphia, Pa.; Wilder D. Bancroft, Ithaca, N. Y.; C. L. Collins, 2d, Charles M. Hall, Niagara Falls; E. A. Colby, Newark, N. J.; Alois von Isakovics, New York city; Francis A. J. Fitzgerald, Niagara Falls; A. A. Knudson, Wm. Hand Browne, Jr., New York; C. F. Burgess, Madison, Wis.; Dr. George P. Sholl, Philadelphia; Orrin E. Dunlap, Niagara Falls; Alfred H. Cowles, Cleveland, Ohio; Henry S. Carhart, Ann Arbor, Mich.; G. E. Cox, Niagara Falls; A. E. Kennelly, Cambridge, Mass.; B. J. Arnold, Chicago; Charles F. Scott, A. J. Wurtz, Pittsburg, Pa.; S. W. Stratton, Washington, D. C.; Henry G. Morris, Philadelphia; J. S. Crider, Cleveland, Ohio; W. E. Goldsborough, Lafayette, Ind.; Elihu Thomson, Swampscott, Mass.

American Electrotherapeutic Association.

The thirteenth annual convention of the American Electrotherapeutic Association was held at Atlantic City, N. J., September 22, 23 and 24. The Hotel Windsor was the headquarters of the convention, and a large number of members was in attendance. A splendid list of subjects was presented for papers and discussion. Two sessions were held each day, and there was a number of special features for the entertainment of the delegates.

International Congress of Electricity.

A meeting of the committee on organization of the International Congress of Electricity, which is to be held during the week beginning September 12, 1904, at St. Louis, in connection with the Louisiana Purchase Exposition, convened at Niagara Falls, N. Y., September 18, during the meeting of the American Electrochemical Society. The executive committee was in session the greater part of the day, and transacted much business pertaining to the plans of the congress. Later on the advisory committee was called in to consider matters concerning the relation of the various scientific and technical organizations to the congress.

Among those present at this meeting were the president, Elihu Thomson; vice-presidents, H. C. Carhart, C. F. Scott, W. E. Goldsborough and W. S. Stratton; secretary, Dr. A. E. Kennelly; the treasurer, W. D. Weaver; forming the executive committee and of the advisory committee, Messrs. B. J. Arnold, A. H. Cowles, C. Hering, J. W. Richards and A. J. Wurts.

"The Deterioration of Incandescent Gas Mantles While Burning" was made the subject of a lengthy paper last winter before the Michigan Gas Association by Mr. Alfred H. White, director of chemical technology University of Michigan, and Mr. M. E. Mueller. The principal conclusions arrived at by the authors were: the greatest cause of the gradual deterioration is the loss of cerium oxide, which slowly volatilizes in the intense heat. Experiments on mantles containing originally more than one per cent of cerium indicate that their efficiency increases until the cerium content of the hot zone has dropped to about one per cent, and that from that point on they deteriorate. The rate of deterioration of commercial mantles varies greatly, but the important factor is still the decrease in the percentage of cerium. Some mantle manufacturers are able to very greatly lessen the rate of loss of cerium, and thus make mantles which retain their efficiency for long periods. The experiments do not support the theory of periodic change in the mantle's illumination, but confirm the position previously taken that the alteration of the heating power of the gas, with its consequent effect on the temperature of the mantle, is the most important factor in causing the fluctuations in the illuminating power of a mantle from one day to the next. The amount of moisture in the atmosphere also exercises an appreciable influence.

BOOK REVIEW.

"Electrical Engineering." E. Rosenberg. Translated from the German by W. W. H. Gee and C. Kinzebrunner. New York. John Wiley & Sons. Cloth. 267 pages. 6 by 9 inches. 263 illustrations. Supplied by the ELECTRICAL REVIEW at $1.50.

This book gives the construction and the principles of operation of alternating and direct-current generators and motors, accumulators, converters, and lightning arresters. It also has chapters on electric lighting, polyphase apparatus, and the working of dynamos in parallel. The author, who is the engineer of a prominent European manufacturing company, conceived the book while preparing a number of lectures to be delivered before workmen of the manufactory. The author's style is admirably suited to this class of readers. No mathematics is employed except arithmetic in a few numerical problems and the various expressions for Ohm's law. A treatment of alternating-current subjects, without the use of mathematics, is of necessity imperfect and therefore this book will be found unsatisfying and inadequate to the needs of those students who are mathematically equipped. On the other hand, the extensive engineering knowledge of the author has filled his book with interesting and suggestive statements of facts and details, which will be of value to those who are already familiar with the principles of the subject. The pieces of apparatus which are employed as types for purposes of illustration have a foreign look. The book ought to find a field among those who are forced to self-study.

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INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Recording Wattmeters for Alternating-Current Circuits.

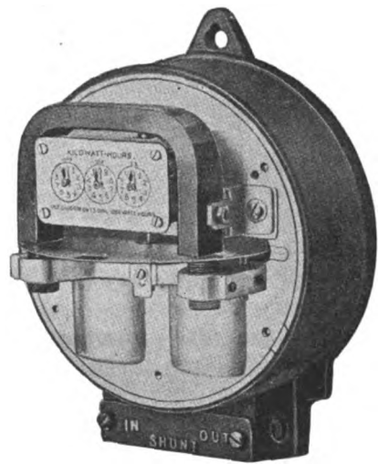
The accompanying illustrations show a new form of recording wattmeter for alternating-current circuits which has been developed by the Stanley Instrument Company, of Great Barrington, Mass. The significant features of this wattmeter, and for which special merit is claimed by the manufacturer, are light weight of the moving parts, perfect spring support, high effective torque, no change, braking air-gap by temperature, complete magnetic shield against short-circuits, balanced thrust, no kicking or pusher auxiliary friction devices, and no jewel wear from hammering or side thrust. The instrument, the company states, ranks next to its magnetic suspension wattmeter.

In this wattmeter the side thrust toward the centre of the disc of the meter is counterbalanced by closed circuited copper rings placed over the side of the field or shunt pole nearest to the edge of the disc. The result of this construction is that a thrust is set up across the field pole in the opposite direction to that produced by the eddies in the disc. This secondary or opposing thrust is so proportioned that it counterbalances exactly the side push.

Special care has been taken by the designers of the Stanley wattmeter to determine the causes of all manner of friction and wear on the bearings, or any magnetic influence which tends to produce error in the operation of the meter. Counterbalancing principles have been employed, so that the only element of friction existing in the balanced thrust wattmeters is that due to the simple rubbing of the very small end of the disc and shaft upon the surface of a highly polished jewel. The employment of special features and the elimination of kicking or other auxiliary devices have done away entirely with vibration, hammering, trembling, side thrust or side dipping or slanting.

The shunt and series system of the wattmeter is enclosed in an iron box forming the back of the case of the meter, which is entirely covered by the magnetic shield. The magnetic shield constitutes the division plate between the back and the front of the meter. Upon the front of the magnetic shield plate is mounted the disc shaft and its bearings, the brake magnets and air-gap adjusting screws, the train gearing and dial, and also the clamp wherewith the disc shaft is supported from its lower bearing during transportation.

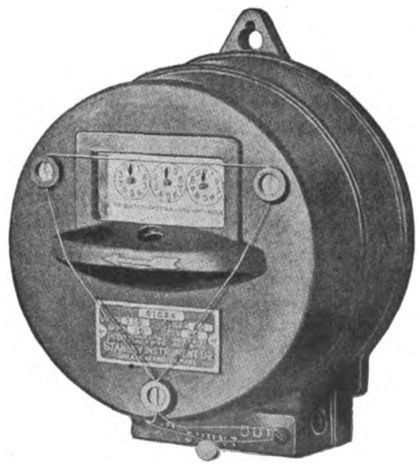
The air-gap or distance between the disc and the brake magnets can not be changed by variation of temperature, as the brake magnets are held rigidly in a



COVER REMOVED, RECORDING WATTMETER FOR ALTERNATING-CURRENT CIRCUITS.

permanent position, so that they can not expand or contract. The air-gap can be changed only by means of large adjusting screws placed in the yoke below the disc, for the purpose of adjustment of the rate of disc rotation.

The method of sealing shown is by pass-



RECORDING WATTMETER FOR ALTERNATING-CURRENT CIRCUITS, SHOWING METHOD OF SEALING.

ing a thin wire through a hole in the head of each screw holding the terminal box cover in place; then through a hole in the rim surrounding the head of each screw fastening the main cover in place and through the slot in the head of each of those screws, finally fastening the two ends of the sealing wire in a lead seal crimped together in the usual manner. This method can be modified in various ways at the pleasure of the company using the meter. When so sealed the meter will be dust-tight, air-tight, moisture-tight and insect-tight; its condition can not thereafter be disturbed without breaking the sealing wire and thereby disclosing that it has been tampered with.

The disc shaft, when in place for rotation, rests upon a finely polished, carefully selected jewel, mounted in a carrier supported on a most accurately graduated spring; the whole arrangement of jewel, carrier and spring being immediately in sight and most readily accessible for adjustment or replacement if such ever becomes necessary.

Although elimination of hammering and side thrusts is thoroughly effected by the design of meter and a spring-supported jewel carrier is not at all a necessary requirement, except in places where there is excessive exterior vibration, the balanced thrust wattmeter is provided with a method of spring support adjustment which is most unique, simple, sensitive and sturdy. For transportation and handling, the shaft is lifted and held fast by a clamp to prevent injury to the jewel by heavy jar; it is readily released when meter is in place ready for service.

The cover of the standard model H Stanley balance thrust wattmeter will be all glass, in one piece, through which will be visible all the parts seen in the illustration herein of meter with cover removed.

The glass cover will be thick and of strong and tough material, not easily liable to fracture; it will be secured to the iron case in the same manner as the metal cover, embedded on a gasket and making an air and dust-tight joint; it will be sealable in the same manner as the metal cover.

The model H Stanley balanced thrust wattmeter is small and compact, being but seven inches diameter, five inches high and weighs but about twelve pounds; in every detail of construction it is made in the very best possible manner; every requirement of the highest class meter has been considered and supplied.

An innovation in the line of railroad telegraph service has been put into use on the New York Central Railroad between Utica and Albany. By the means of the apparatus a single wire can be used for telegraph and telephone messages at the same time. While the operator is ticking away a telegram in Morse code another person can telephone a message without the slightest interference.

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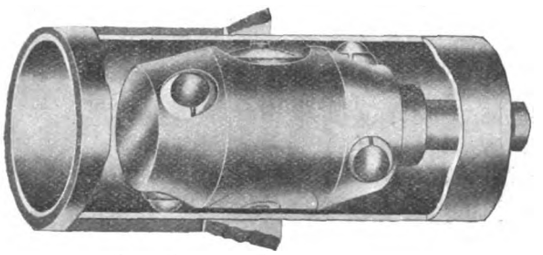
A New Form of Boiler Cleaner.

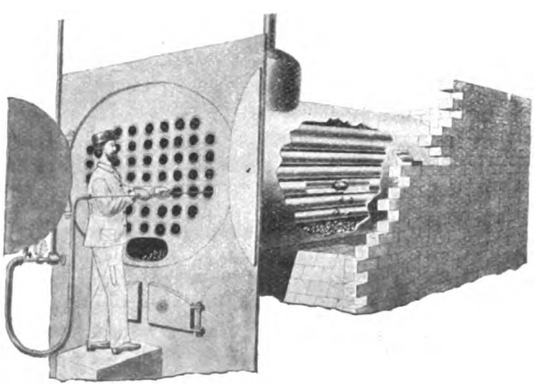
The importance of preventing or removing all scale formations from boilers for reasons of both economy and safety is so well established and the difficulty of accomplishing it so well known, that every advancement in this department of engineering is of pecuniary, as well as humane, interest to both the man who pays the coal bills and the engineer in charge of the power plant.



NEW FORM OF BOILER CLEANER.

Innumerable devices and means have been invented to prevent the formation of scale in the boiler and on the whole conditions have been generally improved. Still in the light of our present knowledge, it may well be doubted whether any practical means can be devised that will positively ensure the user against the presence of scale in the boilers.

The net result, therefore, is that from time to time the scale that has formed must be removed either by entering the boiler and chipping it off by hand, or using some mechanical contrivance for doing the same work.



METHOD OF USING BOILER CLEANER.

To any one at all familiar with the construction of the boiler of to-day, especially of the return tubular type, where the scale forms on the outside of the tubes, the impossibility of cleaning the tubes of this scale by hand is at once apparent, and is the chief reason for the great favor into which mechanical cleaners have sprung with the trade. The inspection of this form of boiler is so difficult that scale is very often present without being known by the engineer.

The construction of a return tubular boiler is such that all these mechanical cleaners have taken the form of some device or machine which has entered the tube, and has a knocker or rapper that may be operated by hand or power, so as to rap or hammer on the inside of the tube sufficiently hard to jar the scale from the outside.

A careful study of the problem at hand has clearly shown that the most effective and least dangerous method of rapping the tube consists in having the highest possible number of raps in a given time, which otherwise may be comparatively light blows, the effect of which will be to set up a more or less local, but very rapid, vibration to the walls of the tube, which by reason of the more brittle and non-elastic character of the scale formation breaks up, loosens and shakes off the latter, without subjecting the tube to any undue strain.

Keeping these points well in mind the General Specialty Company, of Buffalo, N. Y., has devised a machine in which the motive fluid is applied in the most direct manner, thus ensuring the greatest speed of piston, and the double-acting knocker rod, which is firmly secured to the former, in which the travel of the knocker rod is so limited that though it is capable of exerting a sufficiently hard blow on the tube, it could not puncture or injure it, because even though the tube were not present to stop the motion of the rod, it would not travel beyond the point where the walls of the tube would be. This construction makes it possible to safely operate the machine at boiler pressure, thus obviating the necessity of using a separate steam gauge or reducing valve to lower the pressure.

For obvious reasons the body of the machine must be made considerably smaller than the inside diameter of the tube, and this, in connection with the rest of the construction, necessitates some means for accurately maintaining the machine in the axis of the tube. This is accomplished by two sets of centering lugs, one ahead and one back of the piston, which are forced out against the inner surface of the tube by steam pressure.

The undue heating of the tube operated on is further avoided by so using the steam that it is expanded to such a point before exhausting into the tube that its temperature is only a very little above that of the atmosphere.

An actual test of this machine showed a speed of 3,000 strokes and upward per minute, according to the pressure used, nor was the temperature of the tube at the end of thirty minutes raised so much but what it could be easily handled without gloves.

The illustrations appearing herewith show the cleaner in operation. Further information can be procured from the manufacturer, the General Specialty Company, 705-711 Seneca Building, Buffalo, N. Y.

A New Record for Wireless Telegraph.

The De Forest Wireless Telegraph Company has recently made out a summary of the work done for Sir Thomas Lipton, on board his steam yacht Erin during her stay in American waters. During the seventy-three days that the yacht was in New York waters, almost constant communication was maintained with the De Forest stations at Coney Island, State street, New York, and Block Island. The bulk of the matter transmitted was personal correspondence of Sir Thomas Lipton, and comprised 2,000 individual messages, footing up a total of over 40,000 words, and in addition 130 cable messages all in cipher code. A total of 10,750 words were transmitted for the press, for which a collection of $25 per day was made. The average length of a message was twenty words, and frequently a message ran as high as ninety words, from which it will be seen that in this case the De Forest system fulfilled very nearly the function of the telephone. To transmit this bulk of

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business it was necessary to send at an average speed of thirty-two words per minute. In length of time, speed, transmission and accuracy, under every imaginable condition, weather and distance, this service certainly makes an enviable record. Sir Thomas has sent the following letter to Dr. De Forest:

S. Y. ERIN,
NEW YORK, 11th Sept., 1903.

DEAR DOCTOR DE FOREST.

It gives me great pleasure to speak a good word for the working of the De Forest wireless system, which was installed on my yacht Erin in Glasgow last May.

The system has been of great use and value to me, and my guests, since my arrival in this country on the 24th June, from which time up to the present it has been in use. As many as ninety messages in a day have been sent and received on the Erin.

Many prominent visitors have made use of the system, among them being Adjutant-General Corbin, the Earl of Shaftesbury, J. H. Flagler, Paymaster General Bates and many others. I, myself, have used the system very extensively, not only for inland messages, but also for the sending and receiving of many cables from all parts of the world. Many of these cables have been in cipher code and, without exception, all have been sent and received correctly. I believe the day will come when every ship will have wireless telegraph on board, and I shall take pleasure in strongly recommending the De Forest system. Its use can only be appreciated by those who have tested it, as I have done for a period of over eight weeks.

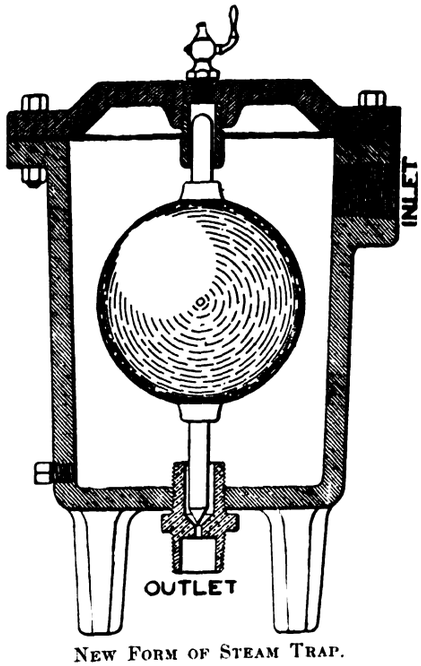
I am, yours faithfully,
(Sgd.) THOMAS J. LIPTON.

DR. LEE DE FOREST,
100 Broadway,
New York city.

This installation on a private yacht, and its performance, should augur well for its general adoption by this kind of craft.

A New Form of Steam Trap.

The "Monash" steam trap made in five sizes for high or low pressure embodies many advantages over the ordinary steam trap. Persons who have had the opportunity of acquainting themselves with steam plants will be able to appreciate the advantage of having a trap which is positive in its action (which the manufacturer claims for the "Monash" trap), thereby doing away with the pounding in the steam pipes due to the steam coming in contact with the water, which was there because of the trap not working. The "Monash" trap, illustrated herewith, is said to be the simplest steam trap on the market, being made of but three pieces, body, float and cover. This trap, it is asserted, is always ready for work and no adjustment is required. The manufacturer claims that the "Monash" trap never fails to act perfectly as the float is held in a central position by the steam and therefore obviates the possible chance of sticking. The operation of this trap is as follows: When the float is at the bottom position, as shown in the illustration, the valve at the outlet is closed, water enters the trap at the inlet and gradually fills the trap about two-thirds full, at which point the buoyancy of the float overcomes its gravity and any pressure tending to hold the valve at the outlet closed. The float then rises, thereby permitting the accumulated water to pass through the outlet. When the water in the trap has been discharged to a point about three inches from the bottom, the float will have sunk so that the steam will close the outlet opening and the trap begins to fill again. A certain quantity of water always remains in the trap, thus preventing the discharge of any steam. The floats are of copper manufactured by an electroplating process and are



NEW FORM OF STEAM TRAP.

tested under a hydraulic pressure of 600 pounds to the square inch. This trap is made by the Monash-Younker Company, 45 Centre street, New York city, and 207 South Canal street, Chicago.

Dam to Give Chicago Power.

The business interests of Chicago, Ill., and the small manufacturing towns along the drainage canal even further south than Joliet will be greatly benefited if the plans of the Sanitary Board are carried out. The first step to bring this about has been taken by the Sanitary District of Chicago filing a petition for the condemnation of land in Lockport township for the construction of a water power plant utilizing the flow in the Chicago drainage channel. The board is planning to drain the water and transmit the power to Chicago and the other towns for electrical illumination and other purposes.

Westinghouse Electric and Manufacturing Company's Balance Sheet.

A comparison of the last balance sheet, issued in 1897, which the Westinghouse Electric and Manufacturing Company has recently published in connection with the application for listing new stock, shows a decided gain in financial strength, as reviewed by the *Wall Street Journal.*

Working capital, or the balance of current assets over current liabilities, is now $12,134,395, compared with $2,093,146 in 1897, an increase of $10,041,249. This does not include stocks and bonds in the treasury, which have increased from $5,964,879 in 1897 to $7,251,385 in 1903. These securities are carried at cost.

The company's fixed assets, including property and patents, have increased from $7,816,089 in 1897, to $13,577,701 in 1903, a gain of $5,761,612. Besides this, there has been written off, according to one of the reports, $2,786,719, indicating a total expenditure of $8,548,331.

In 1901 $3,000,000 stock (par $50) was issued at $55 a share; and now $4,500,000 is being issued at $80 a share. When the new stock will have been issued, total capital increase in the six years will have amounted to $10,853,000 (par value), and $3,865,000 proceeds from stock to issue is still to be added to working capital.

The surplus after dividends for the six years may be figured as follows:

Gain in working capital	$10,041,249
Gain in stocks and bonds owned.	1,286,504
Gain in fixed assets	8,548,084
Total gain in assets	$19,876,084
Stock and bonds issued (less retired) par value	6,353,711
Balance	$13,522,373
Less premium on stock sold	1,551,000
Balance, surplus earnings	$11,971,373

This amount is probably not far from the actual amount of earnings after dividends and interest since 1897.

The gain in working capital is a reflection of the rapid growth in the company's business. This growth may be seen in the following figures of gross sales for the years ending March 31:

Year.	Sales.
1898	$4,378,060
1899	6,901,760
1900	11,963,646
1901	15,853,481
1902	19,975,958
1903	23,899,492
Total sales, six years	$82,972,397

Twenty per cent of the above total gross sales would be about $16,500,000, which is probably the amount of net earnings before dividends and interest.

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CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

POWER FOR WASHINGTON—The War Department has formally approved plans for the long proposed dam in the Potomac river at Great Falls. Work is to be begun at once by the Great Falls Electric Power Company, which is to supply the City of Washington with power for electric lighting and for its street railways and other institutions.

PENNSYLVANIA RAILROAD SHOPS TO BE ELECTRICALLY DRIVEN—Announcement has been made that the new shops of the Pennsylvania Railroad Company at Wilmington, Del., will be equipped with electric motors throughout. Each machine which requires power will be furnished by a small independent motor which will be directly under the control of the man running the machine. Power will be furnished by the power-house which is being erected, and will be conveyed to the motors by distributing wires.

TO TUNNEL UNDER NATIONAL CAPITOL—The district government at Washington on Wednesday, September 8, granted the formal permit to the Pennsylvania Railroad to construct the twin tunnel under the United States Capitol and the adjacent blocks and streets, electricity being agreed upon as the motive power. The tunnel will be 3,000 feet long, beginning at the intersection of Massachusetts avenue and First street, northeast, going under Capitol hill to New Jersey avenue and D street, southeast. The total cost of the work will be approximately $800,000.

KANSAS CITY TELEPHONE RATE LITIGATION—The ordinance compelling the Missouri-Kansas Telephone Company to reduce its rates for business and residence telephones from $96 and $60, respectively, to $60 for business telephones and $36 for residence telephones, has been upheld by T. J. Smith, of Butler, Mo., the referee appointed by the Supreme Court to hear the evidence in the company's contention that the measure was unreasonable and practically meant confiscation. The referee's finding means apparently that Kansas City has the right to regulate telephone rates for local service. The Supreme Court will convene in October, when it will pass upon the findings of the referee.

NEW POWER PLANT FOR MICHIGAN—Plans for a new hydroelectric plant on the Huron river, near Rockwood, Mich., are in process of completion. Mr. M. R. Bacon, of the Michigan Alkali Company, Wyandotte, and Frank Nellis, of Wyandotte, are said to be the prime movers in the project. The capitalization of the company will be from $200,000 to $500,000. The erection of a water power plant on the Huron, the power to be furnished by the river, with the aid of a large dam, is contemplated. At the location in view the river is less than 100 feet wide and about six feet in depth. It is said that the construction of the dam is designed to raise the depth of water to ten or twelve feet. Contracts will probably be made to furnish power to run the electric cars of the Detroit & Toledo Shore Line.

THE EARNING POWER OF THE NEW YORK & BROOKLYN BRIDGE—Commissioner Lindenthal has recently made an estimate of the earnings of the New York & Brooklyn Bridge. He expects that the profit for next year will be $35,000. It is expected that $77,000 will be collected in roadway tolls and $65,000 from trolley cars. The elevated railroads will pay $90,000 for their use of the bridge. Real estate rented in the terminal structures will bring $90,000 to the city treasury, and the companies laying wires on the bridge will pay $8,000 for the privilege. The mail tube across the bridge brings $1,000 a year to the city. The total receipts are estimated at $357,000, and the expenditures, including salaries of $52,000 and payrolls of $210,000, are put at $322,000. No estimate is made of the interest on the investment, which would not show a profit if this item were reckoned in.

NEW NIAGARA POWER LINES IN OPERATION—Current was transmitted for the first time to a consumer over the new lines of the Niagara Falls Hydraulic Power and Manufacturing Company at 8 o'clock Monday morning, September 14. The transmission line feeds the north end industrial district of Niagara Falls. The Carter-Crume Company, of Niagara Falls, is the first consumer on the new transmission line. The new three-phase generators which are to supply the new transmission line with power were built by the Bullock Electrical Manufacturing Company, of Cincinnati, but the new switchboard which has been installed at the power-house is the work of the employés of the company themselves. The transformers were furnished by the Westinghouse Electric and Manufacturing Company and the cables by the National Conduit and Cable Company. The transmission line is one of the finest pieces of work of its kind ever done in this vicinity. The poles are of cedar and were brought from Idaho.

SOUTH AFRICAN POWER PLANT—Contracts are to be let for the power-house and equipment for an extensive electric traction system to be constructed in Johannesburg, South Africa. Bids are to be received by the British electrical engineering firm of Mordey & Dawbarn. There are two sets of specifications, one calling for steam engines and the other for gas engines to operate the road. The boiler capacity of the plant will be somewhat over 10,000 horse-power. The specifications for the gas plant require a gas-producing plant capable of gasifying seven and one-half tons of coal per hour, with coal-conveyor and cleaning and cooling plant and accessories; four gas engines, each to drive a 1,350-kilowatt dynamo; three gas engines, each to drive a 650-kilowatt dynamo; three gas engines, each to drive a 675-kilowatt, two-phase, alternating-current generator; two motor-generators, each consisting of a 250-kilowatt, two-phase alternator; two dynamos of 150 kilowatts capacity each, and two 450-kilowatt dynamos. The specifications for the steam generating plant comprise four water-tube boilers of 10,000 horse-power, with conveyors, automatic stokers, economizers, condensing plant, engines or turbines and electric generators and motors.

ST. LOUIS LIGHTING MERGER—A certificate of incorporation for the new Union Electric Light and Power Company, of St. Louis, has been issued by Secretary of State Cook and filed with the recorder of deeds in St. Louis. At a meeting of the board of directors, held recently, it was voted to combine the two companies—the Missouri Edison Company and the Union Electric Light and Power Company—under the latter name. Most of the officers of the old Union Electric Light and Power Company were retained as officers of the new corporation. The only changes were in the election of a new first vice-president and the creation of two new offices, those of second vice-president and assistant secretary-treasurer. C. W. Wetmore, of New York, succeeds Charles W. Walsh as first vice-president. William F. Nolker was made second vice-president, and Sherman B. Pike, formerly secretary of the Missouri Edison Company, was made assistant secretary-treasurer. The following new directors were elected to fill vacancies made by resignations: C. W. Wetmore, to succeed C. W. Morath; George R. Sheldon, to succeed S. Pollak; John H. Beggs, of Milwaukee, to succeed John H. Bradelle; and C. E. Thister, of Milwaukee, to succeed Harold P. G. Coates.

TO LAY ALASKAN CABLE—The United States cableship Burnside has sailed from Seattle, Wash., for the north to continue the work of laying the cable from the head of the Lynn Canal by way of Sitka, the capital of Alaska, to Seattle. She has a stretch of 600 miles of cable aboard, which was transferred from the steamship Texan, which brought the cable around Cape Horn from New York. On board the Burnside when she sailed were General A. W. Greely, chief signal officer of the United States Army; Colonel James Allen, of the Signal Corps, under whose general supervision the line will be laid; Captain Edgar Russell and Captain George O. Burnett, of the Signal Corps; Henry Winter, cable engineer; Lieutenant Charles P. F. Chandler, of the quartermaster's department. Captain A. H. Laffin is in command of the vessel. The Burnside proceeds direct to Juneau, where, after making a short line connection, she will start for Sitka, paying out about 250 miles between the two towns, and continuing south

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from the capital by the open ocean, as far as the cable rope will reach, possibly to a point off Queen Charlotte Isle. It is expected that the entire consignment of cable on the Burnside will be laid and the vessel be back in Seattle by October 15.

A NEW YORK-BOSTON TROLLEY—Plans have been completed for a through trolley line from New York to Boston, and those back of the project say that it will be in operation within two years. It is probable that several trolley lines now in operation between these two points may be absorbed by the new company, or, at least, an arrangement be made to use some of the tracks of these companies. The object of the new line is to provide through service between New York and Boston, and to have trains equipped with sleeping and parlor cars. The line is to be by way of Worcester, Hartford and New Haven. After the completion of the line, residents of New York and Boston will be able to take this trip between the two cities in only twice the running time of the present steam railroad, and at half the expense. Some trolley sleepers have already been finished for the syndicate, and they are to be tested shortly on a line running from Indianapolis to Columbus. They are said to be the first trolley sleeping cars ever built in this country. S. Harrison Wagner, an attorney for the syndicate, has made this statement: "There is plenty of capital behind the syndicate, and the work of completing the line will go on as fast as possible. I do not know just how far along on the stretch between Worcester and Hartford the construction of the track has been completed, as I have not seen the men of the syndicate in about three weeks. Neither could I say just when the line between Hartford and New Haven will be started. There are some preliminary steps to be taken before the track laying is actually begun. The route between New Haven and Port Chester has not been settled as yet. There will be no trouble from the New York, New Haven & Hartford Railroad because of any running of tracks parallel with the tracks of that company. The New York, New Haven & Hartford withdrew from the legislature the proposition making it necessary to take out a special charter. The electric company will therefore pass through the state under the general railroad laws. As to the road being a three-rail system, I suppose some parts of it will be, but in other places along the line it must be the overhead trolley."

CARS FOR NEW YORK SUBWAY TESTED—The Interborough Rapid Transit Company, the company which will operate the cars in the New York rapid transit subway, tried five of the new subway cars last week on the Third and Second avenue elevated structures, New York city. These cars are apparently unusually substantial in construction. They are four inches lower than the elevated cars, but three inches wider at the bottom and four feet longer, the length over all being fifty feet, one inch over the platforms, and the car body forty-two feet seven inches. The width at the deck eaves moulding is eight feet five inches. The height over top of rail roof is twelve feet. Especial care has been taken to equip the cars in a manner to prevent accident by fire from the electrical apparatus. The floor framing is composed chiefly of rolled steel beams. Over the truck containing the motors a steel plate has been framed in, and on top of this plate is a sheet of one-quarter inch asbestos. Beneath the double maple flooring of the car proper has been placed a sheet of one-quarter inch asbestos fire felt, and underneath the body of the car a one-quarter inch sheet of specially prepared asbestos board called "transite." The wires are insulated with asbestos and are run in hard moulded asbestos forms, so that there are several layers of incombustible material between the wiring and the electrical apparatus and the car interior. The sheathing on the side, which extends from the bottom of the car to the windows, is made of copper sheet, rolled on. The cars carry two lines of air pipes, known as a main reservoir and train line pipe for the automatic brake system. When the train is in motion the main reservoir line is charged with ninety pounds of compressed air to the square inch. The air is compressed by means of electrically driven compressors, which are installed under each motor car. When the train is in motion the train line pressure is so regulated that seventy pounds pressure to the square inch is carried, and any reduction in the train line pressure causes the brakes on the entire train to set automatically and simultaneously. The train line pressure is coupled with the electric controller, and if at any time, while the current is being fed into the motors, the motorman should for any reason take his hand off the controller when the train is in motion, the brakes are at once set on the entire train. Just before the brake is automatically set the current is cut off from the motors on the entire train. This is also done automatically. There are no gates on the cars, but sliding doors and vestibules. These are opened and closed by means of levers. The windows open from the top instead of the bottom. Each train will have eight cars, five of them motor cars and three trailers. Five hundred cars are at present being built. They will run on the Second avenue elevated line during the winter, and the cars now running on that road will be distributed over the other lines. Among those on the initial trip of the experimental car, which was from Third avenue and Ninety-eighth street to Bronx Park on the Third avenue line, and down Second avenue to South Ferry, then uptown again on the Second avenue track, were George H. Pegram, chief engineer of the Manhattan division; C. L. F. Deyo, chief engineer of the Interborough Rapid Transit Company; L. B. Stillwell, electrical director of the Interborough Rapid Transit Company; E. P. Bryan, vice-president of the company; Alfred Skitt, vice-president of the Manhattan division; C. E. Case, assistant engineer of the General Electric Company; W. H. Sawyer, assistant engineer of the General Electric Company; W. T. Thompson, master mechanic of the Subway division; J. S. Doyle, master mechanic of the Manhattan division; Hugh Hazleton, electrical engineer of the Manhattan division; F. R. Slater, H. F. Putnam, John B. McDonald, August Belmont, Walter G. Oakman and George W. Young.

ELECTRIC RAILWAYS.

OTTAWA, ILL.—The Illinois Valley Traction Company proposes to extend its line from Marseilles through to Morris and Joliet as soon as the road between La Salle and Marseilles is completed and in operation.

TUSCOLA, ILL.—The Decatur, Tuscalo & Champaign Railway Company has been incorporated to build a line from Champaign to Tuscola, connecting all intermediate towns. It is said that work will begin at once.

EVANSVILLE, IND.—The Evansville, Boonville & Rockport Electric Company has filed a $10,000 bond with the city treasurer guaranteeing to build its road. The survey is completed and work will begin this fall.

ST. LOUIS, MO.—The county court at Clayton has granted a franchise to the St. Louis & Olivette Railroad Company, for two lines between St. Louis and Olivette. The work of construction is to begin May 15 next.

RICHMOND, IND.—Construction has been begun on the Eastern Indiana Traction Company's road, which will extend from Hamilton, Ohio, to Marion, Ind., passing through Richmond, Fountain City, Lynn, Winchester and Gas City.

HARRISBURG, PA.—The West Fairview & Marysville Electric Railway Company has passed into the hands of the Harrisburg & Mechanicsburg Electric Railway Company, which is controlled by the Cumberland Valley Railroad Company.

PHILADELPHIA, PA.—Articles of incorporation have been filed in the Camden County Court for the Porto Rico Railway, Light and Power Company, with a capital of $125,000. The purpose of the corporation, the articles state, is to build a trolley road from San Juan to Ponce, Porto Rico, and to construct waterworks at several points on that island.

BETHLEHEM, PA.—The New Jersey & Pennsylvania Traction Company, which now has its line running from Newton to Trenton, is rapidly completing plans for extending it from Newton to Willow Grove, and it is thought that the road will be in operation within a year. The line will pass through Richboro, Southampton, Davisville and Hatboro, and connections will be made at Willow Grove with the Rapid Transit Company's system.

HEMPSTEAD, L. I.—It is stated that the Long Island Railroad Company will construct a trolley line from Jamaica to Rockaway Beach, connecting Belmont Park, Springfield, Woodsburg, Cedarhurst, Lawrence and Far Rockaway. It is also stated that the Long Island company will substitute electricity for steam by the end of the year on the Bayside and Port Washington divisions, and that eventually this plan will be followed on all the shorter branches on the island.

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ELECTRICAL SECURITIES.

The developments in last week's stock market showed that the bear interests were still in a strongly intrenched position and were meeting with extreme success in forcing prices downward. Such good securities as United States Steel were depressed until the low level of 17 had been reached; but, upon support, this came back to 17½. Prices, compared with a week ago, are generally lower, but it can be said that conditions, on the whole, are not adverse. The bear pressure was distinctly responsible for the decline, and liquidation did not enter into the question as a potent factor. Brooklyn Rapid Transit also was the subject of manipulation, and it seems likely that this stock is being worked by important interests in order to bring about a condition that will ultimately mean the reorganization of the shareholdings.

ELECTRICAL SECURITIES FOR THE WEEK ENDING SEPTEMBER 19.

New York:	*Closing.*
Brooklyn Rapid Transit	37¼
Consolidated Gas	170½
General Electric	155
Kings County Electric	160
Manhattan Elevated	131⅞
Metropolitan Street Railway	111⅝
New York & New Jersey Telephone	140
Westinghouse Manufacturing Company	160

The directors of the Metropolitan Street Railway Company have declared the regular quarterly dividend of 1¾ per cent, payable October 15. Books close September 24 and reopen October 16.

Boston:	*Closing.*
American Telephone and Telegraph	130
Edison Electric Illuminating	230
Massachusetts Electric	80
New England Telephone	124
Western Telephone and Telegraph preferred	80½

The directors of the American Telephone and Telegraph Company have declared the regular quarterly dividend of 1½ per cent on the company's stock.

Philadelphia:	*Closing.*
Electric Company of America	8¼
Electric Storage Battery common	55
Electric Storage battery preferred	55
Philadelphia Electric	6⅜
Union Traction	43⅞
United Gas Improvement	84½

The directors of the Electric Storage Battery Company have declared the quarterly dividend of 1¼ per cent on the common, and 1¼ per cent on the preferred stocks, payable October 1. Books close September 23 and reopen October 1.

The balance sheet of the Philadelphia Rapid Transit Company, as of June 30, 1903, shows total assets of $6,574,424 and liabilities of $6,168,536, leaving a net surplus of $405,888.

The Union Traction Company has issued its balance sheet of June 30, 1903, which shows assets of $17,342,447 and liabilities of $13,269,870, leaving a surplus of $4,072,577.

Chicago:	*Closing.*
Chicago Telephone	115
Chicago Edison Light	145
Metropolitan Elevated preferred	55
National Carbon common	21
National Carbon preferred	88
Union Traction common	5
Union Traction preferred	33

ELECTRIC LIGHTING.

SOUR LAKE, TEX.—The Light and Power Company has completed its plant and the same is now in operation.

HUDSON, OHIO—L. H. Chopin has secured a franchise for an electric light plant for this town.

DES MOINES, IOWA—F. E. Sanders, of Fayette, will erect the waterworks and electric light plant there.

MANCHESTER, OHIO—The streets of Manchester are now lighted by electricity, the new plant having been completed recently.

PERRYSVILLE, OHIO—At a meeting of the citizens it was decided to install an electric light plant for street lighting and other purposes.

ROYERSFORD, PA.—The electric plant of the Schuylkill Valley Electric Illuminating Company, on the south side of the Schuylkill river, at Cromby, has been completed and put in operation.

SPRINGFIELD, ILL.—Work has been commenced on the construction of a large power-house for the Decatur, Springfield & St. Louis electric railway on the Sangamon river. The building will be 400 feet long and will cost $230,000.

AUSTIN, TEX.—The charter of the Amarillo Water, Light and Power Company has been filed with the secretary of state. The company has a capital of $100,000, and the incorporators are W. F. Ramsey, John K. Brydes and L. W. Chase.

ACKLEY, IOWA—The electric light plant in this city has again changed hands, the George C. Wright Company, of St. Paul, Minn., which purchased the property this spring, selling to R. W. Smith, of Cleveland, Ohio, and D. J. Smith, of Central City, Col. The consideration was $20,000.

SPRINGFIELD, MASS.—The Boston & Albany Railroad will install an electric plant at the Union station for furnishing light to its freight yards, signal towers and contiguous yards. Power will be obtained from the Westfield river.

SALT LAKE CITY, UTAH—The Utah Light and Power Company will increase the capacity of its West Temple station from 1,100 horse-power to 2,000 horse-power. This improvement will involve the outlay of $50,000 within the next twelve months, and ultimately a total outlay of $100,000.

DES MOINES, IOWA—Improvements and repairs aggregating $60,000 will be made to the plant of the Des Moines Edison Light Company, work to begin at once. Chief of the improvements planned is the total abolition of the smoke nuisance by the equipment of the furnaces with an automatic device for this purpose.

DANSVILLE, N. Y.—The Dansville Gas and Electric Company has sold its entire plant and business to the Mill Creek Electric Light and Power Company, and the new company has taken possession. New machinery will be put in whereby more power will be furnished, and the electric lighting plant will run all day as well as at night.

MARION, OHIO—The Electric Light Company's plant at Prospect has been sold to the Columbus, Delaware & Marion Electric Railway Company, the consideration being about $10,000. The plant has a capacity of 25,000 candle-power. It will be converted into a power plant for the interurban line and considerably enlarged. The contract for lighting the streets of Prospect and furnishing commercial lights will be carried out by the new owner of the plant.

DETROIT, MICH.—It is stated that capitalists at Wyandotte, a suburb of this city, are about to launch an enterprise that has for its object the development of water power on the Huron river. A company with a capital of $300,000 is being formed for the purpose of erecting a large electrical plant to be operated by power procured from the Huron river. It is said that a contract has been made to furnish electric power to operate the new Detroit & Toledo Shore Line Railway.

WINONA, MINN.—Articles of incorporation of the St. Charles Light and Power Company have been filed with the county register of deeds. The purpose of the organization is the manufacture, distribution and sale of electric current for heat, power and lighting. The principal place of business of the company is to be St. Charles, Minn., and its term of existence is to be thirty years, beginning on September 5, 1903. The capital stock is placed at $12,000, and the incorporators are as follows: M. J. McGrath, of Winona; Charles F. Knapp, Herman Canfield, Thomas Shock and A. G. C. Rabben, of St. Charles.

AUGUSTA, GA.—It is understood that a northern syndicate which is interested in the development of the Anthony shoals property has completed its plans and that work will commence shortly. It is reported that the syndicate has options on over 4,000 acres of property right as a site of the proposed power plant, and that 8,000 horse-power will be developed. The company's first move will be the construction of a railroad from either Middleton or Elberton to the shoals, a survey of which has already been made, and which will later be continued to Tignall, in Oglethorpe County, and then through Lincolnton to Augusta. It is estimated that the dam which the company proposes to erect at the shoals will cost it $17,000, while the canal will cost about $60,000.

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PERSONAL MENTION.

MR. S. G. BENTLY, of Chicago, Ill., has been appointed manager of the Postal Telegraph-Cable Company at Chattanooga, Tenn.

MR. E. B. RAYMOND has been appointed general superintendent of the Buffalo plant of the General Electric Company.

MR. H. WHERLAND has been appointed as superintendent of the electric light plant at the University of Minnesota.

MR. L. W. LAWSON has been appointed superintendent of the Washburn shops of the Worcester Polytechnic Institute, Worcester, Mass.

SIR DAVID BARBOUR, Baron Ribbesdale, and several other members of the commission on London traffic have sailed for the United States to enquire into the street railway systems of New York and Boston.

PROFESSOR HENRY B. DATES, professor of electrical engineering at the Clarkson School of Technology, Potsdam, N. Y., has been appointed professor of electrical engineering at the University of Colorado.

MR. J. F. ROSSMAN, president of the B-R Electric Company, Atlanta, Ga., was married to Miss Agnes Rose Lee, of Brooklyn, on September 16. Mr. Rossman has been identified with the street railways and electrical matters in Atlanta and the South.

MR. L. F. MAHLER, formerly assistant manager of the De Laval Steam Turbine Company, at Chicago, has taken charge of the St. Louis office of the Bullock Electric Manufacturing Company, with offices at 1505 Chemical Building, St. Louis.

PROFESSOR A. W. SMITH will soon take up his duties as head of the mechanical engineering department at Stanford University, California. Professor Smith has been spending the summer doing engineering work for Westinghouse, Church, Kerr & Company.

PROFESSOR W. KARAPETOFF, E. E., of St. Petersburg, in the employ of the Russian Government, taking a course at the Westinghouse works, has been commissioned by his government to inspect the South Pennsylvania Oil Company's electrical power plant at Folsom, W. Va.

PROFESSOR GEORGE H. ROWE, who has been appointed associate professor of electrical engineering at Stanford University, California, comes from the State University of Colorado, located at Boulder. Professor Rowe was the dean of the school of engineering and applied science at Boulder.

MR. JOHN W. FERGUSON, of the Chicago Edison Company, is to be further complimented for his excellent paper on "Tactful Relations with Customers," read before the last meeting of the National Electric Light Association. While the paper was addressed primarily to those concerned with electric lighting, it contained so many valuable suggestions of general application that the American Telephone and Telegraph Company has distributed copies of the paper among its employés in all parts of the country.

MR. F. A. BABCOCK is building a special electric automobile at the Buffalo Electric Carriage Works to undertake the feat of making the run from Boston to New York in an electric carriage. The distance is 235 miles in round numbers. Mr. Babcock stated that he expects to make the start from Boston on Friday, September 25. The vehicle will carry six people. It will have a speed of twenty-five miles an hour and its capacity will be seventy-five miles on one charge.

PROFESSOR C. P. MATTHEWS, associate professor of electrical engineering at Purdue University, has found it necessary to retire from active duty for a year owing to trouble with his eyes. Professor Matthews has carried on an extensive series of photometric tests and his reports to the National Electric Light Association have been widely quoted. Cornell University granted him a doctor's degree in recognition of his development of his integrating photometer. It is thought that constant work has overstrained his eyes. He has been granted a year's leave of absence by Purdue University.

PROFESSOR SAMUEL JACKSON BARNETT, of Stanford University, California, has returned after several months spent in survey work along the Alaskan coast. Professor Barnett made a special investigation of the peculiar magnetic disturbances which have made navigation difficult in certain localities. Near Skagway these disturbances are very severe, the deflection of the compass being so great that it is rendered almost useless in that vicinity. It was found that this strange state of affairs was due to an abundance of magnetic rock in the locality, which rock is present in enormous quantities at Douglas Island and on the mainland and near Skagway. Professor Barnett stated that there was an almost perfect magnetic pole at that point.

PROFESSOR A. SLABY, inventor of a system of wireless telegraph, was recently awarded a subsidy by the German Government of 200,000 marks to continue his experiments. The professor gives an account of the success of his latest experiments. In a statement he says in part: "It was until recently an open question whether the earth played any part in wireless telegraphy. To solve the question I had the floor of my laboratory covered with zinc, thereby making an artificial ground circuit, and have succeeded in proving that waves are transmitted not only through the air but through the earth as well. I have besides this been occupied in trying to simplify the instruments so that even a person without any scientific knowledge may measure the length of the waves transmitted and have succeeded in constructing a dozen different types which are all of great practical value."

MR. CYRUS O. BAKER, JR., of the firm of Baker & Company, 120 Liberty street, New York city, gold and platinum refiners, has recently completed an extensive trip abroad. Mr. Baker, who is the most prominent refiner of platinum in the United States, has many interests abroad, and during his trip visited England, France, Italy, Austria, Germany, Belgium and Russia. When asked for his opinion regarding the scarcity of supply of platinum, about which considerable outcry was raised a short time ago, Mr. Baker said:

"There is no doubt in my mind but that the cry of stringency is overdrawn. Of course, Russia continues to be the fountainhead of the supply of crude platinum. It is difficult to estimate the output, but as far as I can see there is not and there is not likely to be any dearth of supply. There are rumors, of course, at all times as to the French syndicate controlling the output of the mines, due to long contracts which have been made with the miners. As long as these conditions hold, I do not see the possibility of there being any reduction in prices. The Russians tell us that we can look for an increase in prices. The demand for platinum is increasing, the ratio of increase in the United States being greater than in any other country. It may be said, also, that the amount of platinum produced outside of Russian territory is far greater than ever before and appears to be increasing."

"During your trip did you notice any new methods of processing the platinum ores, and did you hear of any new extensive territories being opened?"

"No; there is nothing new in the way of processing. All the properties which I looked up are jogging along in the same old lines, and as far as there being any new territories opened, I have heard statements to the effect that there were extensive districts recently opened up in Russia, but these, I believe, are promulgated by stock-jobbing concerns, and in my mind there has not been any new territory opened up in some time."

Mr. Baker did not lose his genial heartiness during his trip abroad, and if extraneous appearances are any indication of good faith in the stability of the platinum market, he stands as a typical representative of unabated prosperity.

LEGAL NOTE.

AN INTERESTING SUIT AFFECTING CANADIAN ELECTRIC COMPANIES—The arbitrators in the case of the Consumers' Electric Company *vs.* the Ottawa Electric Company handed down their decision on August 10, which was in favor of the plaintiffs. At the time the city (Ottawa, Canada) council granted the Consumers' company permission to do business in the city it was stipulated with the agreement of the Ottawa Electric Company that the Consumers' company should be allowed to string wires on the rival company's poles on certain streets. The Ottawa Electric Company, however, afterward refused this permission on the ground that the stringing of the Consumers' wires on its poles would impair the efficiency of its service. The Consumers' company brought action against the Ottawa Electric Company in the high court.

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TELEPHONE AND TELEGRAPH.

REINBECK, IOWA—A telephone exchange is to be established in this town.

NORFOLK, VA.—A charter has been granted to the Clinton & Garland Telephone Company.

ST. LOUIS, MO.—The Kinloch Telephone Company will construct a line from Alton to Springfield.

BURLINGTON, VT.—The New York & Northern Telephone and Telegraph Company has applied for a franchise.

COHOES, N. Y.—The Home Telephone Company will shortly commence the construction of a line to Crescent.

CANAJOHARIE, N. Y.—The capital stock of the Glen Telephone Company is to be increased from $100,000 to $300,000.

DEADWOOD, S. D.—The Nebraska Telephone Company has applied for a twenty-year franchise to operate in this city.

INDIANAPOLIS, IND.—E. M. Beekman and E. O. Woods have purchased the Van Buren telephone system from R. Lowe.

FLORENCE, ALA.—The new telephone system for Florence has been completed and is now in operation. It cost $9,000.

NEW BRITAIN, CT.—R. L. Andrews has been granted a franchise to establish a telephone line in Great Barrington, Mass.

SOUTH NORWALK, CT.—Arrangements are being made to extend the local telephone system to North Stamford and to Long Ridge.

TERRE HAUTE, IND.—A. A. Tibbe has sold the electric light and telephone system at Washington, Mo., to the firm of Hibbler & Earnst.

AUGUSTA, GA.—The Bell Telephone Company has begun operations on the construction of its long-distance line from Augusta to Lincolntown.

BALTIMORE, MD.—The Petersburg Telephone Company has completed a line to City Point, and that place is now in communication with Petersburg.

SALISBURY, MD.—The Diamond State Telephone Company is arranging to build a new line from Salisbury to Hurlock, *via* Hebron, Madela and Vienna.

HAWKINSVILLE, GA.—The Southern Bell Telephone Company has been given the right to extend its lines to Eastman, Cochran and Hawkinsville, from Macon.

PITTSBURG, PA.—It is stated that the management of the Erie Railroad has decided to equip the entire system with telephones, at an expense of nearly $1,000,000.

DOVER, DEL.—The Diamond State Telephone Company is making arrangements for a line from Salisbury to Hurlock, Md. Hebron, Mardela and Vienna are the towns on the proposed line.

FLORENCE, COL.—The Colorado Telephone Company has begun the work of stringing a new line between Florence and Canon City, and between this city and Cripple Creek.

GRAND RAPIDS, MICH.—The A. C. Himebaugh Telephone Company has changed its name to the Southern Michigan Telephone Company and increased its capital from $5,000 to $60,000.

COLUMBUS, GA.—The Adams telephone system, of Stewart County, has been extended to this city, a line being built through Russell County, Alabama, up the Chattahoochee River to Girard.

COLUMBIA CITY, IND.—At a recent meeting of the business men of this city, a farmers' telephone company was organized, to be known as the Farmers' Mutual Telephone Company, of Whitley County.

MARLBORO, MASS.—Arrangements are being made by the New England Telegraph and Telephone Company for a direct wire between Marlboro and Worcester, and the work of stringing the wire will begin at once.

CHATTANOOGA, TENN.—H. S. Chamberlain has been elected temporary chairman of the Hamilton Telephone Company, and E. Y. Chapin, secretary. The company will shortly install an independent service in this city.

MIFFLINSBURG, PA.—The Columbia County Telephone Company has been organized for the purpose of building a line for the exclusive use of farmers residing in the counties of Columbia, Montour, Lycoming, Luzerne and Sullivan.

WEST UNION, OHIO—The Adams County Telephone Company, of Peebles, has been incorporated at Columbus with a capital of $10,000. The incorporators are E. Humphrey, J. F. Platter, Dr. J. S. Berry, John Blair and Dr. G. F. Thomas.

WICHITA, KAN.—The Whitewater Telephone Company has been incorporated with a capital of $2,500. This company will establish an exchange in Whitewater, which will connect with the long-distance lines of the Wichita Telephone Company.

MILWAUKEE, WIS.—Articles of incorporation have been filed for the Knapp Telephone Company, Knapp, Dunn County, with a capital of $5,000. The incorporators are C. A. Silkworth, J. J. Osborn, of Eau Claire, and Charles Townsend and C. McV. Fletcher, of Knapp.

ST. LOUIS, MO.—It is stated that a project is under way for an independent telephone system for St. Louis County. A number of capitalists of the country are said to be interested, among them J. D. Houseman, J. B. Lucas, D. C. Taylor, F. A. Heidorn and Edward Miller.

AUSTIN, TEX.—The People's Home Telephone Company, of Gainesville, Denton and Mineral Wells, Tex., Wilkesbarre, Pa., and Chicago, has been organized with a capital of $250,000, for the purpose of constructing and operating telephone exchanges and long-distance lines.

GLOVERSVILLE, N. Y.—The board of trustees of Fonda has granted the Glen Telephone Company permission to set poles and string wires in the village. The company will in a short time combine its Fultonville business with the Fonda office and an all-night telephone service will be given.

ALBANY, N. Y.—The Earlville Telephone Company has been incorporated with a capital of $40,000, to operate in Madison, Chenango, Delaware, Otsego, Cortland, Oneida, Broome, Onondaga and Oswego counties. The directors of the company are Parker Newton, Guy C. Clark, Clayton I. Burch and Avery M. Hoadley.

DETROIT, MICH.—The plant of the People's Telephone Company, representing an investment of approximately $400,000, has been sold to a syndicate now operating independent telephone systems throughout the country. The company has petitioned the common council for a new franchise to operate lines in the city and connect with independent telephone lines throughout the state.

MINNEAPOLIS, MINN.—The amount of indebtedness to which the Northwestern Telephone Company may be liable has been increased from $2,000,000 to $4,000,000. The company will spend $800,000 in improvements during the present year, consisting of extended toll lines, better equipment wherever possible, improved service in this city, and the erection of a new addition to its east station.

KANSAS CITY, MO.—Fire in the five-story telephone building in this city burned all the toll boards and damaged the main switchboard so that for at least thirty days, and probably for some time, there will be no telephone service in the business district, and no toll or long-distance service between Kansas City and any outside point. The loss on the building and apparatus will be about $150,000, fully covered by insurance. The origin of the fire is unknown.

TRENTON, N. J.—Articles have been filed with the secretary of state, merging the American Telephone and Telegraph Company of New Jersey, the New York & Philadelphia Telephone and Telegraph Company and the Midland Telephone and Telegraph Company into the American Telephone and Telegraph Company of New Jersey. The new company has an authorized capital of $130,000, and is a long-distance branch of the Bell telephone system. The officers are Edward J. Holl, Morris Township, N. J., president; Edward P. Meaney, Newark, vice-president; Melville Egleston, Elizabeth, secretary; James P. Vail, New York, treasurer.

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INDUSTRIAL ITEMS.

NERNST LAMP COMPANY, New York, announces the removal of its office from the Equitable Building to the New Hanover Bank Building, 11 Pine street.

CROCKER-WHEELER COMPANY, Ampere, N. J., has issued a very attractive bulletin showing a Crocker-Wheeler railway generator, which will be sent upon request.

MOHAWK AUTOMOBILE COMPANY, Detroit, Mich., is about to have an immense factory erected. The company was recently incorporated with a capital of $400,000.

NEW YORK CENTRAL & HUDSON RIVER RAILROAD COMPANY is having installed at Carman, N. Y., an automatic electric system of signals at an expense of $25,000.

THE GREENFIELD ELECTRIC LIGHT AND POWER COMPANY, Greenfield, Mass., has petitioned for leave to issue $100,000 of bonds, $75,000 of which will be for a dam and power plant on the Dearfield river.

SARGENT, CONANT & COMPANY, Boston, Mass., have recently completed the installation of an electric lighting and power system for the town of Groton, Ct., and will shortly begin work on a similar equipment for the town of Millers Falls, Mass.

WESTINGHOUSE MACHINE COMPANY, Pittsburg, Pa., recently secured an order for the largest turbo-generators in the world, which are to be installed at the Long Island City powerhouse of the new Pennsylvania terminal, and will consist of three 5,500-kilowatt turbo-generator units.

THE NERNST LAMP COMPANY, Pittsburg, Pa., has recently established an agency for the sale of Nernst lamps and supplies with the W. G. Nagel Company, Toledo, Ohio. The W. G. Nagel Company, for several years past, has acted as selling agent for the Westinghouse Electric and Manufacturing Company.

THE OSBURN-MORGAN COMPANY, Cleveland, Ohio, has entered into negotiations with the Crouse-Hinds Company, Syracuse, N. Y., to take over the sole patents and rights of the Osburn-Morgan Company's arc lamp department. The matter is not at present consummated, and a further statement will be made by the company at a later date.

THE L. B. ALLEN COMPANY, Inc., Chicago, Ill., is distributing some attractive literature descriptive of its several specialties. This consists of soldering sticks, pastes or salts, and commutator compound. The Allen soldering stick is popular for many forms of work. This is a soldering agent put up in round sticks, six inches long and one inch in diameter.

THE BOARD OF PUBLIC WORKS, Seattle, Wash., has let part of the contracts for the proposed municipal power plant as follows: Wiring cable, Standard Underground Cable Company, Pittsburg, Pa., amounting to approximately $29,856; water-wheels and equipments, Pelton Water-Wheel Company, New York, amounting to approximately $13,080; 250 tons, forty-eight-inch steel pipe, T. A. Gillespie & Company, Pittsburg, Pa., amounting to approximately $14,098.

THE MONASH-YOUNKER COMPANY, 43 Centre street, New York city, and 207 South Canal street, Chicago, is manufacturing the Monash automatic air valve for steam radiators, for which the manufacturer claims several excellent characteristics. It prevents flooding of floors, it has no cap to be lost and there are no screws exposed. The company states that these automatic air valves are in use in over 55,800 buildings in this and foreign countries. A card descriptive of the Monash steam trap for high or low pressure will be sent on request.

THE THOMAS E. CLARK WIRELESS TELEGRAPH-TELEPHONE COMPANY, Detroit, Mich., gave a practical demonstration of the commercial availability of its system at the Michigan State Fair, recently held at the city of Pontiac. A number of stations was located on the grounds, in charge of the company's operators, who were kept busy sending and receiving over 3,000 messages to private parties, heads of departments, officers, judges of the fair and city officials. The "Junior" type Clark instruments, operated with dry batteries, were used. The company states that a high efficiency of operation and positive accuracy were secured.

THE NORTH ELECTRIC COMPANY, Cleveland, Ohio, gave its annual field day to its employés at Silver Lake, thirty-five miles south of Cleveland, Ohio, on Saturday, September 12. An elaborate programme of field sports was indulged in, for which valuable prizes were given. Two baseball teams, composed of employés of the North Electric Company, contested for the valuable silver cup which is a permanent challenge trophy and is played for by these teams each year. The party went to and returned from Silver Lake in a special train of ten coaches. Mr. F. F. Sapp, manager of the sales department, was the official starter.

KELLOGG SWITCHBOARD & SUPPLY COMPANY, through its eastern district office, Philadelphia, Pa., reports recent sales as follows: Dallas, Pa., 209-line switchboard and telephones; Tunkhannock, Pa., 100-line switchboard and telephones; New Albany, Pa., 25-line switchboard and telephones; Waterside, Pa., 25-line switchboard and telephones; Alexandria, Va., 350-line switchboard and telephones; Perth Amboy, N. J., 150-line switchboard and telephones; Lambertville, N. J., 150-line switchboard and telephones; Flemington, N. J., 150-line switchboard and telephones; New Egypt, N. J., 100-line switchboard and telephones; New Lisbon, N. J., 100-line switchboard and telephones. In addition to the foregoing list of sales, the company has just received orders for substantial additions to the "Main" and "Race" Exchanges of the Keystone Telephone Company in Philadelphia, amounting to five sections for each exchange, making the total present equipment of each of the above exchanges 5,200 lines. Mr. Paul W. Bossart is manager of the eastern district office of the Kellogg Switchboard and Supply Company.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, Pa., has recently closed contracts for the installation of batteries of chloride accumulator for the Indianapolis & Northern Railway, of Sulphur Springs, Ind., making seven batteries operated by this company at Broad Ripple; an increase in the two batteries recently installed for the Los Angeles Railway Company, Los Angeles, Cal.; and an installation for the Northwestern Elevated Railway, of Chicago, Ill. Four new batteries have been contracted for by the Chicago Edison Company, making thirteen batteries operated by this company. An installation has been contracted for for the Paterson Edison Company, Paterson, N. J., also a second battery for the Los Angeles Edison Company, Los Angeles, Cal., and an additional battery for the New York Edison Company, which makes twenty-two batteries operated by this company. Isolated lighting and power plants are being installed for the Murphy Building and for William P. Stevenson, Detroit, Mich.; Alexander Winton, Cleveland, Ohio; F. T. F. Lovejoy, Pittsburg, Pa.; the House of the Good Shepherd, Roxbury, Mass., and for the Irving Building, Louisville, Ky.

LOOSE-WILES CRACKER AND CANDY COMPANY, Kansas City, Mo., has recently completed the construction of a new factory located at Eighth, Santa Fe and Henning streets. The new building is of modern mill construction and is 184 feet long by 128 feet in width and consists of six stories and basement. The power equipment of this factory embraces one seventy-five-kilowatt and one 100-kilowatt Westinghouse generators, connected to straight line high-speed engines. There are also a number of Westinghouse motors in use in this establishment. The current which is supplied to these motors at 110 volts is conveyed from the switchboard by means of rubber-covered cables, the power is economically distributed, a submotor being provided for each department. All motors are suspended from the ceiling and are connected to the machinery by belts. The switchboard apparatus is also supplied by the Westinghouse company. Connections between the switchboard and generators are such as to allow the operation of either generator for power or lighting exclusively or both generators may be used for lighting and power at the same time. The boiler plant consists of six tubular boilers, each sixty inches in diameter by sixteen feet long. These boilers are equipped with Roney mechanical stokers.

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CHARLES W. PRICE . . . . . PRESIDENT AND EDITOR
STEPHEN H. GODDARD . . . . . SECRETARY AND MANAGER
WM. HAND BROWNE, JR. . . . . TECHNICAL EDITOR
AINSLIE A. GRAY . . . . . ASSISTANT EDITOR

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CONTENTS

EDITORIAL 461, 462, 463
The Institute Meeting 461
Are Dynamos Ill Tempered? 462
Electricity in Gold Extraction 462
Electric Power from Space 462
New Methods of Fuel Economy, by George E. Walsh 464
A Suggested Hydraulic Unit, by Ralph L. Montagu 465
Electric Car Lines in Germany 465
European Electrically Operated Cranes, by Frank C. Perkins 466
The Franklin Institute 469
The Brooklyn Institute of Arts and Sciences 469
Night School Courses in Electrical Engineering 469
The Use of Aluminum as an Electrical Conductor, by John B. C. Kershaw. 470
An Efficient High-Pressure Water Power Transmission Plant, by George J. Henry, Jr., and Joseph N. Le Conte 472
Train Lighting by Oil Engine Units 477
The 179th Meeting of the American Institute of Electrical Engineers 478
Electrical Progress in Russia 479
Elimination of Platinum in Incandescent Lamps 479
Two Western Power and Lighting Plants, by J. H. Rusby 480
New South Wales Railway and Tramway Ambulance Corps 481
Electrical Patents 482
Effect of Vacuum on the Steam Turbine 483
A Proposed Electric Railway in Switzerland 483
REVIEWS OF CURRENT ENGINEERING AND SCIENTIFIC LITERATURE 484
Good Telephone Talking 485
INDUSTRIAL SECTION:
Twenty-two Thousand Horse-Power in Steam Turbines for Pennsylvania Railroad 486
A Heavy Service Electric Truck 486
Motor-Driven Bolt Cutters 487
An Electric Car Lighting System 487
Paper-Insulated Cables 487
New Magneto Series or Bridging Telephone 488
A Light Weight Motor 488
A New World's Record in Coal Hoisting 489
New Type Battery Telephone 489
Vacuum Drying and Evaporating Apparatus 490
The American Electrotherapeutic Association 490
American Telegraphers' Tournament Association 490
A Possible Method of Reducing the Time in Making X-Light Exposures 490
Artificial Niagara at St. Louis 491
New Fireproof Car for the Paris Metropolitan, by C. L. Durand 491
CURRENT ELECTRICAL NEWS 492–496

In Europe several installations for transmitting power have adopted a high-tension direct-current system and use the earth as the return conductor. The problem is now presented to the officers of these companies to prevent outsiders from diverting the return current on its way back to the power-house and using it for their own purposes. The question involved is troublesome because any one who has authority to run an electric circuit may ground his line as often as he pleases, and if part of the current returning to the power-house finds it easier to travel along one of these lines, the constructor can not be blamed for this. Indeed, such a current might be very troublesome. On the other hand, if the owner of such a line can utilize a wandering current of this kind for charging a storage battery, say, or any other purpose, he can hardly be made to pay for this, because he is really doing the power company a favor in allowing part of its current to return over his line.

THE INSTITUTE MEETING.

With the meeting on Friday, September 25, the American Institute of Electrical Engineers began another busy year. Mr. Bion J. Arnold, the new president, took the reins and in a short address outlined his policy for the year. His plans are conservative and are intended to strengthen the Institute where it is now weakest and to maintain the interest in it and in its work. The remarkable increase in membership during the last year, due largely to an active canvass and the establishment of local sections, can not go on indefinitely, and to prevent retrogression the interest of the members in the local sections must not be allowed to lag.

Fewer Papers—More Discussion.

A much needed change in the conduct of the monthly meetings was referred to by the new president. More time is to be allowed to authors for presenting their papers, and to members for discussion. It has frequently been the case that so many papers were presented at one meeting that it was necessary for the author to present his paper in a greatly mutilated condition, and the result has been that few of the members present felt sufficiently familiar with the paper to discuss it intelligently. If more time is allowed for each paper there is no doubt that this will cause a more satisfactory discussion which will probably be the means of bringing to the Institute some valuable papers which would not otherwise be presented. To say the least, there is little satisfaction in preparing a paper carefully, with much expense of time and trouble, and then being forced by lack of time to read but the merest outline and to get little or no discussion. This policy should also raise the standard, as a whole, of papers presented to the Institute. Not to mince matters, a number of papers has been presented at Institute meetings which amounted to nothing more than an announcement of a new system of operation or a new class of apparatus. In papers of this kind the authors can give but little information of technical value, and the time of the Institute should not be taken up by them. The desired publicity can be secured by publication in the technical journals.

Standardization Committee.

Mr. Arnold also pleaded for assistance for the Institute standardization committee. The work of this committee is of great importance to the engineering profession, and members should feel bound to assist it in every way possible.

Papers on Electrohydraulics.

At the meeting three papers on matters connected with electrohydraulics were read. These were all by members from the far West. The authors themselves were not present and the

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papers while of much interest drew out little discussion. This is to be regretted, as the paper by Messrs. Henry and Le Conte described a water power development of unusual interest.

ELECTRIC POWER FROM SPACE.

We have already commented upon the scheme of a western, shall we say, inventor, who says that he is able to draw electricity from the heavens above in unlimited quantities by means of a cable which he intends throwing up into the air.

The Scheme Endorsed.

This gentleman has recently been fortunate enough to have his plans examined by a western, shall we say, engineer, who, according to the daily press, is as enthusiastic as the originator of the idea. The former gentleman says that the latter purposes firing a cylinder vertically into the air above Pike's Peak. This cylinder will contain a magnet, a coil of strong copper wire and a time clock. When a height of two miles is reached the clock (if still in running order) will open the cylinder and the wire will begin falling and uncoiling as the magnet ascends. Finally the magnet will reach the ether and be held there, while the end of the coil of wire touches the earth.

A Possible Danger to Aeronauts.

The unimaginative may wonder why the wire should begin to fall, although the cylinder still keeps on its upward journey. The reason for this is, we are told, the presence of the magnet in the cylinder, which at that height, according to the originator of this scheme, is attracted strongly up into the ether. We would advise all aeronauts to take warning from this, if any magnetic material has been used in the construction of their machines, and never by any possibility rise two miles higher than Pike's Peak. They should remember, as stated in the prospectus of the inventor of this scheme, "from the earth's mass outward in every direction the mind of man contemplates persistent and insatiable distance, engulfing persistent and insatiable distances," lest they too be caught up by the mighty ether, that "unfathomable mystery" which as it "rolls along swallows up, in utter contempt of their magnitude, all these distances and passes on."

ARE DYNAMOS ILL TEMPERED?

Our esteemed contemporary, the *New York Times*, in commenting upon the very creditable performance of the generating plant of the Westchester Railway Company, at New Rochelle, N. Y., which continued to run during a fire that destroyed the power-house, says: "It really seemed to the imaginative as if the steam monsters were inspired by a heroic sense of duty and determined to stick to their posts, whatever might be done by their accustomed companions of flesh and blood. And stick they did for at least an hour and a half, until the fire had burned itself out and the engineers were able to make their way in and put an end to the queer display. What renders the episode the queerer is the well-known ill temper of dynamos, big and little, and their tendency to get more or less seriously out of order with small excuse, or none at all, that their attendants can discover."

The editor of the *New York Times* is evidently more familiar with the performance of electrical machinery through reports of accidents and breakdowns than from personal acquaintance with the machines at home. A dynamo is not ill tempered, though it naturally resents abuse, as does any thoroughbred. It requires a little attention, but very little, and when in charge of a man who understands it and sympathizes with it, it will do its work uncomplainingly and will stand more overwork than possibly any other class of machinery. As surmised above, the critic probably has little acquaintance with the behavior of dynamos when at work, a defect which will be corrected with time and the increasing use of electrical machinery.

Bulletin No. 3 of the United States census report on electric railways, just issued, shows that there are now 987 companies with a cost of construction of $2,167,634,077 and a capital stock of $1,315,572,690, as against, in 1890, 706 companies with a cost of construction of $389,357,289 and a capital stock of $289,058,163. In the year 1902 there were 5,871,957,830 passengers who traveled by street and electric railroads. During this time the cars traveled a distance of 1,805,397,802 miles.

ELECTRICITY IN GOLD EXTRACTION.

The gold with which we are most concerned for the moment is that which occurs in metallic form in quartz and quartziferous rocks accompanied only by the usual impurities such as pyrites, mispickel, etc., and alloyed with small quantities of silver, platinum, rhodium, etc. Copper and lead ores in which it is present are best left for discussion when dealing with these metals.

The Classification of Gold Ores.

The gold ores can be conveniently divided into two classes; (*a*) "free milling" and "alluvial" ores, and (*b*) "refractory" ores. These two classes sometimes overlap, as for instance when it becomes necessary to treat an ore by an amalgamation process and the tailings from this process by a subsequent chlorination or cyaniding process. The washing and amalgamation of free milling and alluvial ores are both very simple and inexpensive matters and in all probability the only difficulty that electricity can ever be made to overcome has already been successfully met by the now well-known "Molloy" process, in which the mercury is used as a cathode in dilute sodium sulphate. By this means a "film of hydrogen" is formed on the mercury, or perhaps it is more correct to say that a small quantity of sodium is deposited into the mercury and any oxidation of its surface consequently prevented, so that the prevention of "sickening" is successfully accomplished, the surface remaining bright and more easily catching up and retaining the fine gold. If the price of sodium metal falls sufficiently, it is possible that the more direct means of keeping the mercury bright by simply adding sodium to it will be again resorted to.

Processing Refractory Ores.

The case is somewhat different with regard to refractory ores or tailings which have refused to give up a large proportion of

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their gold to the amalgamation plates. In the ordinary way two courses are open for the treatment of such materials, they must be chlorinated or cyanided. If they are chlorinated a somewhat complicated plant is required and the chlorine has itself to be made, which is a fairly expensive matter in districts where it is usually carried on. The ore is then leached and the resulting dilute solution of gold reduced by charcoal, sulphurous acid or ferrous sulphate, methods in themselves efficient and satisfactory, but somewhat cumbersome.

The Work of the Electrician.

A fair amount of attention has been given by the electrician to this part of the problem, but as a rule it has seemed as though the position of affairs had not been fully understood. As already pointed out, a really free milling ore is better left to the devices of the gold miner, and the electrician need only turn his attention to the refractory ores. In many electrolytic processes the ore is stirred up in a vat with a solution of common salt, carbon anodes are continually agitated in this mud and serve to liberate chlorine which immediately acts upon the gold and dissolves it. The cathode is a mercury one and is intended to catch all gold reduced into it from the chloride of gold solution in the vat. There is reason to believe that all gold which is naturally sufficiently finely divided, together with any float gold, is largely chlorinated and voltaically reduced. The bulk of mud being treated by such a method is, however, very large; there may be for instance several tons of mud being continuously stirred and electrolyzed for a long period of time in a complicated and expensive apparatus, involving large wear and tear and unavoidable loss of mercury. For this reason this method has not attained to much commercial importance.

The Cyanide Process.

The other way of dealing with a refractory ore is by the cyanide method, and here we have an almost perfect process in which electricity, although not essential, may be employed to make it even more perfect. The main disadvantages in the cyanide process are the excessive time required for the cyanide to dissolve the gold, the poisonous nature, and the high cost of the cyanide. The excessive length of time required for the dissolving is to some extent accounted for by the fact that air is required in the reaction, oxygen or some other oxidizing agent, in fact, seems to be necessary, and on a small scale it is possible to hasten the reaction by the use of some such oxidizing agent as bromine, but in practice it does not appear practicable. A very weak solution indeed is theoretically needed to dissolve the gold from an average ore, say 0.005 per cent or less, but in practice it is found necessary to use 0.05 per cent cyanide to dissolve the gold. Even this is too weak to enable the zinc afterward to precipitate the gold from the solution, so that it is found necessary to use five or even ten times as much cyanide for this reason. On the Rand a solution of about 0.3 per cent cyanide is generally used.

Electrical Reduction.

Attention has been directed to the electrical reduction of gold and regeneration of the solution with some degree of success, the solution being made to pass slowly between the electrodes, the gold being plated on to the cathode in the ordinary way. Out of the several processes devised for this purpose probably the most successful has been that of Siemens & Halske. In this process iron anodes and lead cathodes are used; when the cathodes are sufficiently coated with gold they are cupeled for the precious metal. One of the great advantages of electrical processes over the ordinary methods is that they enable a much weaker solution of potassium cyanide to be used than is necessary for the spontaneous precipitation of the gold by metallic zinc, and the strength of the solution may then be influenced only by that necessary for dissolving the gold from the ore, thus saving a considerable loss in cyanide. The electrical method of precipitation is gaining headway in South Africa and in New Zealand. According to A von Gernet, the cost of electrical precipitation for a plant on the Rand treating 500 tons of gold ore per day is as follows:

	Pence per Ton of Ore Treated.
Cyanide	3.4
Filling	10.0
Fuel, power and lime	4.5
Labor, native and white	6.9
Lead and iron	1.8
Charge due to extra cost of plant	0.5
Stores and general	3.2
	30.3

According to another authority as much as ninety-nine per cent of the total gold in the solution can be separated on the cathodes and a strength of 0.5 per cent cyanide (provided that there is no cyanicide in the ore) is sufficient to dissolve the gold at a reasonable rate. The current density generally stated to be most desirable is from 0.03 to 0.06 ampere per square foot of cathode surface and the voltage from four to six volts. The time required to deposit the whole of the gold held in solution seems to vary considerably according to the efficiency of the circulation of the liquid, but Cowper-Coles, by his process, claims to have deposited from a 0.01 per cent solution of potassium cyanide containing 2.5 pennyweights of gold per ton, ninety-five per cent of the total in ten hours, the rate of flow of liquid being fifteen gallons per 100 hours for every cubic foot of cell or three square feet of cathode surface.

Electricity in the Cyanide Process.

Many suggestions have been made for aiding the dissolution of the gold in the cyanide by electrical means, but the fundamental principle upon which they are based is weak. It is an obvious impossibility to bring any reasonable proportion of the fine gold into contact with an anode, however it may be constructed, and the mere passing of the current through the mud and thus using the small gold particles as "intermediate" or "secondary" electrodes can not be expected to help matters at all, since, the particles being so small, the current would prefer to go round them to passing through them, and thus would be of no service. Even if a small proportion did go through these particles of gold, the efficiency of the process would be almost nil.

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NEW METHODS OF FUEL ECONOMY.

BY GEORGE E. WALSH.

The question of saving of labor in the boiler room has always been considered of first importance in all matters pertaining to economy of power production, and the mechanical appliances invented for accomplishing this purpose are almost infinite in their variety and working efficiency. But apparently we have almost reached a limit in this direction, and what may be called indirect economy of fuel in the past will no longer hold out alluring prizes to the inventor. To-day the direct method of saving in fuel is the one which attracts attention, and which must continue to expand in proportion to the development of our industries. Whether we consider the steam or electrical plants throughout the country, the same demand for economy in fuel is observed, and manufacturers are earnestly seeking some way to cut down the cost of their fuel outlay.

There is good reason for this, for the price of coal threatens to rise to almost prohibitive figures. With the wonderful expansion of our industries in the past decade, the call upon our coal supply has outrun all increase in the production. On the Pacific coast and in the great central states, manufacturing industries were practically shut out of existence because of the expense of fuel; but within the past few years there has developed a most remarkable change in these sections. Scores of manufacturing plants have sprung up in all of the central prairie states and on the Pacific coast simply through the use of oil as a fuel or by the harnessing of streams of water and the long-distance transmission of electrical energy. A cheap power has thus suddenly been placed within the reach of all, and the country is amazed at the rapid industrial development of the great Rocky mountain regions and Pacific coast states.

Fuel economy of a direct or indirect nature has been the cause of this industrial revolution. Electrical energy transmitted from the mountain streams of California long distances for lighting the streets, and operating cars and factories, has entered directly into competition with the users of petroleum for generating power. If it had been otherwise the price of oil on the Pacific coast would have long before this advanced so that it would have been less profitable to use it for power purposes. The advent of electrical power in the field will not only keep down the cost of engine fuel, but it may in time to a large extent supersede it entirely.

It has been shown on the Atlantic coast that the cost of fuel varies directly and very quickly with the expansion or contraction of manufacturing trade. Coal as a fuel has long been the criterion of trade. Prices for it have depended upon the industrial condition of the country. It was never so high as it has been in the past few years since our manufacturing industries reached their highest maximum. Then came oil as a fuel, and Texas and the South promised to place within the reach of all a cheaper fuel than was ever before used on the Atlantic seaboard. But the supplies of oil are after all limited, and extensive demand for the fuel inevitably increases the price. Oil has advanced with coal, and if much further increase in the price is made it will be on a par with coal. Yet indirectly the general use of oil as a manufacturing fuel improves the situation. It reduces the use of coal to a certain extent, and anything which does this must tend to check advancing coal prices. Every boiler-room appliance for saving steam, power and waste in any form acted in the same way: but the trouble has been that all these combined have failed to offset the increasing expansion of our industries dependent upon fuel for their life and growth.

The widespread use of electricity for manufacturing purposes has even a more important effect upon the fuel problem. Every time a river, stream or waterfall is harnessed for long-distance transmission of electrical energy there is a distinct saving in the fuel bill to the whole country. The demand for coal is just so much limited and restricted. A greater fuel economizer could not thus be invented by man than this. The great central Rocky mountain regions and the Pacific coast states can get along without much coal, and yet support a great manufacturing industrial life. The change affected makes these regions independent of the coal states and the owners of the mines. Likewise in the great Niagara district coal is no longer an important factor. It has been eliminated for industrial use, and it will gradually receive less and less attention as a household factor. The harnessing of Niagara has completely changed the whole face of the question.

But in the seaboard states coal must continue indefinitely as a factor in the industrial situation, and even the generators of electrical power must look to the fuel problem with anxious eyes. The boiler room is still with them one of the most important parts of their plants. Fuel economy indirectly with the use of mechanical appliances for saving fuel, and directly in burning substitutes for coal, must concern the electrical plants as much as the steam power factories. The two have similar ambitions and the same class of difficult questions to overcome. Electrical energy from the tides and ocean may some time in the future make the seaboard as independent of the coal pile as the Pacific coast region is to-day; but until such a happy realization of long-anticipated dreams, the solid, hard facts of the case must be faced. It is neither upon coal nor oil that the manufacturers can place their utmost reliance. The two are bound to seek a maximum price which will exact every pound of flesh from the manufacturers. Competition is the only factor that can change all these. A new fuel, or substitutes for coal and oil, must be discovered to fight down the rising prices for fuel, and to supply the expanding industries with all that they need to keep their factories and mills running.

The briquetting of waste fuels is probably one of the most satisfactory methods of meeting this condition. We have made great improvements in the boiler room by burning slack coal by the aid of the automatic stoker, and we have succeeded in burning coal dust by means of blasts of air driven under pressure into the furnaces; but all the economies effected in these directions are still inadequate. Waste fuel material must be briquetted and prepared for market so that it can enter into direct competition with coal. In this respect we have been far behind the European countries. Germany and England use briquetted fuel on an extensive scale, and from their point of view we are the most wasteful nation in the world in using fuel. We let waste material lie around us undisturbed, while we foster the advance of coal prices by using it freely and wastefully. The few briquetting plants established in this country in the past few years are laboring, largely experimentally, to establish an industry which shall completely change past conditions.

It is estimated that millions of tons of excellent peat are scattered over the surface of this country, covering thousands of square miles. In its present form it would be of little general use as a factor in the situation; but if briquetted and pressed into marketable shape it

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would gradually prove a formidable rival to coal and oil. If these peat beds were worked successfully, and the briquetting plants permanently established with a large output, the price of coal would undoubtedly be lowered. The ordinary laws of supply and demand would cause this. In certain lines of manufacturing hard and soft coal can never be displaced by any substitute fuel, but where we find one plant limited in this respect there are a score which could use peat put up in briquette form with the most satisfactory results. The restricted use of coal would thus permanently affect the market prices, and enable manufacturers to realize profits where to-day they frequently must see them go up the chimney in smoke.

The electrical plants using fuel for generating their power could make a good start in the right direction by the general use of fuel substitutes whenever possible. In time we may find it possible to generate electrical power as cheaply with briquetted fuel as from the tides of rivers; but certainly not until a new industry of enormous proportions has been established. Meanwhile, reports are current that German briquetting companies are receiving options on the extensive peat beds in various parts of the country for the purpose of duplicating their home success in this country. Certainly this would prove gratifying to the manufacturing industries if Americans are not ambitious enough to see and make the most of their opportunities.

A SUGGESTED HYDRAULIC UNIT.[1]

BY RALPH L. MONTAGU.

There is a unit of measurement of the flow of water known as the "miner's inch." The legal definition of the means of measuring this volume varies so much in different states that the actual flow of legal miners' inches is from 1.36 to 1.73 cubic feet of water per minute. For this reason a miner's inch unless the cubic feet flow per minute that it represents is specified, can be dispensed with.

On the other hand formulæ relating to horse-power of water are based on the number of cubic feet of water per minute, or gallons, under a certain head; that is, the vertical distance of fall. I wish to suggest that a new unit composed of one cubic foot of water per minute under one foot head be recognized and a name for it suggested by members of the Institute.

This unit = 62.3808 foot-pounds.
= 0.00189 horse-power
= 1.40994 watts.

An analogy can be drawn between this unit and the watt, inasmuch as the head in one is similar to volts in the other, and the cubic feet of water per minute takes the place of amperes in the other.

The following formula for horse-power of water is based on this unit or its equivalent value, *viz.*, 0.00189 horse-power.

$$\text{H.P.} = \frac{\text{Cu. ft. of water per min.} \times \text{hd. in ft.}}{K} \quad (1)$$

$$K \text{ for any efficiency } x = \frac{52900.8}{x} \quad (2)$$

Example—A water power consists of a flow of 3,700 cubic feet of water per minute, with a total available head of 763 feet. There are the following losses due to friction resistance, etc., *viz.*:

Five per cent loss of head from friction in pipe line.

Fifteen per cent in prime motor.

Three per cent in generator.

Three per cent in step-up transformers.

Ten per cent in transmission line.

Three per cent in step-down transformers.

Two per cent in low-tension wiring.

Six per cent in motors.

Required total horse-power available at motor pulleys.

Total efficiency = $100 \times .995 \times .85 \times .97 \times .97 \times .90 \times .97 \times .98 \times .94 = 63.12$.

$$K = \frac{52900.8}{63.12} = 838 \quad (2)$$

$$\text{H. P.} = \frac{3700 \times 763}{838} = 3368 \text{ horse-power available at motor pulleys.} \quad (1)$$

VALUES OF "K" IN FORMULA NO. 1.

Per Cent Efficiency.	"K."	Per Cent Efficiency.	"K."	Per Cent Efficiency.	"K."
94	562	79	669	64	826
93	568	78	678	63	839
92	575	77	687	62	853
91	581	76	696	61	867
90	587	75	705	60	881
89	594	74	714	59	897
88	601	73	724	58	912
87	608	72	734	57	928
86	615	71	745	56	944
85	622	70	755	55	961
84	629	69	766	54	979
83	637	68	777	53	998
82	645	67	789	52	1017
81	653	66	801	51	1037
80	661	65	813	50	1058

NOTE—These values are based on water of specific gravity = 1.

One cubic foot water (sp. gr. 1) weighs 62.3808 pounds.

[1] A paper presented at the 179th meeting of the American Institute of Electrical Engineers, New York, September 25, 1903.

Electric Car Lines in Germany.

Recently published figures place the total number of miles of electric car lines in Germany at 2,117. Considering the area and population of the Empire, these figures show a comparatively slow development of this branch of railway building—this, too, in spite of the fact that in electric lighting and in other applications of electricity Germany has taken advanced rank. The cause of this backwardness is to be sought mainly in the fact of state ownership of the larger part of the existing steam railways and the unwillingness on the part of city and other authorities to grant charters to private companies. Local and suburban travel is heavy, but is as yet carried mainly by steam railway lines, often of cheap construction.

The Grand Duchy of Baden, a small part of the Empire, has an area slightly larger than that of the state of Connecticut, with a population somewhat more than twice as great. In 1900 it had five cities of upward of 40,000 population, namely, Mannheim, Carlsruhe, Freiburg, Pforzheim and Heidelberg. There were in 1900 fourteen cities of upward of 10,000 population. The state includes a thickly settled portion of the Rhine valley about 160 miles long, with an average width of ten miles, which would seem to be a specially good field for electric railway lines, and yet at present electric lines are in operation only in or near the following cities:

	Length of Line. Miles.
Mannheim (including Ludwigshafen extension)	25
Carlsruhe (including line to Durlach)	9
Heidelberg (including Heidelberg-Wiesloch line)	11½
Freiburg	8

In each case the same track is used in part by the cars of several lines. Thus the total track length of the Mannheim city and suburban lines is fourteen miles.

The city of Kehl, Baden, is connected with Strassburg by a branch of the Strassburg city lines, but does not operate an independent line. Of the above lines, each belongs to the respective city except in the case of the Heidelberg city lines which are operated by a private corporation, the city being the owner of three-quarters of the capital stock.

The fare charged varies with the distance, long rides and transfers on a single fare not being permitted to the extent they are in the United States. The fare for ordinary distances is ten pfennigs (two and one-half cents), tickets good for twenty-five rides being sold for two marks (forty-eight cents).

Of the lines now in operation in Baden only two can be said to be interurban lines—a line of about nine miles from Heidelberg to Wiesloch and a somewhat shorter line from Carlsruhe to Durlach.—*H. W. Harris, Consul, Mannheim, Germany, August* 14.

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Vol. 43—No. 14

European Electrically Operated Cranes.

By Frank C. Perkins.

THE use of electric power has caused quite a revolution in the operation of cranes of all types, including the portal, station and traveling jib cranes, and overhead traveling cranes for shops, and factories. The harbor and dock cranes throughout Europe have until recent years been of the steam-driven type, but electric power is now being extensively used throughout the world for this class of work.

FIG. 1.—GERMAN ELECTRIC PORTABLE REVOLVING CRANE AT HAMBURG HARBOR.

Two particular advantages of the electric motive power for cranes of all sorts are the relatively inconsiderable weight of and the small space occupied by the electric motors employed for the raising, turning and traveling gears. The hydraulic crane is not economical, as the consumption of water and, therefore, the power used are in proportion to the height the weight is raised and not at all in proportion to the work done. The amount of power used is thus the same for light loads and heavy loads, and the danger from the frosts during cold weather is always troublesome, while for traveling cranes they are practically useless on account of the difficulty in supplying the hydraulic power. The steam crane also has its disadvantages in that, in addition to the engine, a boiler is required with its added attention in stoking. With the steam crane considerable fuel is wasted in keeping up steam continuously, whether the crane is in operation or not and regardless of how long the intervals may be during which it is at rest. With the steam crane the several movements required must be taken care of by a single engine or two engines at most, as the large amount of space required for three engines to answer the three movements of the crane would be excessive. With one engine a complicated driving gear is necessary, which is entirely avoided by the three-motor electric crane.

The power is easily transmitted to the electric motors on the cranes by small wires and a single controller is often used for operating the three motors, one of which raises and lowers the load, the second directs the swinging to the right or left, while the third motor moves the entire crane into a new position. These movements may be effected independently, or two or three movements may be made simultaneously, thus making it possible for the load to be carried through the shortest distance from one point to another.

The German portal revolving crane, noted in the accompanying illustration, Fig. 1, was constructed at Duisburg On-The-Rhine by the Duisburger Maschinenbau - Actien - Gesellschaft, formerly Bechem & Keetman, and is now in operation at Hamburg at the shipyard of Blohm & Voss. The jib is adjustable and it can execute a full revolution of 360 degrees. The upper carriage of the frame runs on a portal-shaped structure of compact and pleasing appearance, which has sufficient height and span to provide ample space for a double line of

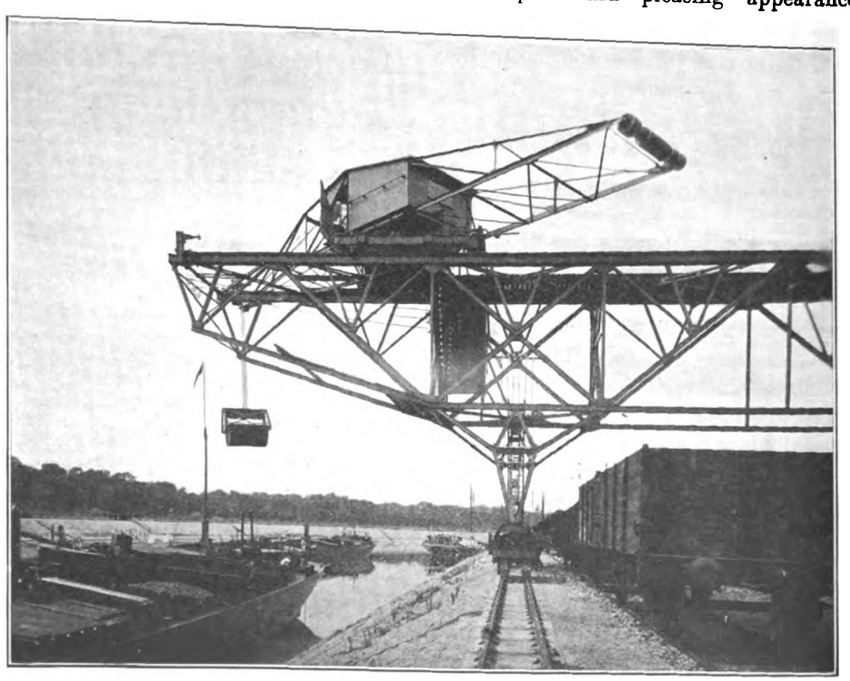

FIG. 2.—ELECTRICALLY OPERATED CRANE BUILT AT KARLSRUHE, BADEN, BY THE GESELLSCHAFT FUR ELEKTRISCHE INDUSTRIE.

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rails and cars passing underneath. The gangway, which is situated on the side overlooking the water and by means of which the traffic between the quay and the ship's deck is carried on, can be adjusted according to the state of the tide.

The carriage of this crane runs on a central pivot and rests upon eight cast-iron-steel wheels, each two of which are joined by an engine beam and run on a roller path which consists of a cast-steel ring with steel rail. The driving power is supplied by a continuous-current motor, and for slewing as well as for adjusting the jib two other motors are provided. There are also two sets of lifting gear for heavy and lighter loads which are driven by a reversible motor. The increasing lifting speed is effected as the load decreases down to the empty hook by the automatic increase of number of revolution of the series motor.

With the large hook and a load of fifty tons, the highest projection of jib being 18.75 metres, the lifting speed is 2.1 metres per minute, and seventy-five tons is used as a trial load with the same highest projection of jib. With twenty-five tons the highest projection of jib is 29.3 metres and the crane operates with an empty hook at a lifting speed of fifty metres per minute. With the small hook and a load of eight tons the highest projection being 31.5 metres, the lifting speed is 15.5 metres per minute, while that of the small empty hook is forty metres per minute.

A complete revolution of the crane takes place in about two and one-quarter minutes. The lifting gear of the large hook carries the load on eight ropes and that of the small hook on two ropes, both ends of the ropes being simultaneously tightened in both of the above cases and each is wound on two drums. The drawing in of the jib is effected by two spindles of wrought steel, which work in boxes of manganese bronze. The spindles work in opposite directions so that the friction moments in the boxes are neutralized in the cogwheels of the jib and have no outward effect. The far-reaching top of the jib is constructed as light as possible, but of ample strength so that the one-sided revolving momentum created by the pressure of the wind is reduced as much as possible.

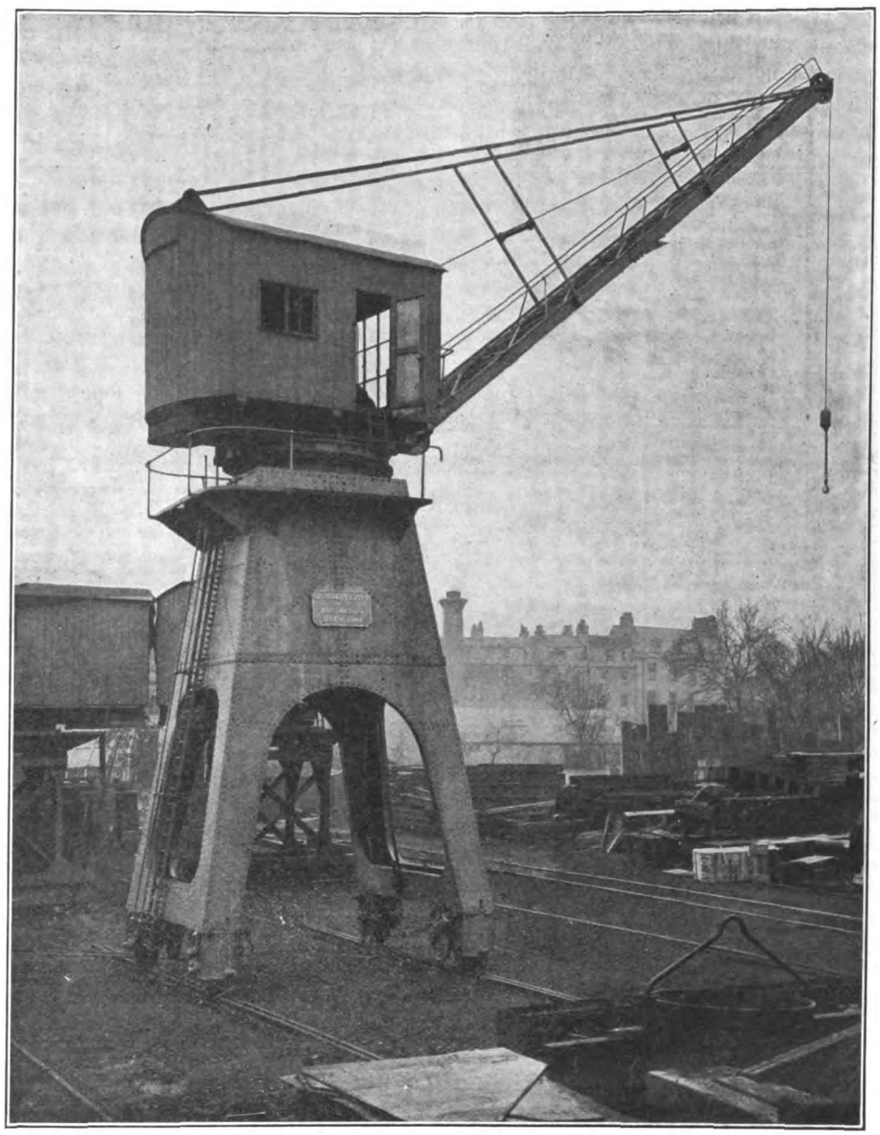

FIG. 3.—THREE-TON ELECTRIC CRANE, BUILT AT BATH, ENGLAND.

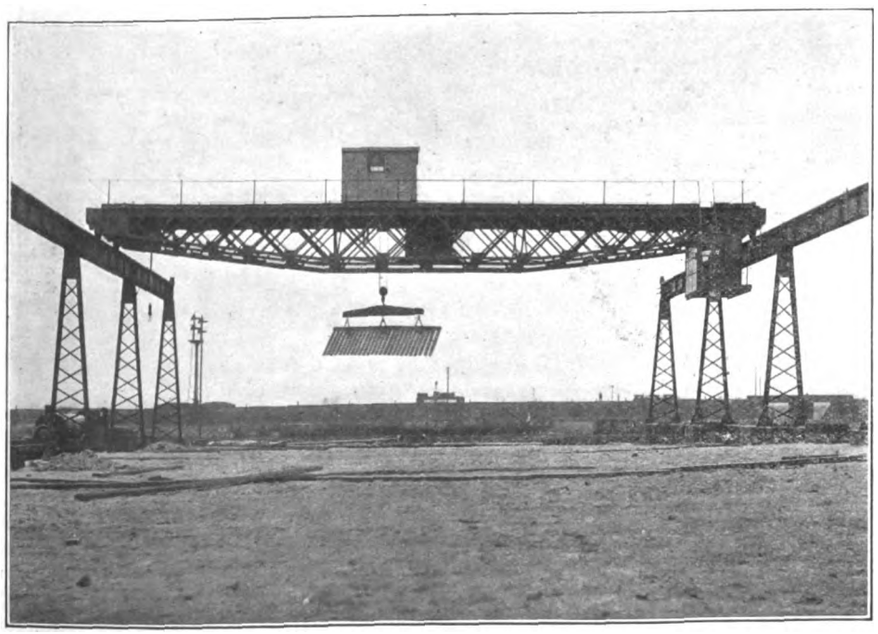

FIG. 4.—FIVE-TON THREE-MOTOR CRANE, SEVENTY-FIVE-FOOT SPAN.

The illustration, Fig. 2, shows an electric coal discharging bridge and crane at the harbor of Karlsruhe, Baden, which was constructed by the Gesellschaft Für Elektrische Industrie. A tower electric crane built at the same plant has a capacity of ten tons, the radius of the jib being six metres and the height twenty-five metres. The three-ton electric crane shown in Fig. 3 was built at Bath, England, for the Clyde trustees of Glasgow

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by Stothert & Pitt, Limited, while Fig. 5 shows another type of electric traveling crane constructed by Royce, Limited, at Manchester. The legs of this crane travel upon rails laid upon the ground, while

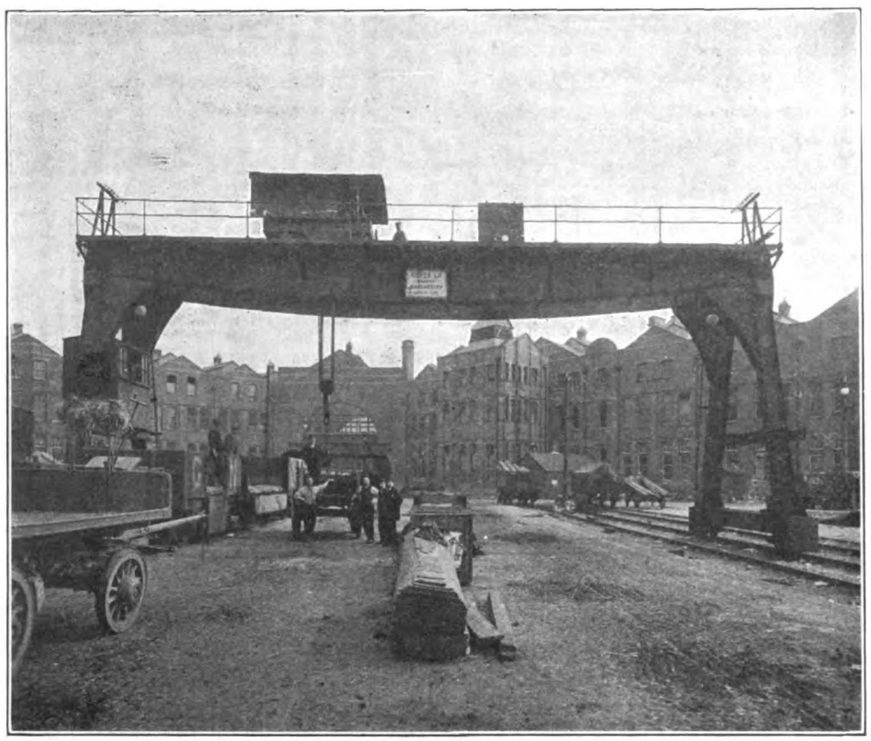

FIG. 5.—TWENTY-FIVE-TON ELECTRIC TRAVELING CRANE, BUILT AT MANCHESTER, ENGLAND, BY ROYCE, LIMITED.

the electric crane seen in Fig. 4 used for a similar purpose is operated upon rails located on elevated structures at either end of the span which measures seventy-five feet. This is a five-ton three-motor crane owned by the Cranforth Hematite Iron Company, Limited, and constructed at Huddersfield, England, by Thomas Broadbent & Sons, Limited, at their Central ironworks.

This crane has a height of lift of thirty feet, and the crane is proportioned in such a manner that the factor of safety is not less than six when operated at full load, this factor being based on the ultimate strength of the materials used.

The speed of longitudinal travel of this electric crane is 400 feet per minute, while that of the cross travel is 100 feet per minute. The rate of lifting the maximum load of five tons is sixty feet per minute, but lighter loads may be lifted and moved at quicker speeds without change of gear.

As will be noted by the illustration, the cross girders are of the double lattice type built up of steel plates, angles and tees, while the end carriages are of box section, the girders being built into them. The trolley is of open box-section steel frames and travels on steel rails placed over the centre of each girder. The steel track wheels are four in number and revolve in bronze bearings.

The motors are of the enclosed ventilated type and operate at 200 volts pressure, direct current being used. The hoisting motor has a capacity of thirty-five horse-power and operates at a speed of 500 revolutions per minute, and the motor for longitudinal travel has the same capacity and speed, while that for cross travel, although running at the same speed, has only an output of five brake-horse-power.

The electric overhead traveling crane for shops, factories and power plants has proven of such great value that it would hardly be dispensed with under any consideration, for the hydraulic, steam or compressed air overhead crane for shop practice or power-houses would hardly be as efficient or convenient as the electric cranes now in use.

Fig. 6 shows an electric overhead traveling crane of the four-motor type, having a capacity of thirty tons, installed for the Bradford Corporation, of England, by Thomas Broadbent & Sons, Limited. One of the larger erecting shops of Brown, Boveri & Company, of Baden, Switzerland, is equipped with two electric traveling cranes of fifteen and thirty tons capacity; and there is an electric alternating-current crane of fifteen tons capacity in operation at the works of the Maschinenfabrik Oerlikon, of Oerlikon, near Zurich, Switzerland.

In considering these various types of electric cranes as utilized for different purposes in European countries, it is interesting to note that foreign engineers are taking advantage of every facility which electric power places within reach for increasing the output of the workshop, for increasing the amount of material handled at the wharves in the principal harbors, and for obtaining this result with less expenditure of energy, thus giving greater economy than could possibly be attained with the older methods of operation.

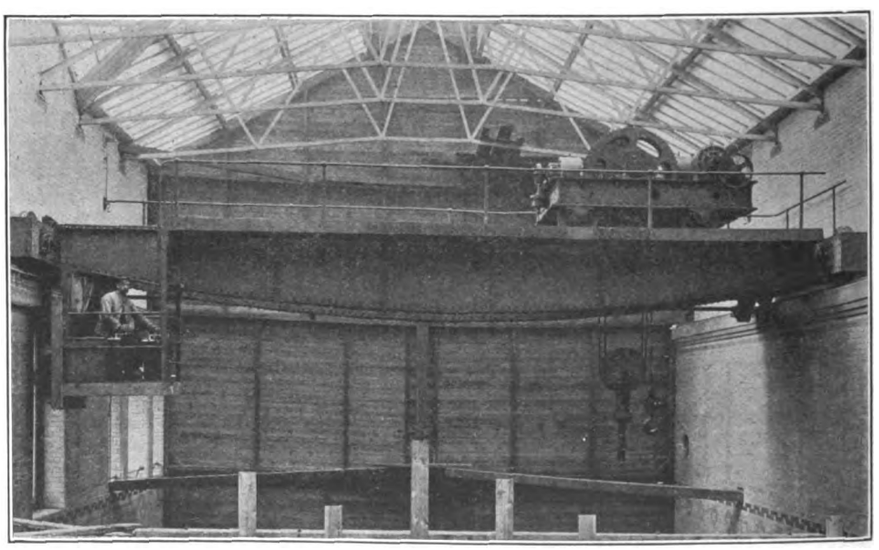

FIG. 6.—THIRTY-TON FOUR-MOTOR CRANE.

According to *Terrestrial Magnetism* the Dutch Government has granted the means for a new magnetic survey of the Dutch archipelago during the years 1904-1907. During each of these years the field work is to cover two to four months, only a general survey being possible with the present means. A beginning has already been made, observations having been made on the "tin island," Billiton, and at some points in the neighborhood of Batavia, and it is also hoped to secure values at different stations in Java partly to obtain early information regarding the secular variation.

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The Franklin Institute.

The Franklin Institute, Philadelphia, Pa., has issued its annual announcement and programme of lectures for the season of 1903-1904. The Franklin Institute of the State of Pennsylvania, for the promotion of the mechanic arts, was founded in 1824. At the present time the library contains 55,468 volumes, some 39,351 pamphlets, 2,860 maps and charts, and 1,240 photographs classified in catalogue. It is exclusively scientific and technical in character, and is steadily increasing in members and importance. It embraces, in addition to the standard and current works on mechanics, physics and chemistry—pure and applied—the publications of the principal scientific and technical societies of the world, files of 528 domestic and foreign scientific and technical serials, and sets of the British (and Colonial), French, German, Austro-Hungarian, Russian, Swiss, Finnish and American patent records.

A series of lectures will be delivered in Association Hall, Fifteenth and Chestnut streets, Philadelphia, under the joint patronage of the institute and the central board of the Young Men's Christian Association, beginning on Friday, October 16. The first lecture is by Mr. William J. Hammer, on "Radium and Other Radioactive Substances." In addition to this the following programme has been arranged:

Friday, October 23, 8 P. M., Dr. H. W. Wiley, chief of bureau of chemistry, United States Department of Agriculture—"Experimental Studies of the Effects of Preservatives and Coloring Matters on the Health and Digestion."

Friday, October 30, 8 P. M., Professor Eugene C. Foster, Philadelphia, Pa.—"Liquid Air."

Friday, November 6, 8 P. M., Mr. John Bradley, Philadelphia, Pa.—"Historic Philadelphia," with colored photographs.

Friday, November 13, 8 P. M., Professor R. W. Wood, Johns Hopkins University—"Fluorescence, Phosphorescence and the Chemical Action of Light."

Friday, November 20, 8 P. M., Mr. F. H. Newell, United States Geological Survey—"The Reclamation Work of the United States Geological Survey."

Tentative engagements have been made with well-known lecturers for the winter course.

In the instruction department, a drawing school and school of machine design, and a night school of naval architecture have been instituted.

In the year 1826 the institute began the publication of a journal devoted to science and mechanical arts, which has been continued uninterruptedly to the present day. The institute meets on the third Wednesday of each month, except in July and August, when papers on important scientific and technical subjects are read and discussed.

The Brooklyn Institute of Arts and Sciences.

The prospectus of the Brooklyn Institute of Arts and Sciences for 1903 and 1904 offers a very attractive series of opportunities in the department of electricity. This covers a course of eight illustrated lectures on "Recent Discoveries in Physical Science and Their Relation to Theories of Matter and Energy," by Professor John S. McKay, Ph. D., on Saturday afternoons at three o'clock; a course of six illustrated lectures on "The Electron Theory; Its Experimental Basis and Its Chemical and Physical Application," by Professor Ernest R. Von Nardroff, Ph. D., on Monday evenings; a course of five illustrated lectures on "Electric Currents," by Professor William E. Geyer. In addition to these there will be a series of illustrated lectures on subjects of current interest during the season. On October 5 there will be a lecture by Professor Harry C. Jones, Ph. D., of Johns Hopkins University, on "Physical Chemistry and the Theory of Electrolytic Dissociation," and on February 8 there will be a lecture by Professor M. I. Pupin, Ph. D., of Columbia University, on "Electric Resonance," or on a kindred subject. Visits to important electrical power stations and works will be made during the year by members of the department.

The collection of electrical apparatus belonging to the department has been transferred to the new museum building, on the Boulevard, opposite the Flatbush avenue entrance to Prospect Park. Important additions have been made to this during the past two years.

In the department of engineering a series of illustrated lectures on engineering will be held at the regular monthly meetings of the department on the fourth Friday evening of each month. This will include a lecture on October 23 by the Hon. William C. Redfield, Commissioner of City Works, Brooklyn, on "Public Improvements in the Borough of Brooklyn;" on November 27, a lecture by Mr. William Hildenbrandt, of the Department of Bridges, on "The Spinning of Bridge Cables;" on January 22, a lecture by Mr. Rudolph Hering, C. E., of the New York City Commission on Additional Water Supply, on "The Supply of Additional Water to New York City;" on February 26, a lecture by Mr. Edward Wegman, C. E., of Katonah, N. Y., on "Roman Aqueducts." Other lectures will be given by the Hon. John M. Woodbury, Commissioner of Street Cleaning, on "The Utilization of City Waste;" on "Bridges Over the East River," by Mr. O. F. Nichols, president of the engineering department, and on "The Engineer, the Contractor and the Proprietor," by Mr. F. Hopkinson Smith, C. E.

Night School Courses in Electrical Engineering.

The Casino Technical Night School, East Pittsburg, Pa., announces several special educational advantages to mechanics, clerks and apprentices. In the various works at East Pittsburg there is a large class of men who are beyond the range of college opportunities, but who will gladly devote a few of their spare hours to profitable study. This school is stated in its prospectus to be adapted to the needs of those who are willing and anxious to advance. Facilities for practical demonstrations, classrooms and a lecture hall capable of seating 350 people have been provided in the Casino buildings at East Pittsburg.

School sessions will be held at the close of shops and offices, at such hours as will be found most convenient for the students. The courses consist of mechanical-electrical engineering, mechanical-steam engineering and shop practice. Each course can be completed in two years.

The school will be under the management and personal supervision of Mr. Henri F. Chadwick, B. S., who has had considerable experience as a teacher and was formerly one of the faculty of Tufts College and of the American School of Correspondence at the Armour Institute of Technology, Chicago, Ill. A number of engineers with theoretical and practical training have been engaged upon the staff of instructors.

Light buoys using electric light, several of which have been used for some years in New York harbor to mark the ship channel in the lower bay, have now been abandoned, and the power station on Sandy Hook which supplied them with current has been closed. The electric buoys have given more or less trouble, mainly because of damaging and breaking of the supply cables by ice or other causes. They have been replaced by the regular style of Pintsch gas buoy.

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THE USE OF ALUMINUM AS AN ELECTRICAL CONDUCTOR.[1]

BY JOHN B. C. KERSHAW.

Introduction—The increasing use of aluminum as an electrical conductor for bare overhead transmission lines, especially in the United States, and the claims made for this metal as a substitute for copper, led the author, in October, 1899, to commence a series of exposure tests at two localities in Lancashire, England.

These tests were made in order to ascertain the resistance to corrosion offered by commercial aluminum rod and wire under the conditions obtaining, with exposed bare overhead wires. Samples of aluminum rod and wire were obtained from the principal English firms, and in order to make the series of observations more complete, samples of galvanized iron wire, and of copper, and tinned copper wire, were also submitted to atmospheric influence. The methods of observation and the results obtained during the first exposure period (from October, 1899, to August, 1900), were described by the author in a paper read before the London Institution of Electrical Engineers on January 10, 1901.

The present paper is the record of the observations made since the date named above, and contains the chemical and physical tests of the aluminum wires exposed at Waterloo, Lancashire, together with the results obtained during two further periods of exposure, namely, from August 22, 1900, to November 6, 1901, and from November 9, 1901, to December 4, 1902.

I. Production and Price—Table I of the 1901 paper dealt with the world production and average price of aluminum in the United States down to 1899. This table has been extended to the year 1902. It will be noticed that no material alteration in the price of aluminum has occurred since 1897, although the production has materially increased.

II. Relative Costs of Copper and Aluminum—As regards the relative costs of copper and aluminum, the formula given in the 1901 paper for calculating the relative prices of equal lengths of the two metals, of equal electric capacity, was as follows:

$$\frac{S \times P \times c}{s \times p \times C}$$

where S, P and C represent the specific gravity, price and conductivity of copper, while *s, p and c* represent the corresponding values for aluminum.

Inserting the latest figures[1] for these values in the formula given above we have

$$\frac{8.93 \times 66 \times 59}{2.68 \times 159 \times 100} = \frac{34,773}{42,612} = \frac{816}{1,\ 00}$$

as the price ratio of the two metals when

TABLE I—WORLD'S PRODUCTION AND AVERAGE PRICE OF ALUMINUM EACH YEAR FOR THE PERIOD 1890–1901.

Year.	Production in Metric Tons of 2,204 Pounds.*	Price per Pound in Pence in U. S. A.	Remarks.†
1890	165	..	
1891	233	75	
1892	487	49	
1893	715	37	Average quality. .93 to 1.64 per cent Si. .32 to 1.66 per cent Fe.
1894	1,240	30	
1895	1,418	27½	
1896	1,789	20	
1897	3,394	17½	
1898	4,033	16⅕	Average quality. .02 to .13 per cent Si. .12 to .32 per cent Fe.
1899	6,807	16⅕	
1900	7,743	16	
1901	7,240	15½	
1902	8,000	..	

* From the "Mineral Industry Annual," vols. viii to xi.
† From *Comptes Rendus*, 1898 - Moissan's tests.

used for electrical purposes, and copper is seen to be the less costly metal. The price of electrolytic copper has, however, undergone such striking variations during the last twelve months that this ground of superiority over aluminum may be lost before this paper is read.

III. Installations of Aluminum for Conducting Purposes—With reference to installations of aluminum for conducting purposes in place of copper, the following must be added to the list of bare transmission lines given in the earlier paper:

1. Niagara Falls and Buffalo, U. S. A., 15,000 horse-power transmitted twenty-two miles. Three aluminum cables; three-phase transmission at 22,000 volts. Each cable made up of thirty-seven strands of aluminum wire.

2. Snoqualmie Falls and Seattle, Wash., 12,000 horse-power transmitted thirty-two miles at 30,000 volts. New aluminum transmission line.

3. Sarno, Pompeii and Forre Annunziate, Italy, transmission of 450 horse-power twelve miles at 3,600 volts.

4. Lewiston & Auburn Electric Company, U. S. A., twenty-one miles.

5. Boston & Maine Railroad, U. S. A., twenty miles.

6. Boston Electric Lighting Company, U. S. A., 100,000 pounds.

7. Shawinigan Falls and Montreal, Canada (under construction), transmission of power eighty-four miles at 50,000 volts. It is stated that 250,000 pounds of aluminum will be required for his line, which is to be made up of seven strands of No. 6 wire.

8. Massachusetts Electric Company, 500,000 pounds.

9. Old Colony Street Railway Company, Maine, ten miles.

The author has heard of only one installation of bare aluminum conductors for power transmission in the United Kingdom or in Germany, outside of the works manufacturing the metal.

IV. Durability Tests of Aluminum and Other Metals under Atmospheric Exposure—As regards the durability tests of aluminum and other wires, commenced in October, 1899, the following details from the original paper are given in order to enable those present to understand the methods of observation employed.

The rods and wire were cut into two-foot lengths, and were mounted upon glass insulators in two frames, so that their position was parallel one to the other, and all were horizontal with regard to the ground. The frames carrying the wires were so placed that the drops of water collecting upon the wires in wet weather could not by any chance pass from one wire to another, and thus bring electrolytic action into play. Each length of wire was carefully marked and weighed before commencing the exposure, and the weights recorded. The one frame with its nine insulated sample wires was exposed upon the roof of a building in St. Helens, Lancashire, from October 11, 1899, to August 23, 1900; and the second frame was similarly exposed at Waterloo, Lancashire, for the same period of ten months.

The climate of St. Helens is probably too well known to need description; but it has improved considerably in recent years owing to the closing of several chemical works. The place in which the wires were exposed is now singularly free from chlorine and hydrochloric acid gases.

Waterloo is on the Mersey, six miles north of Liverpool, and its atmosphere is that of an ordinary west-country seaside town, plus much sand. During the exposure period of ten months the frames were not touched or moved. At the end of this period the wires were removed from the frames, cleaned from the soot and dirt of all kinds which had accumu-

[1] Abstract of a paper read before Section G of the British Association at Southport on Monday, September 14, 1903.

[1] Prices of the metals in rod form, July 31, 1903 - Copper, £66 per ton; aluminum, £159 per ton.

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lated upon them, and after thoroughly air-drying, were weighed.

The second set of wires which were exposed at St. Helens, were unfortunately destroyed in 1901 during repairs to the roof upon which they were placed, and consequently the exposure tests have only been continued at Waterloo.

The sample of aluminum wire marked 4, though purer than the other samples, was nevertheless badly corroded at the end of one year's exposure.

The galvanized iron wires though unchanged in appearance to the eye, gradually lost in weight—this loss being a progressive one, and greatest in the third year.

strength; but the one per cent of silicon was an unnecessary and harmful impurity. The low relative conductivity of fifty-one for this wire is only what one would expect with a sample containing over three per cent of silicon and iron.

V. Conclusions.—The author does not wish to base any unfair conclusions upon the result obtained in these exposure tests.

TABLE II—RESULTS OF EXPOSURE TESTS ON ALUMINUM AND OTHER WIRES AT WATERLOO, LIVERPOOL.

Composition and Form of Sample.	First Exposure, October 18, 1899, to August 16, 1900.		Second Exposure, August 22, 1900, to November 6, 1901.		Third Exposure, November 9, 1901, to December 4, 1902.	
	Changes in Weight.*	Remarks.	Changes in Weight.*	Remarks.	Changes in Weight.*	Remarks.
Aluminum rod, ⅜ in. diameter...	Nil.	These five samples were all pitted, especially on the undersides where water drops had collected and dried.	+ .11%	Badly pitted and corroded, especially on undersides of rods.	+ .03%	Badly pitted and corroded, especially on undersides of rods.
" ½ in. "	+ .13%		+ .18%		+ .025%	
Aluminum wire, No. 1 sample..	+ .41%		This sample was withdrawn for physical and chemical tests, August, 1900.			
" No 2 "	Nil.		+ .50%	Badly pitted and corroded, especially on undersides of wires.	This sample was withdrawn for physical and chemical tests Nov., 1901.	
" No. 3 "	+ .55%		Nil.		+ .33%	Badly pitted and corroded, especially on undersides of wires.
" No 4 "	....	.....	..	.....	+ .87%	
Galvanized iron wire, No. 1 sample.....	— .15%	No change in appearance to the eye.	— .46%	No change in appearance to the eye.	— .54%	No change in appearance to the eye.
Galvanized iron wire, No. 2 sample.....	— .16%		— .80%		— 1.10%	
Copper wire No. 1 samp'e.....	Nil.	Oxidized on surface but not pitted or corroded.	Nil.	Tinned copper wire no longer distinguishable from untinned wire—both coated with fine black deposit of CuO.	— .10%	Wires indistinguishable, both quite black.
Tinned copper wire, No. 1 sample.....	Nil.		Nil.		— .06%	

* + equals gain, — equals loss.

Tables II and III contain the results obtained with the Waterloo set of wires and rods, during the three exposure periods extending from October, 1899, to December 4, 1902, and the facts and figures given in these two tables deserve careful consideration.

Summarizing the results recorded in table II, we may say that all the samples of aluminum gained in weight during exposure, and that all were pitted and corroded, especially on the under side where the water drops had collected and dried. The rods appeared to have suffered rather less than the wires, and it is therefore probable that in the course of drawing down into wire the aluminum undergoes physical changes.

The copper and tinned-copper wires, judging by the weight method of testing, stood exposure best, but the latter wire had lost nearly the whole of its tin covering by the end of the second year; and the wires are now indistinguishable.

Table III contains the results of the chemical and physical tests made with the aluminum wires, Nos. 1 to 4. The most striking feature of these results is, the high percentage of impurity, and the low relative conductivity of the samples of aluminum, sold for conducting purposes in the United Kingdom in the year 1899, and the slight deterioration both in breaking load and conductivity during exposure. No. 1 wire was evidently alloyed with iron to increase its tensile

He may, however, claim to have proved that some of the aluminum rod and wire which was being manufactured and sold in England for electrical purposes in the years 1899 and 1901 was not able to stand atmospheric exposure on the coast of Lancashire without corrosion. It is only a fair deduction from these exposure tests to assert, that aluminum manufacturers have yet to prove the metal to be a satisfactory and durable substitute for copper in bare overhead transmission lines, or for electrical work which involves exposure to climate near the coast.

The author's thanks are due to Dr. Glazebrook, of the National Physical Laboratory, London, for assistance received in the course of this investigation.

TABLE III—CHEMICAL AND PHYSICAL TESTS OF THE ALUMINUM WIRES USED FOR THE EXPOSURE TESTS AT WATERLOO, LIVERPOOL.

No. of Sample of Aluminum Wire.	Where Obtained and Date.	Diameter in Inches.	Chemical Tests.		Physical Tests.					
			Per Cent Fe.	Per Cent Si.	Relative Conductivity, Copper 100.	Tensile Strength, Tons per Square Inch.	Breaking Load in Kgs.		Linear Resistance—Microhms per Metre at 15° C.	
							Before Exposure.	After Exposure.	Before Exposure.	After Exposure.
No. 1.....	British Aluminium Co., 1899.	.129	2.00	1.06	51.3	?	?	157.50	?	?
No. 2.....	British Aluminium Co., 1899.	.130	Qualitative tests only —Si, Fe, Na, traces of Mn. and C.		54.0 52 1	11.93 11.86	160.5	155.25	3,870	4,330
No. 3.....	T. Bolton & Co., 1899.....	.112	.59 .55	.57	56.0	13.97 14.47	142.25	141.0	4,745	4,900
No. 4.....	Callipe & Dettmar, 1901....	.126	.41 .40	.112 .146	57.6	11.72 11.47	147.0	147.5	3,700	3,760

Notes—1. Owing to the corrosion, no "relative conductivity" tests after exposure were reliable.
2. Chemical tests of Nos. 1, 3 and 4, by J. B. C. Kershaw; of No. 2, by the National Physical Laboratory Chemists.
3. Physical tests of Nos. 2, 3 and 4, by National Physical Laboratory officials.

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AN EFFICIENT HIGH-PRESSURE WATER POWER TRANSMISSION PLANT.[1]

BY GEORGE J. HENRY, JR., AND JOSEPH N. LE CONTE.

An interesting hydraulic electric power transmission plant has recently been started in Southern California by the Edison Electric Company of Los Angeles. The water pressure or head employed is equal to 1,960 feet vertical fall, which is obtained in something over 8,000 feet of pipe line. This gives an effective pressure—after making allowances for friction loss—of considerably over 1,900 feet head, or 825 pounds per square inch, equal to fifty-five atmospheres.

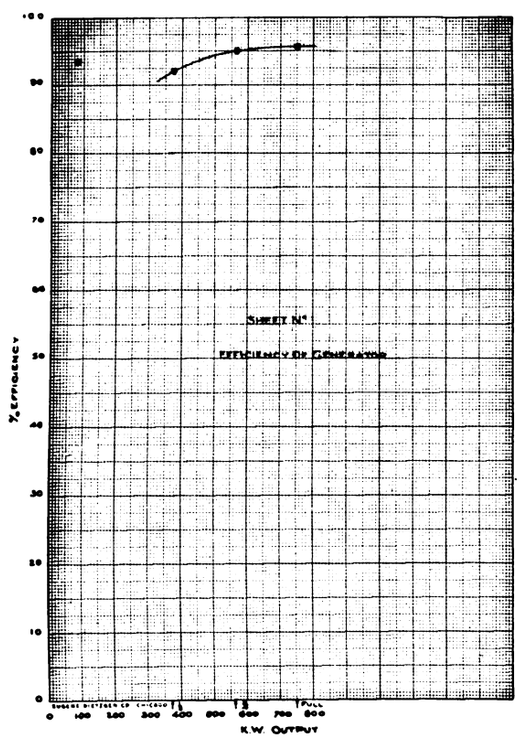

FIG. 1.

The station is located about ten miles from Redlands, in Southern California, and is used on an extensive system, including a number of other power stations, for transmitting power to Los Angeles and largely for irrigation pumping in the San Gabriel valley—celebrated for its oranges and other tropical fruits.

The generators are of 750 kilowatts normal capacity each, running at 430 revolutions per minute and the water-wheels are of the tangential type and mounted on the same shaft as the rotor. This shaft is nine inches in diameter where the wheels are pressed on, and is of forged steel, carried in three generator ring-oiling bearings—the water-wheel being located in what would ordinarily be the pulley compartment of the generator. The box bed-plate of the generator is enlarged to surround the water-wheel pit, and has an opening of three feet four inches by ten feet two inches and is planed and fitted along water-tight joints with the water-wheel housings. These are thoroughly stiffened with internal ribs and provided with centrifugal discs and pockets for preventing leakage of water from the interior of the wheel compartment to the outside, entirely without friction.

Each generator is fitted with a single wheel or runner, which, on account of the enormously high peripheral speed of 170 feet per second, is made of a special rolled-steel plate, thoroughly annealed and turned to eliminate all shrinkage strains. The high speed involved is entirely beyond the limits of safe practice for cast iron, and large cast steel discs contain such dangerous shrinkage strains, in spite of the ordinary annealing process, that it becomes dangerous to employ them under such high water pressures. In addition to the centrifugal strains in the rim of a wheel of this character, we have the strains due to water impact on the buckets. This amounts to about 22,000 on the front bolt of each of the buckets.

The buckets are of soft open-hearth steel castings, thoroughly annealed and machine ground, and polished on the inside to give perfectly smooth and true curved surfaces for the water to flow over. The front edge and centre knife of each bucket is dressed to a perfectly true cutting edge and carefully centered on the wheel rim. The buckets are cast with heavy internal projecting lugs, which are milled out and driven over the wheel centre rim.

The wheel hubs consist of heavy semi-steel castings, to which the steel disc is securely bolted by turned nickel-steel bolts driven in reamed holes. This disc is turned perfectly true all over, and carefully adjusted to a running balance at 430 revolutions per minute. In actual operation about 200 buckets come under the action of the high-pressure water jet every second.

The wheels were built for a maximum overload capacity of fifty per cent, and for continuous service of twenty-four hours a day and 365 days in the year, and no trouble is experienced from the cutting of the buckets and nozzles by the high-pressure water, as after five months' operation the wear is almost imperceptible. The water is usually clear, except for an occasional storm, during which considerable sand and gravel may be washed down into the reservoir at the top of the pipe line. The most severe storm known for many years washed considerable sand down the pipe line just after the wheels were installed and started up, but the steel buckets show no appreciable wear as the result of such severe treatment.

The main pipe line consists of 2,485 linear feet of 26-inch inside diameter sheet-steel riveted pipe, varying in thickness from 14 b. w. g. to 6 b. w. g.

Below this is 2,990 linear feet of twenty-four-inch inside diameter sheet-steel riveted pipe, made of gauges running from No. 6 b. w. g. to nine-sixteenths of an inch.

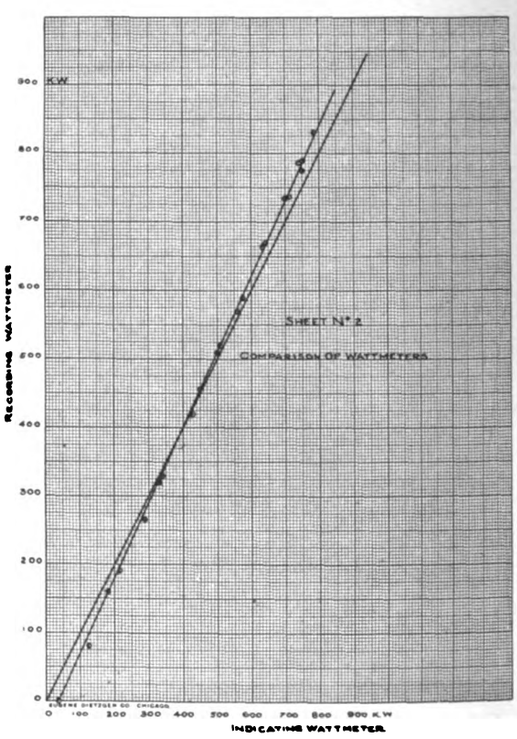

FIG. 2.

Up to this point the design of the pipe line is largely in accordance with well-known practice, but from this point down the pipe consists of:

360 ft. 24" outside dia. 1/8" thick, lap-welded steel pipe.
360 " 24" " " 9/16" " " " "
414 " 24" " " 5/8" " " " "
956 " 24" " " 3/4" " " " "

And below this:

620 ft. 24" outside dia. 3/4" thick, lap-welded steel pipe.

The twenty-foot lengths of the last 620 feet are jointed together with solid steel flanges welded on the ends of the pipe section, all of the other twenty-four-inch lap-welded pipe being put together with "bump" joints.

At the lower end of this flanged pipe

[1] A paper presented at the 179th meeting of the American Institute of Electrical Engineers, New York, September 25, 1908.

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the line branches into two forks, each of which is eighteen inches outside diameter of five-eighths-inch thickness and forty-five feet in length. From each of these terminals the pipe again branches into two lines, each being fourteen inches outside diameter and one-half inch thick, lap-welded—each branch being forty feet in length and terminating just outside of the power-house wall in the cast-steel taper pipe immediately above the gates of the water-wheels. The branch from the twenty-four-inch to the eighteen-inch and the two branches from the eighteen-inch lines to the fourteen-inch are made of heavy annealed-steel castings. The main pipe line, just before the cast steel Y to the eighteen-inch branches, is supplied with a heavy pressure, outside screw and yoke, twenty-four-inch gate valve, and each of the eighteen-inch branch lines is supplied with similar high-pressure cast-steel valves so that the water supply to each of the water-wheels, or groups of water-wheels, may be entirely shut off without emptying the long pipe.

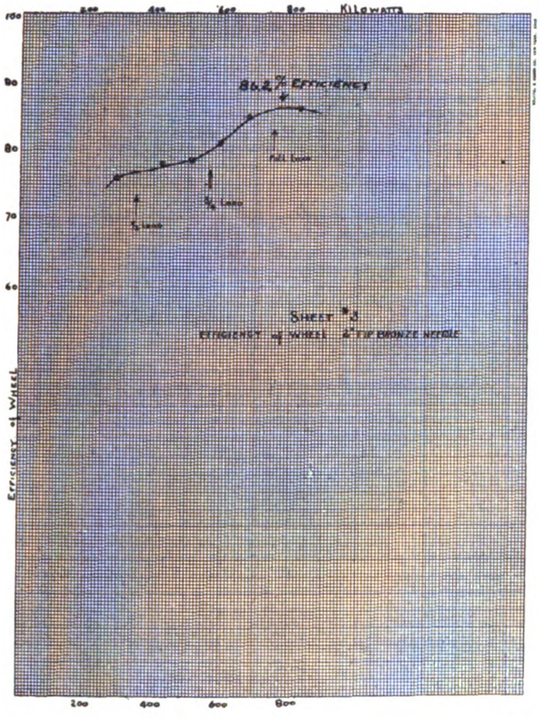

Fig. 3.

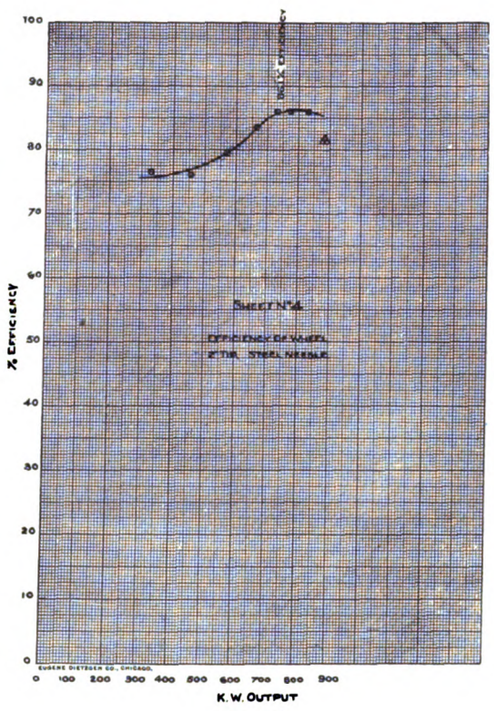

Fig. 4.

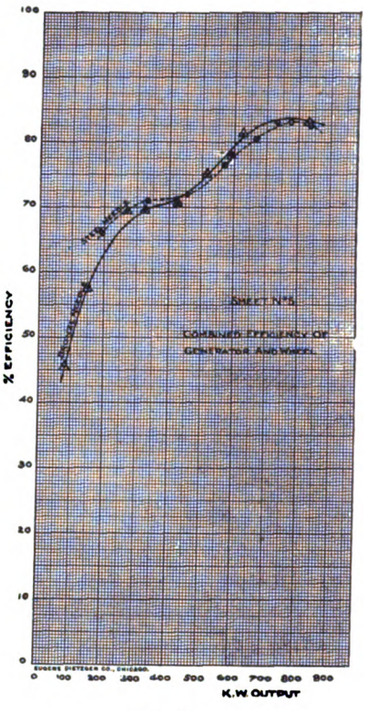

Fig. 5.

The main pipe is protected from accidental water-hammer by several air-chambers of large capacity with the necessary equipment of charging tubes, to recharge the chambers as the air is carried away in solution. The fourteen-inch branch pipes supplying each unit, feed through a cast-steel taper pipe and through a ten-inch single disc, cast-steel body gate valve of outside screw and yoke construction, with Tobin bronze valve stem and with roller bearings for taking up the thrust on the gate-nut in each direction. All of the gate valves are provided with by-passes to reduce the strain when the gates are opened or closed.

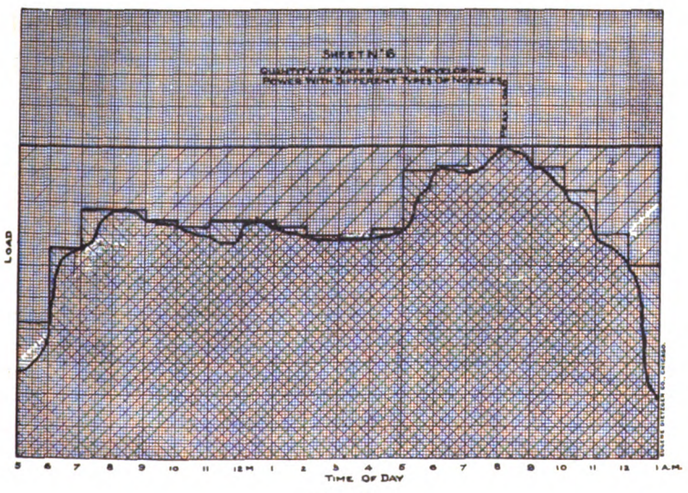

Fig. 6.

The nozzle is one of the most interesting features of the installation. It consists of a combination needle and deflecting nozzle. The deflecting joint arranged for giving the best possible regulation without water-hammer or shock in the pipe line, and water economy secured by the needle nozzle of the Clemmons type. The deflecting nozzle is fitted with a high-pressure ball joint pivoting on nickel steel trunnions, working in oil-packed gun-metal bushings and with leather-packed ball joint. By the motion of the deflecting nozzle the stream may be easily thrown on or off of the buckets by hand, or automatically by the hydraulic governor. It will be readily appreciated that this enables the operator to vary the power output from the wheel from zero to maximum instantaneously and with very small effort, without in any way varying the velocity of water in the main pipe. Absolutely no shock is thus occasioned in the pipe line by the action of the governor due to fluctuations of the load.

The most accurate regulation is further obtainable owing to the very small amount of inertia in the moving parts—the deflecting nozzle joint weighing but a few hundred pounds and being accurately counterbalanced—whereas in turbine installations the unbalanced gates and the inertia of the moving water column seriously interfere with satisfactory regulation. The governor is in no way connected with the operation of the needle, which is for the purpose of regu-

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lating the flow of water through the nozzle at different hours of the day, and is accomplished through suitable geared connections to a floor stand located above the power-house floor. The method of operation is as follows:

From previous records the station attendant knows very closely the peak load that is likely to occur within the hour, and once an hour, or thereabouts, readjusts the size of the stream so that it will safely carry the peak load. The governor then takes care of the load fluctuations, maintaining a constant speed at all times by deflecting more or less of the stream from the water-wheel buckets. In this way a very great saving in water over the old deflecting nozzle when used alone is obtained.

By referring to the accompanying illustrative diagram (Fig. 6), it will be seen that the kilowatt-hours may be represented by the heavily shaded area within the load curves. The lighter shaded space, including the heavy shaded area, indicates the relative quantity of water used by this method to obtain the required output—whereas the very light shaded rectangular area, between the straight line drawn horizontal to the base and passing through the extreme peak, indicates the quantity of water which would be used by a deflecting nozzle only for accomplishing the same power output.

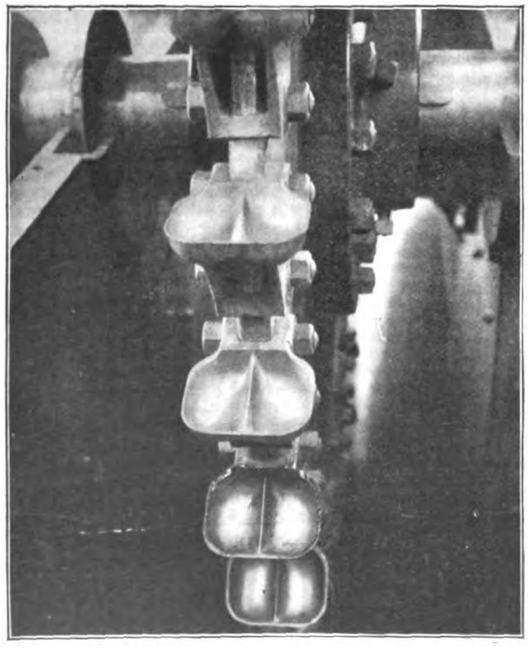

Fig. 8.—Type of Tangential Water-Wheel Buckets Used in the Experiments; One with Paint Partially Washed out to Indicate the Path of the Water-Jet over the Surface During Normal Operation.

It is obvious that the best possible regulation and water economy could be effected without shock to the pipe line if the needle is moved very slowly and follows the action of the governor, closing off some of the water whenever the governor has deflected the nozzle, or opening quickly if the governor calls for more power. The quick opening will not interfere with our pipe safety, whereas quick closing by the needle would be disastrous to a long pipe line under high pressure. With the hand-operated needle and automatic governor-operated deflecting nozzle, this can only be accomplished to a limited degree, as the station attendant can not be expected to remain at the hand-wheel and adjust the size of the stream for frequent governor changes. In some of the most recent plants being constructed we are installing an automatic device for accomplishing this result. This device depends upon the action of the governor before starting its operation and, in combination with the governor, secures the best possible regulation, pipe safety and water economy. The load curve and water quantity curve being almost synchronous, the quantity of water used is about proportional to the kilowatt-hours' output, and exactly so if we leave out of consideration the partial load efficiency of the apparatus. These partial load efficiencies are, however, a very small item in a station employing a number of units and the governors should be adjusted so that they follow each other in action—all but one unit being run full loaded, and governing being accomplished on the remaining unit. A small falling off at partial load efficiency on the unit doing the governing will then represent but an extremely small reduction in the gross efficiency in the whole station.

Fig. 7 shows the curves of the needles used in the following experiments:

The needle nozzle is an extremely satisfactory device in actual operation when well designed and constructed, and the accompanying illustration (Fig. 12) of the jet leaving the nozzle under a pressure of 1,923 feet is interesting as being probably the first instance on record where the spouting stream under so high a water pressure has been photographed.

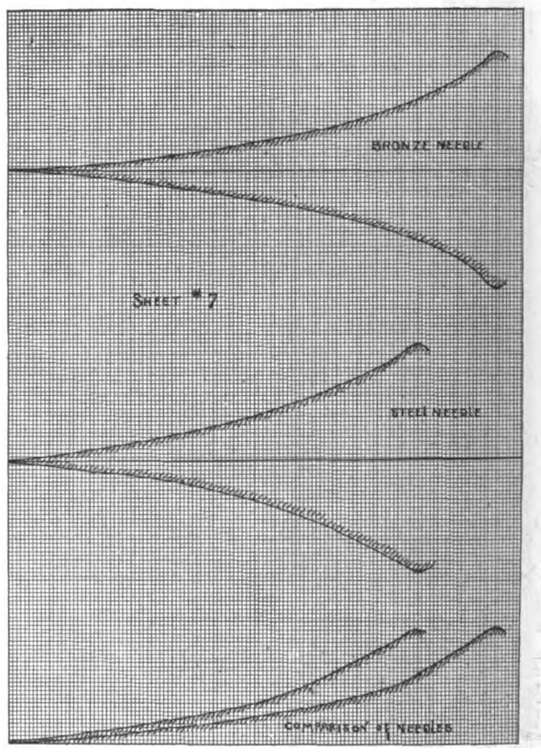

Fig. 7.

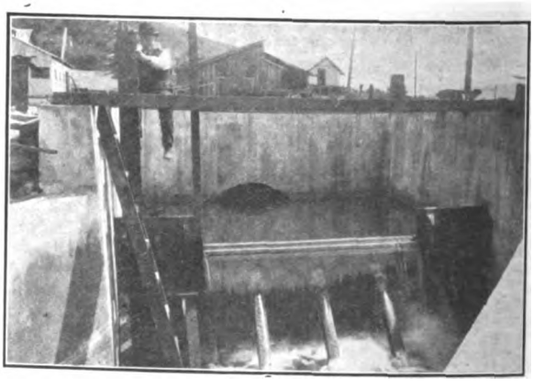

Fig. 9.—Main Weir with Hook-Gauge Measuring Apparatus.

Fig. 8 shows the series of buckets on one of the wheels, one of which the writer painted with a coat of asphaltum varnish. After allowing it to dry for two hours, he put the wheel in operation. The wheel ran at normal load, developing about 750 kilowatts for about twenty hours before being again shut down. The bucket with the paint still remaining on it is clearly shown in the illustration. The location of the remaining paint clearly shows that the water, being discharged from a properly designed and installed wheel with this type of bucket, comes from the sides

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of the bucket and not from the front or back.

For obtaining reliable data for use in the future design of water-wheels some very careful measurements were made on the efficiency and output of these wheels and the results are appended herewith in full.

Although the plant is being used for regular service, it is to some extent in an experimental condition; as, in spite of the high efficiency obtained, some changes are being made with a view, if possible, of still further increasing this. It will be understood that the efficiencies given and exceeding eighty-six per cent are the gross efficiencies of the water-wheel equipment, including the losses in the gate-valve and nozzle, the windage of the wheel, and such slight losses as occur in the buckets. When we consider that the total losses of this type of water-wheel apparatus summed together amount to but a little more than thirteen per cent of the theoretical energy in the water, it will be readily appreciated that the results are extremely high, and can scarcely be surpassed by any other prime mover. The thoroughly satisfactory and continuous operation obtainable from such a tangential water-wheel plant, makes it by far the most satisfactory power known for electric transmission. The maintenance and repair expenses for a plant of this character are almost negligible.

The units are separately excited from a generator driven by an independent water-wheel and from a separate pipe line, supplying only the exciter wheels during the test.

The object of the tests was to determine the efficiency of the wheel for different loads and styles of nozzle tips.

ARRANGEMENTS FOR TESTS AND OBSERVATIONS.

All the water delivered by the wheel under test, as well as that delivered by the exciters, was passed over a rectangular weir of ample capacity. The discharge from the exciter alone was passed over another rectangular weir first, hence the water used by the wheel under test was deduced from the difference of flow over the two weirs. The output of the wheel was determined by the electrical output of the generator, whose efficiency was given by the manufacturer down to half load.

The effective head on the wheel was determined by the survey of the pipe line corrected by the frictional drop as deduced from the dimensions of the pipe line. This correction is so small as to be almost negligible for the quantities used, in fact a one-thousand-pound gauge located forty feet above the nozzle showed

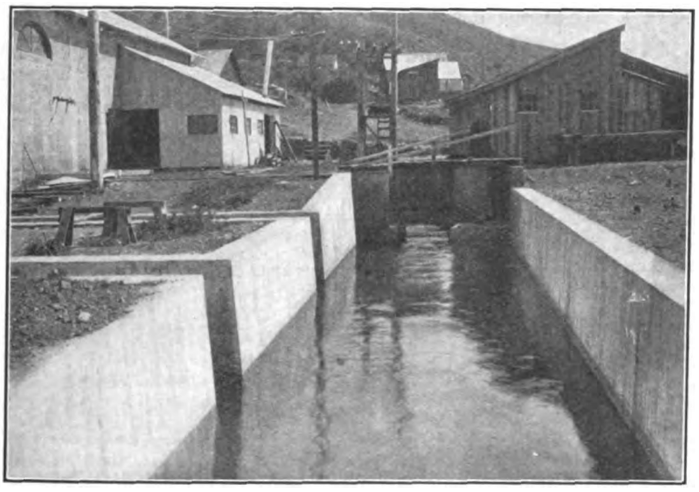

FIG. 10.—EXCITER MEASURING WEIR AND HOOK-GAUGE MEASURING APPARATUS. THIS PHOTOGRAPH ALSO SHOWS THE STILL WATER BACK OF THE MAIN WEIR.

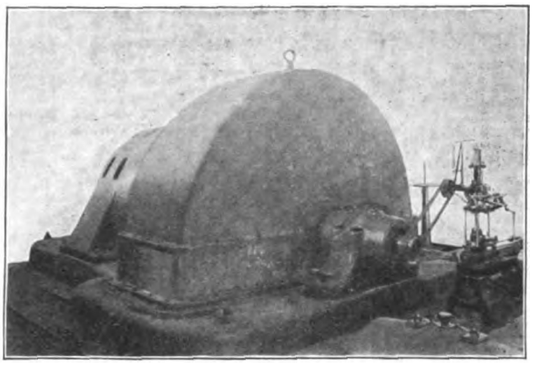

FIG. 11.—WATER-WHEEL HOUSINGS MOUNTED ON GENERATOR BED-PLATE, HYDRAULIC GOVERNOR AND CONNECTIONS AND FLOOR STAND FOR CONTROLLING NEEDLE-NOZZLE.

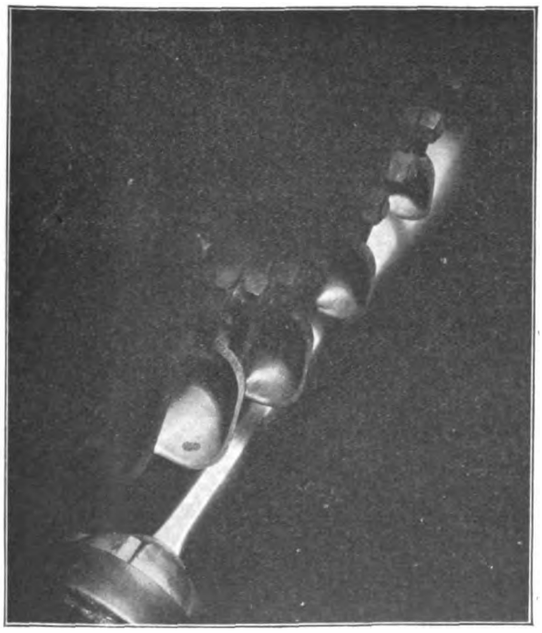

FIG. 12.—HIGH-PRESSURE WATER-JET ISSUING FROM THE NEEDLE-NOZZLE, UNDER A HEAD OF 1,923 FEET.

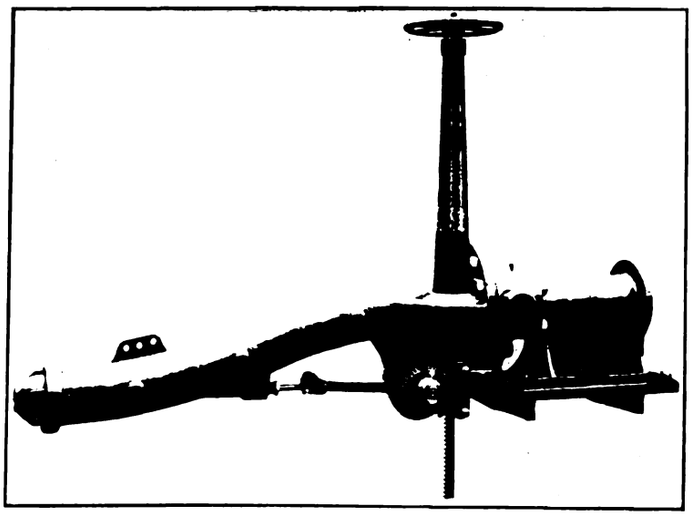

FIG. 13.—COMBINATION DEFLECTING AND NEEDLE-NOZZLE, AND NEEDLE OPERATING CONNECTIONS OF OPEN-HEARTH CARBON STEEL CASTINGS, ANNEALED.

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no appreciable change between the static head and the effective head when one unit was running full power. Still the correction has been made whenever appreciable.

The large weir used for measuring the combined water of the main water-wheel and exciter was well constructed and located, though rather too wide for the quantities used. The bay above was so large as to make the velocity of approach inappreciable. The small weir for measuring the exciter water was not so well located, but, as its flow was absolutely constant, it was checked by the large weir when the main wheel was shut off. Considerable difference was observed between the measures of this latter quantity as given by the two weirs, therefore that deduced from the large weir has been adopted in the following calculations.

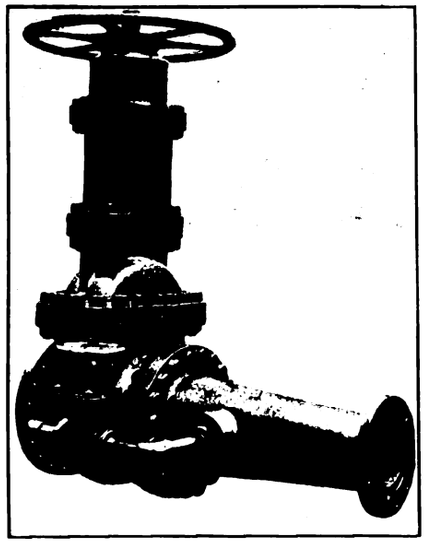

FIG. 14.—TEN-INCH ROLLER BEARING GATE-VALVE AND CONNECTIONS PUT TOGETHER WITH FORGED AND TURNED-STEEL BOLTS IN REAMED HOLES FOR THE WORKING PRESSURE OF 1,923 FEET.

The output of the switchboard was measured by two wattmeters, each of which gave the whole output. One of these was an indicating wattmeter, and the other an ordinary recording instrument. The results as given by the two did not agree for all loads, being about equal at 400 kilowatts, above this the latter reading in excess, and below the former. The comparison of the two instruments is shown in sheet 2. In the calculations which follow, the results given by the recording instrument have been taken, that being considered the more reliable.

The efficiency of the generator is taken as given by manufacturer as 95.6 per cent full load; 95 per cent three-quarter load; 92.1 per cent half load.

Calling the generator efficiency E, we have—

$$\text{H.P. wheel input} = \frac{\text{E. H. P.}}{\text{E}} - \text{(exciter H.P.)}$$

As the field excitation of the machine is ninety-seven amperes, at seventy volts, about 6.8 kilowatts are lost in the field, and the equation becomes:

$$\text{H. P. wheel input} = \frac{\text{E. H. P.}}{\text{E}} - 9.$$

Wheel efficiencies depending on switchboard instruments can not be considered as absolute and can only show in a general way the relation between efficiencies under different conditions.

RESULTS.

The following constants and formulæ have been used in the calculations:

Static head equals 1,923 feet; width of large weir equals eight feet eleven-sixty-fourths inch; width of small weir equals four feet one-quarter inch.

The quantity of water has been computed by Smith's formula:

$$Q = \tfrac{2}{3} c\, b\, h \quad 2g\, h$$
$$= \tfrac{2}{3} c\, b \quad 29\, h\, \tfrac{1}{2}$$

c being taken from Smith's tables.

The available power back of the nozzle is taken from:

$$\text{H. P.} = 0.1134\ \text{Q. H.}$$

FIRST TEST.
2" Tip, Bronze Needle.
Results (Hydraulic.)

Time	Weir	Weir (Feet)	C.	Total Q.	Net Q	Friction Head	Effective Head	H.H.P.
11:35	5-1/16	.422	.616	7.23	6.15	5 ft.	1918	1337
12:27	4-17/32	.3775	.618	6.12	5.04	3.5 ft.	1920	1097
1:00	4-11/32	.362	.619	5.78	4.70	3.5 ft.	1920	1024
1:20	4-3/32	.341	.621	5.285	4.205	2 ft.	1921	916
1:30	3-13/16	.318	.622	4.78	3.70	1.5 ft	1922	807
1:45	3-11/32	.279	.625	3.945	2.865	1 ft	1922	624
1:57	3-5/64	.256	.627	3.48	2.40	0	1923	524
2:10	2-29/32	.242	.628	3.205	2.125	0	1923	409
2:15	2-9/16	.213	.631	2.66	1.58	0	1923	345
2:20	2-17/64	.189	.634	2.23	1.15	0	1923	251
2:30	1-27/32	.1535	.640	1.65	.57	0	1923	124
3:00	1-3/8	.1145	.650	1.08	0	0	1923	0

FIRST TEST.
2" Tip, Bronze Needle.
Results (Electrical, etc.)

Time	Indicating Wattmeter	Recording Wattmeter K.W.	Recording Wattmeter E.H.P.	Power Factor	Efficiency of Generator	Wheel Input	Efficiencies. Wheel	Efficiencies. Combined
11:35	780	(826)	(1107)	.88	95.6	1153	86.2	82.8
12:27	640	665	891	.88	95.3	931	84.9	81.2
1:00	575	593	795	1.	95.1	832	81.2	78.0
1:20	500	510	684	.98	94.4	720	78.6	75.1
1:30	425	423	567	.92	93.3	603	77.2	70.7
1:45	330	320	429	.83	90.5	474	76.0	69.4
1:57	290	269	360					69.5
2:10	260							
2:15	180	146	196					57.9
2:20	125	82	110					45.5
2:30	50	—	—					—
3:00	37.5	0	0					—

FIRST TEST.
2",Tip, Bronze Needle.

Time	Weir	Indicating Wattmeter	Recording Wattmeter Time	Recording Wattmeter Rev.	Volts	Amperes	Speed
11:35	5-1/16	780	——	—	108	620	425
12:27	4-17/32	640	2 min -10 sec	8	108	500	432
1:00	4-11/32	575	3 " 2 "	10	108.5	450	434
1:20	4-3/32	500	3 " 32 "	10	108.5	395	—
1:30	3-13/16	425.	3 " 24 "	8	108.5	350	428
1:45	3-11/32	330	2 " 49 "	5	108	295	428
1:57	3-5/64	290	3 " 21 "	5	108.5	255	—
2:10	2-29/32	260	— —	—	107.5	240	—
2:15	2-9/16	180	1 " 14 "	1	108	205	431
2:20	2-17/64	125	2 " 12 "	1	108	200	—
2:30	1-27/32	50	— —	—	108	180	228
3:00	1-3/8	37½	— —	—	—	—	—

SECOND TEST.
2" Tip. Steel Needle.
Observations.

Time	Weir	Indicating Wattmeter	Recording Wattmeter Time	Recording Wattmeter Rev.	Volts	Amperes	Speed
5:10	1-25/64	375	——	—	108	0	—
5:15	2-23/32	215	2 min.-49 sec.	3	108	180	428
5:22	3-3/8	340	2 " 43 "	5	108	255	—
5:30	3-15/16	450	2 " 46 "	7	108	350	430
5:40	4-5/16	560	3 " 9 "	10	108	430	432
5:55	4-9/16	635	2 " 42 "	10	107.5	500	433
6:00	4-47/64	700	1 " 58 "	8	108.5	540	—
—	4-7/8	750	2 " 20 "	10	109	580	—
11:35	5-3/32	787	3 " 15 "	15	107	615	—

In the electrical horse-power output on the switchboard, correction has been made of four horse-power used to drive the blower, which was not recorded on the meters.

Three tests were made: First, a run on a two-inch tip with bronze needle;

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second, a run on a two-inch tip with a steel needle, and, third, a single observation on a two and one-eighth inch tip, with a steel needle.

Since the efficiency of the generator is not known below half load the results of the combined efficiency of the wheel and generator are given throughout the whole range.

Sheet 1 shows the curve of generator efficiency.

The results show the necessity for very careful calculation to establish the most efficient shapes of needle and tip. When once obtained the efficiency is not only higher when the parts are new but is retained, also, for a much longer time, just as would be expected; less energy being expended in eddy currents that are an invariable cause of wear.

A diagram of the relative needle shapes is given in Fig. 7.

SECOND TEST.
2" Tip. Steel Needle
Results (Hydraulic.)

Time	Weir	Weir Feet	C	Total Q.	Net Q.	Friction Head	Effective Head	H.H.P
5:10	1-25/64	.1158	.649	1.096	0	0	1923	0
5:15	2-23/32	.226	.633	2.91	1.814	0	1923	395
5:22	3-3/8	.281	.624	3.98	2.889	1	1922	630
5:30	3-15/16	.328	.621	5.00	3.904	2	1921	851
5:40	4-5/16	.359	.619	5.705	4.609	3.5	1920	1005
5:55	4-9/16	.380	.618	6.20	5.104	3.5	1920	1112
6:00	4-47/64	.394	.617	6.54	5.444	4.5	1919	1186
—	4-7/8	.40(	.617	6.84	5.744	5	1918	1252
11:35	5-3/32	.424	.616	7.28	6.189	5	1918	1347

SECOND TEST.
2" Tip, Steel Needle.
Results (Electrical, etc.)

Time	Indicating Wattmeter	Recording Wattmeter		Power Factor	Generator Efficiency	Wheel Input	Efficiencies	
		K W.	E H.P				Wheel	Combined
5:10	37.5	0	0	—	—	—	—	—
5:15	215	192	257	.81	—	—	—	66.0
5:22	340	331	443	.99	91.0	482	76.5	71.0
5:30	450	455	610	.99	93.8	646	75.9	72.1
5:40	560	572	767	.99	95.0	799	79.5	76.7
5:55	635	666	892	.97	95.5	940	84.5	80.6
6:00	700	732	982	.98	95.6	1022	86.1	83.1
—	750	772	1035	.98	95.6	1074	85.8	83.0
11:35	787	831	1114	.98	95.6	1156	85.8	82.6

THIRD RUN.
2½" Tip, Steel Needle
Observations.

Time	Weir	Indicating Wattmeter	Recording Wattmeter		Volts	Amperes	Speed
			Time	Rev.			
3:10	5-7/16	870	2 min.-2.5 sec.	10	108	680	430

RESULTS—(HYDRAULIC)

Time	Weir	Weir (feet)	C.	Total Q.	Net Q.	Friction Loss	Effective Head	E.H.P.
3:10	5-7/16	.453	.615	8.04	6.89	7.5	1916	1511

RESULTS—(ELECTRICAL, Etc.).

Time	Indicating Wattmeter	Recording Wattmeter		Power Factor	Generator Efficiency	Wheel Input	Efficiencies	
		K.W.	H H.P.				Wheel	Combined
3:10	870	882	1181	.98	95.6	1230	81.4	78.2

Sheet 2 shows the relation between the readings of the two wattmeters.

Sheet 3 shows the efficiency of the wheel to half load for the first run, using the bronze needle.

Sheet 4 shows the efficiency of the wheel to half load for the second run, with steel needle.

Sheet 5 shows the combined efficiency of the wheel and generator throughout the whole range, with both needles.

The difference between the results with bronze and steel needles is due to the very slight difference in curvature and not in any way to the difference in material.

It is to be regretted that, in taking these measurements, only commercial instruments were available. These, however, were new and in the best possible condition, and there is no reason to believe that the readings are not absolutely correct. It is unfortunate, however, that they could not have been specially calibrated for the work.

In using the recording wattmeter as a basis for efficiency determinations, it should be borne in mind that this is an instrument that has been specially manufactured for recording the kilowatt-hours sold, and is therefore carefully calibrated in the factory, and probably more reliable than an instrument used for indicating the load on the machines only.

In the accompanying tables the amperes recorded are taken from one leg only of the three-phase circuit on which the load was well balanced. Any slight out of balance condition would, however, not materially affect the result as the ampere readings are used only to determine the power-factor.

The voltmeter readings should be multiplied by seven, as that was the ratio of its switchboard transformer.

Train Lighting by Oil Engine Units.

TO THE EDITOR OF THE ELECTRICAL REVIEW:

The description of an oil engine in the ELECTRICAL REVIEW of September 12 reminds me of an arrangement I described to a company a few months ago.

I have had considerable practical experience with electricity and for the last year have had charge of the electrically lighted cars on one of our large railroads.

You are familiar with the different car-lighting systems in use and while they are "just the thing" for private cars they are not up to the standard for train lighting.

I propose using a first class oil engine, direct-connected to a twenty-five-light generator, and put one of these sets in each car; they would cost no more than the Pintsch gas equipment and would take up no more room than the Baker heater or stove which is being replaced by straight steam. I would then run three wires or bus-bars the length of each car with suitable couplings at each end to connect + to +, — to — and E to E, then when the train is made up the machines would all be running in multiple. In this way each car would furnish its own light with the train broken, but with the train made up the combined output of the machines would be more than enough to supply the train, and one or more sets could be cut out and held for emergency.

This company said the plan was both practical and feasible, but when I submitted the plans to the railroad they never got farther than the master mechanic's office.

I realize what a step this is in train lighting and how different from any other system, but I think with proper attention it would work successfully.

LESLIE T. BROWN.

Newport, Ky., September 19.

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The 179th Meeting of the American Institute of Electrical Engineers.

The first meeting of the American Institute of Electrical Engineers after the summer vacation was held at the New York Academy of Medicine, 17 West Forty-third street, on Friday, September 25. The meeting was called to order by past-President Scott, who spoke of the spread of interest in the Institute throughout the country during the past year. It has never been so great, and credit for this must be given largely to the establishment of local branches, although those established already form but the beginning of a broad foundation for a magnificent structure in the future. Under these conditions it is very appropriate that the Institute should have elected as its president for the coming year a prominent engineer of the largest city near the centre of the country. It is with great pleasure that he introduced to the Institute its new president, Mr. Bion J. Arnold, of Chicago.

Secretary Ralph W. Pope announced to the board of directors of the Institute that 108 associate members had been elected.

Mr. Arnold then gave briefly his ideas of the lines along which the Institute should work during the coming year. He spoke as follows:

"Our new constitution does not call for a formal address from the incoming president at the time of his inauguration, as this duty is required of him at the annual convention.

"My worthy predecessor, however, outlined his course on taking office and followed it so well and with such signal benefits to the Institute, that his action prompts me to point out briefly the lines which, I believe, we should follow during the coming year.

"The remarkable development and growth of our body during the past two years has introduced many new elements which must stand the test of time and possibly be tried in a period of financial depression. Our energies, therefore, should be directed toward carrying forward the work so well started by my predecessor upon conservative lines which will ensure its permanency and the greatest good to the Institute.

"1. For obvious reasons our recent great rate of increase of membership can not continue indefinitely, and our expenditures should therefore be gauged to meet this condition.

"2. Our local chapters should, if possible, be made to last after the enthusiasm, born of novelty, has worn off, which implies encouragement from headquarters and sustained effort on the part of the local members.

"3. The work of our special committees, in connection with electrical engineering standardization and the collection of technical data, should be encouraged and additional committees appointed to extend the work in other promising directions.

"4. We should allow the authors of our papers more time for presenting them, and our members more time for their discussion, even, if to accomplish this, we are compelled to have fewer papers.

"5. Contributions making provisions for our interest in the land for the engineering building should be placed in a separate fund, which should be set apart from all other funds and to which should be credited all funds now on hand and subsequently received from donations or from the sale of bonds or other securities, especially created for building purposes.

"6. Our library fund should also be carried as a distinct fund, and all donations and appropriations for library purposes credited to it; all expenditures for library purposes to be debited to this fund.

"7. On account of the international electrical congress to be held at St. Louis in 1904, we shall be called upon not only to contribute to the scientific value of this congress, but to receive and entertain distinguished guests and members from foreign countries.

"Our plans should therefore be so well and broadly laid and executed that our guests shall return home not only fully repaid for their visit among us, but shall feel also that the splendid hospitality which was shown us as a body on our trip abroad in 1900, and to our individual members before and since has been fully appreciated.

"8. Our relationship with the other large engineering societies of this country have, during the past year, become more intimate and we are now about to join with them in the ownership and management of a union engineering building which shall meet the needs of all.

"The general preliminaries have been perfected and the work of the coming year will be the crystallization of the plans and the originating of definite means and methods for raising funds and for the material progress of the work.

"I trust we may be able to carry to a successful conclusion the work so splendidly initiated by my predecessor, Mr. Scott, and his able lieutenants, and in such a manner as not only to retain but to heighten the respect and good will of those who may co-operate with us, by the adoption of rational methods and the exercising of good business judgment in carrying on the work ensure that the generous gift of Mr. Carnegie to the engineering profession shall be ideally, and in its material culmination all that he hoped it would be.

"I wish to express my appreciation of the confidence you have shown in me by placing me at the head of this Institute, the youngest, yet one of the most progressive of the several great engineering bodies of the country.

"I sincerely thank you and I feel that you will accord to me such harmony of action and support that the coming year may be one of great benefit to our membership and add in some slight degree to the prestige of the engineering profession at large."

The first paper for the evening entitled "An Efficient High-Pressure Water-Power Transmission Plant," by Messrs. George J. Henry, Jr., and Joseph N. Le Conte, was read by Mr. F. O. Blackwell. This paper will be found on another page of this issue. It describes an hydraulic plant of the Edison Electric Light Company at Los Angeles, Cal., which is utilizing water power having 1,960 feet head.

After reading the paper, Mr. Blackwell sketched briefly the history of the development of the hydraulic plant in Southern California. He called attention to the fact that the diameter of the Pelton wheel in the plant described by Messrs. Henry and Le Conte was seven feet, while the diameter of the nozzle is only two inches, a ratio of forty to one. This ratio is very high and possibly accounts for the high efficiency of the plant. The use of needle valves, as they are described, is good, as this device not only saves water but gives a higher efficiency to the wheel, since it maintains the stream of water in the centre of the bucket. The efficiency of these wheels is considerably better than that of the early Pelton wheels. In reply to a question of the construction used in the pipe line, he said that line was constructed without flangers and without any slip joints. It takes up its own expansion caused by changes in temperature.

Mr. H. A. Lardner, of New York, gave further details of pipe line construction. The pipe line in the Santa Ana plant is of steel with flange joints. It is buried and gives no trouble from expansion. Certain curves along the line are supposed to assist in taking care of expansion. The Standard Electric Company, of Electra, Cal., has a pipe line of 1,600

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feet, the first one-third of this is of cast iron, the rest of steel. Part of each section of the pipe is set in concrete, thoroughly grouted to the rock. He called attention to the fact that in the plant described in the paper but one water-wheel or runner is mounted on a shaft. In some instances two or more runners, each having its own set of nozzles, are mounted on the same shaft in the same casing. This effects a saving of water at periods of light load, as one of the runners can be shut down. In such plants it is usual to operate a number of units at constant load, one unit taking up all fluctuations.

President Arnold spoke briefly of the difference in water power installations in the East and West. In the East, where the head available is relatively small to develop considerable power, large quantities of water must be handled. Then construction becomes very expensive and in a great many cases it is found that a water power plant would be more expensive than a steam plant. On the other hand, in the West where much larger heads of water are available, and where coal is expensive, the conditions are reversed.

A paper by Mr. Aug. J. Bowie, Jr., of San Francisco, Cal., entitled "Electric Motors for Centrifugal Pumps and Fans," was read by Mr. Lardner. This paper will be published in the ELECTRICAL REVIEW. It gives a theoretical discussion of the conditions under which centrifugal pumps and fans operate and the effect of varying conditions of operation on the performance of the pump. Discussion of this paper was opened by Mr. H. G. Stott, of New York. He said his solution of the problem of determining the power consumed by a centrifugal pump would be to place a wattmeter in the motor circuit. This is the only way in which an accurate determination can be made, because a slight variation in operating conditions will vary the performance of the pump very greatly. He then said that the motor drive for condenser pumps is not satisfactory, since a slight loss of vacuum would lower the voltage at the station, this would decrease somewhat the speed of the motor, and cut down materially the flow of condensing water. The result would be that the vacuum would fall lower still and probably be lost altogether. He advised a steam drive for this work.

Mr. J. J. Brown, of New York, did not agree with Mr. Stott. Although the old type of centrifugal pump, having flat veins, would behave in the way described, with the new type the head may vary greatly, say from zero to sixty-five feet without throwing the motor out of operation. These pumps are run at high speeds, and at these high speeds a high efficiency is obtained.

Mr. Blackwell took the same stand, holding that centrifugal pumps are suitable for motor drive. A slight variation in the head may vary the output from no water to full output. He thought this was the class of work which was suitable for motors. Where high heads are to be overcome, several pumps or runners are connected in series, each delivering water to the one beyond, and each giving a head of about 100 feet. Pumps of this type are now in use overcoming from 700 to 800 feet head. The efficiency is good and is equal to that of the reciprocating pump.

A paper by Mr. Ralph L. Montagu, of Oroville, Cal., entitled "A Suggested Hydraulic Unit," was read by Mr. Blackwell. This paper will be found on another page of this issue. It suggests that a hydraulic unit be recognized and named, which is equal to the power developed by the fall of one cubic foot of water per minute under a head of one foot. This is equivalent to 1.4099 watts. In the discussion of this paper, Mr. C. O. Mailloux, of New York, took occasion to point out the desirability of the metric system which avoids the necessity for adopting many arbitrary units. In his opinion the metric system is ideal for water power engineering calculations.

Secretary Pope stated that a regular place for holding the meetings had not yet been decided upon. The arrangement with the New York Academy of Medicine for the hall they were then using had been for that night only. The meeting was then adjourned.

Electrical Progress in Russia.

It is only within the last few years that Russia has shown any desire to advance in matters electrical, but one notable feature in the progress which has been made is the extensive use of electricity for motive power in factories and works. It is stated that practically all machine shops in Russia have adopted the electrical drive, and enormous central stations have been erected at places where such factories exist. However, up to the present, electricity has scarcely been used at all for the transmission of energy over great distances. The government has recently granted a concession to a company to furnish power to St. Petersburg from the Volhoy rapids. The scheme is estimated to involve a cost of nearly $15,000,000. Power will be transmitted 188 miles. There is another scheme to use the colossal force of the Dnieper river for the generation and transmission of electrical energy. There are many Russian factories which produce cables and insulated conductors. Accumulators are also manufactured in various towns, and such appliances as circuit-breakers, commutators, rheostats, etc., are also made there, but not nearly enough to supply the demand. Measuring instruments are scarcely manufactured at all, these being imported from France and Germany. The manufacture of porcelain insulators has been so well developed as to supply completely the home demand. Incandescent lamps are not manufactured in Russia, and most of the arc lamps are imported from Germany. Signaling and telegraphic apparatus is supplied by the home factories, but the demand for apparatus and machines is little satisfied by them.

Elimination of Platinum in Incandescent Lamps.

The high price of platinum has brought about many attempts to manufacture incandescent lamps without the use of this material, but as yet no other metal has been found which will fully replace it. The reasons for the use of platinum are that its coefficient of expansion is the same as that of glass, and therefore changes of temperature do not cause cracking. A further reason is that when platinum is fused into the glass the latter adheres to the platinum as though cemented. While other metals, particularly some alloys such as nickel steel, have been found, which have a coefficient of expansion equal to that of glass, none of them has the property of forming a tight joint when fused in. To get over this difficulty a French company which manufactures incandescent lamps has discovered a cement which enables it to secure a tight joint around the leading-in wires, without it being necessary to use platinum. This cement is said to be unaffected by air or ordinary temperatures.

Mr. John Clarke Hawkshaw, president of the British Institution of Civil Engineers, thus estimates the world's water power: Assume a depth of ten inches of rainfall to flow off each square inch of land surface, the mean height of which may be taken as 2,250 feet above sea level. Then the water from the whole surface falling through the mean height would give 10,340,000,000 horse-power in perpetuity. Our present yearly output of 225,000,000 tons of coal would give that horse-power for only a little over half a day.

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TWO WESTERN POWER AND LIGHTING PLANTS.

THE COLORADO ELECTRIC POWER COMPANY, CANON CITY, COL., AND THE TRINIDAD PLANT OF THE LAS ANIMAS LIGHT, POWER AND MANUFACTURING COMPANY, TRINIDAD, COL.

BY J. H. RUSBY.

The generating station of the Colorado Electric Power Company, of Cañon City, Col., is situated on West Main street. The building is constructed of red brick, with an iron roof, and is of fireproof material throughout. The dimensions are 50 by 150 feet. A steel stack twelve feet in diameter and 150 feet high is set on a brick base sixteen by sixteen feet and thirty feet high, giving a total height of 180 feet from the floor to the top of the stack.

The boiler equipment consists of four Heine water-tube boilers of 400-horse-power capacity each, heated by slack coal fuel. There are two Snow condensers, two boiler feed pumps, and a complete outfit of auxiliary apparatus.

The engine equipment consists of three 600-horse-power, Hamilton, cross-compound, Corliss engines, direct-connected to three 500-kilowatt alternating-current generators giving thirty-cycle three-phase current at 500 volts. These generators are separately excited by two Westinghouse sets, consisting of Westinghouse upright engines and thirty-seven-kilowatt direct-current dynamos.

The current is taken to a double-deck switchboard, consisting of eight panels of two-inch gray marble on the lower or primary section, and five two-inch gray marble panels on the upper section. These boards are equipped with a complete outfit of up-to-date apparatus for measuring and controlling the output of energy, including oil break switches for the high-voltage circuits and quick break knife switches for the low-voltage circuits.

Westinghouse oil transformers step up the current as follows: For local lighting it is stepped up to 2,500 volts and the various circuits are then fitted with pole transformers which step down the current for local consumption. In addition there is a 500-volt circuit through the town for supplying power to various consumers, which include an ice manufacturing plant, several printing offices, a stone sawing yard, two planing mills and various other industries, including an ore smelter out of town which is served by the 2,500-volt street circuit.

The Colorado Electric Power Company supplies a great part of the Cripple Creek district, and for this load the current is stepped up by a set of Westinghouse oil transformers to 22,000 volts and is then transmitted over a pole line carrying three No. 3 bare soft-drawn copper wires for a distance of twenty-seven miles to the Cripple Creek district. Here it is stepped down to suitable voltages for supplying street and house lighting circuits, mining hoists and other mining machinery, besides supplying most of the power for the Cripple Creek electric street cars.

Edison base sockets and lamps are used throughout the installation.

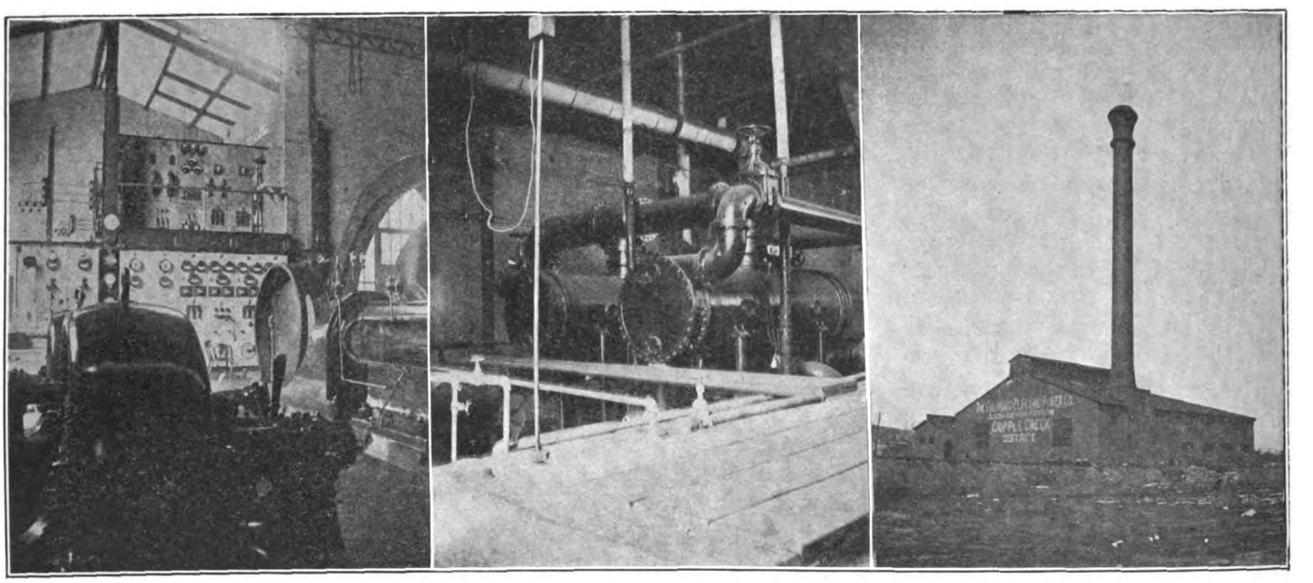
Prices for current range from three to six cents per kilowatt-hour for power, and from ten to fifteen cents per kilowatt-hour for lighting.

This plant claims the record for continuous running, having had no stop since some eighteen months ago, when a cloudburst and flood which destroyed much property forced it to shut down for a few hours.

THE TRINIDAD PLANT OF THE LAS ANIMAS LIGHT, POWER AND MANUFACTURING COMPANY.

The generating station of the Trinidad plant of the Las Animas Light, Power and Manufacturing Company is situated near the centre of the city of Trinidad, Col., alongside the tracks of the Santa Fe Railroad and opposite the railroad station.

The boiler equipment consists of one 200-horse-power Stirling water-tube boiler and three eighty-horse-power Sterns horizontal boilers, all heated by slack coal fuel. There are four feed-water heaters, the water circulating about the outer portion, while the hot gases from the furnace are exhausted through the centre.



ENGINE ROOM AND SWITCHBOARD, BOILER ROOM, AND EXTERIOR VIEW OF POWER PLANT, COLORADO ELECTRIC POWER COMPANY, CANON CITY, COL.

The engine equipment consists of one 150-horse-power Ball engine and two eighty-horse-power Ball engines with Ball valve gear, together with one forty-horse-power and two eighty-horse-power Armington & Sims horizontal automatic spring-governed engines.

The generator equipment consists of one alternating-current, fifteen-kilowatt, separately excited Thomson-Houston generator, supplying two-phase current at 1,000 volts; two twenty-five-kilowatt, Edison direct-current 125-volt generators; two fifty-kilowatt, Westinghouse direct-current 125-volt generators; two Thomson-

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Houston thirty-light constant-current and two Western Electric forty-light constant-current series open-arc machines, all of which are belt-driven.

Current is distributed to street circuits through a wooden switchboard fitted with plain knife switches. Edison and Weston instruments are installed. All low-voltage connections are made with bare copper. The high-voltage arc and incandescent system has enclosed fittings.

Westinghouse pole transformers are used for alternating-current incandescent lighting, stepping the current down to 110 volts for inside use.

The present load is about eighty arc lamps and 2,800 incandescent lamps, with about 4,000 incandescent lamps wired in.

The rates are $5.40 per arc lamp per month on a moonlight, twelve o'clock service; all-night service, $8; residence lighting, incandescent, fifteen cents per kilowatt-hour; store and office incandescent lighting, twelve and one-half cents per kilowatt-hour. The plant capacity is to be extended by the addition of an eighty-horse-power tubular boiler and a fifty-kilowatt generator, to supply the increased demand for light. This company also operates the gas system for the city.

New South Wales Railway and Tramway Ambulance Corps.

The New South Wales (Australia) Railway and Tramway Ambulance Corps is perhaps the best organized and most efficiently drilled of any similar organization known. I have personally, as a physician, thoroughly investigated it, through the courtesy of the chief medical director and of the commissioners and secretary of the New South Wales Railways, and find that it is well worthy of the first place on the list.

The corps was commenced before the present commissioners took office, but at the time of their doing so (in October, 1888) it had a membership of only 191. At the present time the membership numbers about 1,800 certified by examination as capable of rendering first aid; but more than double that number of the employés have received instructions, although, owing to the nature of their duties, many are unable to attend a complete course and therefore have not presented themselves for examination, though in many cases possessing a very good knowledge of ambulance work. The membership is widely distributed, members being found in every branch of the service, in the workshops, and at every station of importance throughout the system.

The desirability of having such a trained body of men connected with the railways of this state is very great, the circumstances of the New South Wales lines differing materially from those in older and more thickly settled countries, where towns are close together and medical aid is readily procurable. Here, however, the lines run at times for 100 miles without passing a settlement of note, and should an accident occur on such a stretch of line it is of great importance that those on the spot should be able to render "first aid" to the injured and be equipped with the appliances essential in treating injured persons.

In regard to appliances, it may be mentioned that every passenger train running outside the suburban section, and mixed trains on branch lines, are fitted with a medical chest and all ambulance requirements in case of an accident. Ambulance equipment is also kept in reserve at a large number of railway stations, and each wrecking car is fitted with a medical chest and full equipment. The ambulance equipment in August of last year, the date of the last annual report of the corps, comprised 126 chests, 254 stretchers, forty hampers or small boxes, seven wheel litters at large centres, and one ambulance wagon (horse) at Sydney, the terminal station.

The work of instruction is conducted by the railway medical officer, who regularly visits the various centres throughout the state. He is assisted by some of the older members of the corps, who, as branch secretaries, advance the interests of the corps by keeping members in touch and proficient by periodical drills and by the formation and carrying on of additional classes. Much assistance is also rendered by medical men in some of the larger centres in the country. To deal with the detail work in connection with the working of the corps and to promote its interests generally, a competent officer has been appointed as general secretary, the whole of whose time is devoted to the work, his salary being paid by the commissioners.

With the view to encouraging the staff to take a course of ambulance training, examinations are held annually of the various classes and each member passing the primary examination, which includes the practical treatment required in rendering "first aid," is presented with a framed ambulance certificate. A second course of a more advanced character is provided for, and successful candidates at this examination are presented with a silver medal suitable for wearing as watch guard. As a special acknowledgment of the exceptional services rendered by some members, gold medals have been presented in a few cases.

For the purpose of increasing the interest in the movement the commissioners some years ago instituted a challenge shield for annual competition among the different branches of the corps. This is a handsome trophy, and each year the names of the winning squad of four men are inscribed on a space provided for the purpose, space being allowed for ten years. It should be added that small gold replicas of the shield are given to the winning team each year, the second team having similar replicas in silver and the third in bronze.

As a further encouragement the commissioners have annually given monetary grants, amounting last year to $1,250, which is distributed among branch secretaries, who maintain a certain number of drills to keep up efficiency. It should be mentioned that the commissioners grant free passes to employés to enable them to attend classes.

The practical value of the knowledge gained by the members of the corps has been manifested on a number of occasions, and the efficiency and skill of the treatment rendered has often been warmly recognized by the medical men who have subsequently treated the cases. The aid of qualified members is often called into requisition, and annually several hundreds of occasions are reported to the corps secretary of such service having been rendered, many cases of accident to members of the general public and unconnected with the railways.—*F. W. Goding, Consul, Newcastle, New South Wales, July 14.*

In a recent communication to the British Royal Society, Sir William Ramsay and Mr. F. Soddy tendered some evidence bearing upon the suspected gradual conversion of radium or radium emanation to helium. Twenty milligrammes of pure radium bromide were dissolved in water and gas was given off which consisted of hydrogen and oxygen. These two gases were removed and the residue examined for helium, and one of the helium lines was found in the spark spectrum. In another experiment practically all the helium lines were obtained. In still another series of experiments radium emanation was condensed in a liquid-air tube and the liquid air was then removed by a pump. The tube showed no trace of helium, but showed a new spectrum, probably that of the emanation itself. After standing for four days the helium spectrum appeared and the characteristic lines were observed, identical in position with those of the helium tube thrown into the field division at the same time.

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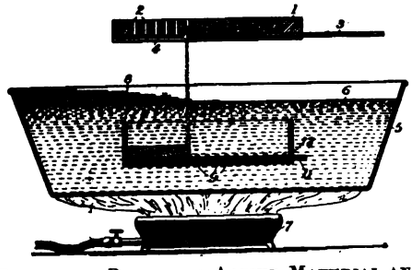
Electrical Patents.

Mr. Oliver P. Fritchle, of Denver, Col., has patented a process of producing active material and electrodes for storage batteries and products thereof. This invention relates to the production of a crystalline non-disintegrating active material of the utmost electrical conductivity and molecular porosity which will allow the freest possible diffusion of the electrolyte on charge and discharge. The new active material may either be compressed into a self-supporting electrode or may be carried by a suitable support or grid. The invention is based on the discovery that finely divided lead, especially when produced by spraying molten lead by means of a blast, obtains a peculiar cohesive property as if in a molten state when subjected to a hot dilute solution of hydrochloric acid and may be welded together into a rigid but highly porous mass by subjecting it to light pressure. The treatment with acid causes a slight evolution of gas, which prevents the particles of lead from settling into a dense, compact mass. The apparatus comprises a device 1 for holding and showering the finely divided lead. This device is a rectangular plate, which may be of wood having a large number of perforations or slots 2 extending entirely through it. A slide 3 is arranged to move in contact with the lower surface of the plate and is supported by rabbeted parallel guide-strips 4, secured beneath the edges of the plate. A vessel 5, which may be a shallow porcelain-lined pan, contains a body of dilute hydrochloric acid 6, preferably a five per cent aqueous solution. Beneath the pan is a gas heater 7, by which the acid solution is brought to a high temperature. A receiver 8 is supported within the pan at some distance above its bottom and directly beneath the showering device 1. This receiver is a shallow rectangular tray of material which is inert toward the acid solution, such as copper. The bottom of this receiver is detachable and has a large number of perforations 9, adapted to receive projections on a grid, allowing the body of the grid to lie flat on the bottom of the receiver. A horizontal slot 10 is cut through one wall of the receiver at or slightly above the inner surface of its bottom, through which may be inserted a grid or plate 11 to receive the treated lead. A strip 12 closes the slot. In employing this apparatus to carry out the process the receiver 8, containing the grid 11, is placed in the pan 5, and the acid solution is heated to a high temperature, preferably to its boiling-point. The apertures in plate 1 are filled with granulated lead previously sieved to a size between sixty and one-hundred mesh, the slide being closed, and the device is placed directly above the receiver 8. The slide is now slowly withdrawn, and the lead falls through the hot acid solution into the receiver and on to the grid 11. The action of the acid solution on the granulated lead quickly causes it to become coherent, as if in a molten state, and the treated mass will occupy about four times the original volume of the lead. The lead is now compressed to about twice its original volume, preferably while it is still within the hot solution. It is important that the treated lead should be compressed without delay, as its property of welding is soon destroyed by the continued action of the acid. The pressure required is comparatively slight, depending upon the required porosity of the mass, and may be effected by a hand-press with screw-and-toggle mechanism. The bottom of the receiver is now detached, and the grid, with the compressed active material on one of its faces, is pushed out and again inserted with the coating of active material below. The bottom is replaced, and the other face of the grid is provided with a coating of active material by repeating the described operation. While the use of a conducting or non-conducting grid or support is often desirable, this element is not essential. The granulated lead after passing through the acid may be received directly on the bottom of any suitable vessel and compressed into a highly porous and self-supporting electrode of sufficient rigidity for practical use. While the process is preferably carried out by the use of the described acid solution, a solution of any other acid, salt, or compound which will yield chlorine to the lead may be substituted, or chlorine water or chlorine itself may be employed. The use of lead which has been granulated by a blast is preferable as the shreds and filaments interlace when the treated mass is compressed, giving the body greater rigidity and firmness.



PROCESS OF PRODUCING ACTIVE MATERIAL AND ELECTRODES FOR STORAGE BATTERIES.

Mr. George Hail, of Providence, R. I., has devised a threshold-illuminating device for elevators, his idea being that, as many accidents are caused by persons attempting to leave or enter an elevator car when the latter is stopped with its floor out of level with the adjacent landing, an illuminated threshold will call the attention of the passenger to any inaccuracies of the kind. The invention is, therefore, believed to be particularly ad-

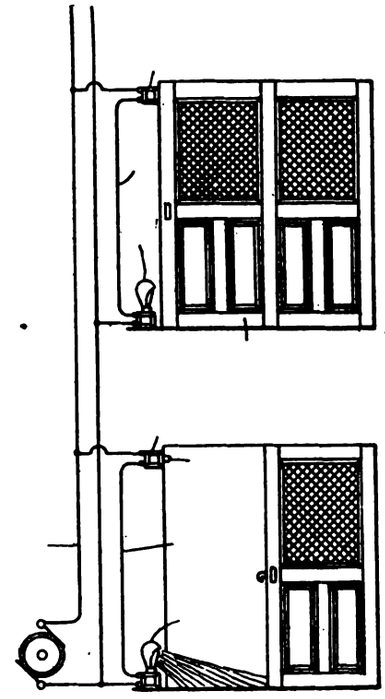


FIG. 1.—THRESHOLD ILLUMINATING DEVICE FOR ELEVATORS.

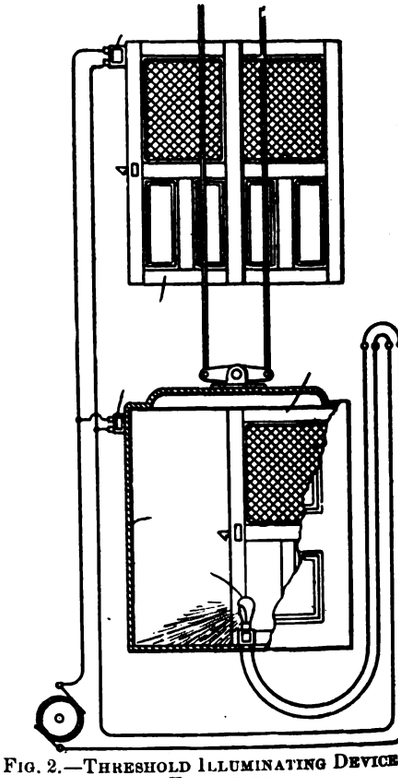


FIG. 2.—THRESHOLD ILLUMINATING DEVICE FOR ELEVATORS.

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vantageous where the car and the well are not satisfactorily lighted, so that the passenger is unable to appreciate the difference in level. Several different forms of the invention are proposed by the patentee. In one he employs an electric circuit extending from the top to the bottom of the elevator shaft and having branches therein that are located at the different landings, as shown in Fig. 1. These branch circuits include an electric lamp so arranged that it will throw light directly upon the landing. A switch is also included in each branch circuit and is normally held open by the elevator door when closed. As soon as the elevator door is opened, however, by the conductor of the elevator, this switch will close, thus closing the circuit through the lamp and causing the same to illuminate the landing. In another form of invention a lamp is carried by the elevator, as shown in Fig. 2, and is automatically illuminated as the car reaches the different floors.

Two Englishmen, Messrs. William Peto and James W. T. Cadett, of Ashlead, England, have taken out a patent in this country on a new composition of matter for battery electrolytes. The composition consists of powdered or precipitated sulphate of lead moistened with dilute sulphuric acid of about the average strength used in electric accumulators, which ingredients are combined in about the following proportions, *viz.*, finely precipitated sulphate of lead, one pound; dilute sulphuric acid of about specific gravity 1.2, four ounces. These ingredients are thoroughly mixed together either by hand or mechanically until they form a soft plastic mass of a paste-like consistency. The proportions stated above are subject to some variation, according to the quality of the sulphate of lead, as some descriptions of sulphate of lead take up more acid than others, while the strength of the acid is varied within ordinary limits, according to the purpose for which the accumulators are to be used. The requisite proportion of acid can be easily regulated by allowing the mixture to stand awhile, when any excess of acid will rise and float on the top and can then be poured off. Sufficient acid must, however, be used to render the composition soft and plastic, for if it be made too stiff the gasing may produce air-spaces therein that may impair the efficiency of the accumulator.

An ordinance has been introduced in the Columbus, Ohio, city council, fixing the price of electric current for the next five years at six cents per kilowatt for lighting and four cents for power purposes.

Effect of Vacuum on the Steam Turbine.

The steam turbine is very sensitive to a vacuum. A couple of inches additional vacuum will increase the efficiency of a turbine much more than it would that of a reciprocating engine. It is easy to see why this should be so. In the reciprocating engine of the most refined type more than twenty expansions are rarely used, usually less. In the steam turbine 100 expansions may be easily realized. Conceive of a steam diagram with twenty expansions. If the counter pressure could be lowered two pounds, an area would be added to the diagram equal to the product of the width representing that pressure and the length of the diagram. Suppose now the number of expansions be increased to 100. Since the length of the diagram represents the final volume, the diagram would be five times as long and the lowering of the counter pressure line two pounds would add five times as much area as it did in the former case. In addition to this area, another gain is derived from the further expansion.

With equal ratios of expansion, as where both engines exhaust against a pressure of, say, five pounds above the atmosphere and the reciprocating engine diagram ends in a point, the turbine will probably be less efficient than the reciprocating engine. The turbine owes its efficiency to the large ratios of expansion which it can utilize and even with these ratios is able to attain efficiencies only equal at best to those of the best piston engines. The reciprocating engine suffers some twenty per cent from internal condensation, due to the alternate heating and cooling of its surfaces. The turbine suffers probably more from lack of mechanical efficiency. When steam is confined its pressure is positively exerted upon the containing surfaces and any increase of volume is positively productive of the corresponding amount of power. In the turbine the energy of the steam is first put into inducing motion in the jet or current and then the turbine is used to absorb it. This it can do perfectly only by bringing the steam to absolute rest, and in the absence of eddy currents and friction. The best water turbines convert only about eighty per cent of the energy of the water, and probably the steam turbine is no more efficient as a turbine, so that whatever advantage the turbine may have over the reciprocating engine in the avoidance of internal condensation is probably offset by its lack of efficiency as a motor.

Another reason why the vacuum is of particular value to a turbine is the reduction which it effects in the windage. A top will spin for an enormously long time in a vacuum. If it had to spin in an atmosphere of compressed air or high-pressure steam, its motion would last for a comparatively shorter time. At the high speed at which the turbine vanes are run the frictional resistance in the dense high pressure steam of the earlier stages must be considerable, but in the much less dense atmosphere of the later stages much less of the energy absorbed is used in overcoming friction. Of course energy can not be continuously imparted to steam in a confined space without heating it, so that the heat developed by this and other forms of fluid friction may go to improving the quality of the steam and preventing its condensation. Since the turbine is less efficient than the reciprocating engine in the early stages of the expansion, but is capable of carrying the expansion practically to so much greater an extent, the idea suggests itself that the turbine might be used to replace the low-pressure cylinder of a compound engine. This would mitigate the loss from internal condensation, as all the heat which goes into the first cylinder, with the exception of that lost by radiation and converted into work, must pass to the receiver and would be available for use in the turbine through the lower temperature range. Great ratios of expansion would be available and the enormous cylinders necessary for even the limited ratios now attained would be avoided. The simplicity and compactness which are such attractive features of the turbine would be, however, in a measure sacrificed, as would the particularly advantageous use of superheated steam and the avoidance of oil in the condensed exhaust. —*Power.*

A Proposed Electric Railway in Switzerland.

A correspondent in the London *Times* says that it has been proposed to build a new railway running to the top of Mount Blanc. This line would start at Les Houches, the village at the top of the gorge of the Arve and at the entrance of the Chamonix valley, and end at the Janssen Observatory on the actual summit. The line would be a rack and pinion one, and the motive power would be electricity generated from dynamos worked by turbines, the water power of the river Arve being utilized for this purpose. This fall already supplies current for the Fayet-Chamonix Railway. It is estimated that the cost of a ticket to the top of Mount Blanc would be about $20, which would be comparatively cheap as compared with the $50 or $60 that must be expended at present on guides and porters and for lodging.

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Reviews of Current Engineering and Scientific Literature.

The Wittfeld System of Train Lighting.

This system of train lighting has been used on three lines of the Prussian state railway—from Berlin to Sassnitz, from March, 1902; on the line from Berlin to Hamburg and Altona since November, 1902, and from Berlin to Hamburg and Kiel. In this system a twenty-horse-power steam turbine driving a small generator through gearing by a reduction of ten to one is mounted on the locomotive boiler. The generator is entirely enclosed, and after being started and adjusted is governed by an enclosed regulator. The speed of the generator is 2,000 revolutions per minute. It has an output of 12.6 kilowatts, and the voltage can be varied between sixty-four and ninety-five. Each car is equipped with an accumulator, the elements of which are contained in hard rubber jars with hard rubber covers. As the voltage of the batteries varies considerably, in series with each lamp is placed a ballast consisting of a fine iron wire sealed in a glass tube which is filled with hydrogen. This ballast is so designed that a change of nine per cent in the current strength produces a change of 300 per cent in its resistance. When in operation it shows a dull red glow. Throughout the length of the cars two main leads are run, carried in iron tubes. From these branch the circuits to the battery and to the lamps. In putting the system into service the engineer brings the generator up to speed and then, by means of his voltmeter, he adjusts the potential to about four volts above that of the batteries. No further attention is required, as the regulator controls the potential and an automatic switch cuts out the generator as soon as the batteries are fully charged.—*Translated and abstracted from the Centralblatt für Accumulatoren-Elementen und Accumobilen-Kunde (Gross Lichterfelde West), September* 1.

Tests on Variable Speed Motors.

One way of varying the speed of direct-current motors is to change the strength of the magnetic field by varying the length of the air-gap. This system is used in a well-known American make and has been adopted by a French house. In these machines, which are here described by M. Courbier, the air-gap is varied by shifting the core of the field pole. Two types of motor have been built—bipolar and multipolar. In the former the two cores are shifted by means of a toggle-joint operated through a screw and nut, the latter being attached to the frame of the motor and turned by a hand-wheel. In the multipolar machines the poles are moved simultaneously by means of a ring forming really a system of inclined planes which, when turned in one direction or the other, shift the pole cores in or out. In all the motors the cores are carried on ball bearings to overcome friction. Against this method of regulation it has been urged that the motors are inefficient at high speeds. The author has conducted tests to determine the weight of this objection. Curves are given for the performance of a two-pole machine with a normal rating of twenty-eight amperes at 220 volts. The curves show that at full load this machine had an efficiency of eighty-six per cent at 500 revolutions per minute. The efficiency rose to eighty-seven per cent at 600 revolutions, and then fell practically along a straight line to eighty per cent efficiency at 1,800 revolutions. At half load the machine had an efficiency of eighty-four per cent at 500 revolutions. This rose to eighty-five per cent at 600, and then fell evenly to seventy-eight and five-tenths per cent at 1,800 revolutions. At full load the efficiency falls six per cent from the maximum with an increase in speed of 200 per cent.—*Translated and abstracted from the Bulletin de la Societe Internationale des Electriciens (Paris), July.*

A Basis for the Comparison of Dynamo Designs.

Various coefficients useful in comparing the merits of alternative designs have been suggested by Kapp, Steinmetz, Mavor and Thompson. These coefficients are here discussed by Mr. H. M. Hobart, who takes the stand that while they have been useful to the designer, they are comparatively unsatisfactory for use in final comparisons, because they neglect to take into consideration the end connections. He therefore suggests a coefficient for the "specific output," found by dividing the rated output in watts by the product of the cylindrical surface of the armature and the speed in revolutions per minute. To show that the specific output, as thus defined, is a true criterion of commercial economy obtained in the given design, the coefficients given for a number of machines of the same general type are plotted on rectangular co-ordinates, the ordinate being the cost of the machine. The results given by machines made by four separate companies in each case fall very nearly on a straight line. From the data given for costs, that machine is of the most economical design in which, when complying with a given specification, the maximum "specific output" is obtained. To illustrate this point eight generators with an output from 200 to 1,600 kilowatts, and designed by five engineers, are compared by plotting the "specific output" against the rated output, reduced to a common speed. The specific output varies from 0.038 to 0.163, the points falling fairly well on a regular curve. Variations from this curve may be due to special design or abnormal rating, and do not necessarily indicate poor design. Curves plotted in this way show that for every speed there is a rated capacity beyond which the "specific output" decreases. The point of maximum "specific output" is obtained at lower rated outputs the higher the rated speed. Dynamos built on present approved designs do not reach these maximum points on account of commutating limitations. —*Abstracted from the Electrician (London), September* 11.

The Cause of the Earth's Magnetism.

Many theories have been put forward to explain the earth's magnetism. The one here discussed by Mr. William Sutherland attributes this to electrical charges existing on the earth. There is strong evidence as to the two distributions of electricity throughout the substance of the earth. In Helmholtz's theory of chemical valence of the atoms, each bond between the atoms in a molecule is supposed to consist of two opposite electrons associated with the atoms. Every molecule then involves in its own existence that of at least one or the other charge. The whole earth, therefore, contains two opposite enormous charges of electricity. These are so nearly equally distributed throughout the earth that they produce no external electrical effect. If the two charges were distributed in absolute equality, their magnetic fields would exactly neutralize one another, and we should have no terrestrial magnetism. The author then considers what differ-

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ence in the distribution of the earth's two charges would be required to account for its magnetic field, and he finds that if the negative and positive electricities in the earth are spread over concentric spheres whose radii differ only by the diameter of a single molecule, they can account for the earth's primary magnetic field. Upon this theory magnetism must be a property of all rotating bodies. It is the comparatively minute outstanding difference between the two opposite magnetic fields generated by the opposite electricities, associated with matter. In this aspect it reminds one of surface-tension, which reveals the play of molecule forces that escape ordinary observation. To carry the present theory of steller magnetism further, the main desiderata are, first, a demonstration of the difference in the attraction of matter for the two sorts of electricity; and, second, a determination of the law of attraction between matter and electricity, to ascertain whether it is such as to cause negative electrons in molecules to take up the position which, on the whole, is farther from the centre of the earth than that taken by positive electrons.—*Abstracted from Terrestrial Magnetism and Atmospheric Electricity (Baltimore), June.*

Electricity on the Farm.

Although electrical power is well suited for farmwork, there are comparatively few farms where it is used to any great extent. M. E. Guarini in this article describes three European installations which are of interest. At Simmern, Germany, power is obtained from the river for operating a turbine driving an eleven-kilowatt 110-volt dynamo. This machine is used to charge a battery of accumulators with a capacity of ninety-five ampere-hours for a ten-hour discharge, and operates much of the farm machinery. The motors have been selected to replace, as far as possible, men and animal power. They are all easily portable, and where there are a number of machines needing a certain power, it has been considered sufficient to install only one motor powerful enough to work them all. Individual driving has been avoided. At Simmern one motor is of ten horse-power, runs at a speed of 1,200 revolutions per minute, and is mounted on a truck. It was not possible to do all the work of this farm with this one motor, so a number of small motors mounted on portable platforms are also used. At Quednau power is generated by a steam-driven dynamo. The output of the generator is forty-five kilowatts. This is reenforced by a battery of accumulators. Power is distributed at 500 volts and is used for lighting and heating the buildings. There are three motors at this farm. The one with a rating of two and one-half horse-power is fixed, and is used for driving cutting machinery. There are two portable motors, one of them being rated at fifteen horse-power. At Crottorf, Germany, a water power is utilized, but a reserve steam unit has been installed. At this station alternating current is generated at 7,000 volts, there being three 500-kilowatt alternators. Power is distributed over districts within a radius of thirty kilometres. The average demand on this station is about 450 horse-power. What has been especially tried at Crottorf is the use of electricity for threshing grain. The threshing machine is driven with a portable motor and is connected to the high-pressure mains, wherever necessary, through a portable transformer.—*Abstracted from the Electrical Review (London), September 11.*

An Oscillation Galvanometer for Measuring Electromagnetic Rays.

The description recently published of a magnetic detector invented by Dr. Fleming has led Herr Erich F. Huth to describe an apparatus which he has constructed for the same purpose—that of making quantitative measurements of electromagnetic waves. The apparatus, which is called an oscillation galvanometer, consists of a bundle of thirty steel wires having a diameter of one-tenth of a millimetre and a length of sixteen millimetres, mounted upon an ivory rod. Upon this rod is also attached a reflecting mirror, and the system thus constructed is supported by a phosphor-bronze strip and held in tension by a phosphor-bronze spring. Damping wings are also attached to the moving part. Around the bundle of steel wires is wound a magnetizing coil to which current is led from a storage battery by means of the suspending and torsion wires. In use, a current of 0.12 of an ampere has been found most satisfactory. When set up for use this apparatus is connected in the antenna circuit, so that any oscillation set up in the antenna will cause currents to pass through the magnetizing coil and thus to the earth or a condenser. To make an observation, a current is passed through the magnetizing coil, magnetizing the steel wires and causing the movable system to take a steady deflection due to the opposing forces of the earth's field and the torsion wire. If, then, an electrical oscillation impinges upon the antenna, the oscillating currents passing through the coil cause a demagnetization of the steel wires, proportional to the intensity of the wave. The deflection then diminishes in a corresponding degree, the difference between the two deflections being read off by means of a telescope and scale. The instrument may be used in another way: If an electrical wave strikes the antenna while the current from the storage battery is passing through the magnetizing coil, the magnetization of the wire is increased, and an increased deflection is caused which is also proportional to the intensity of the wave. To illustrate the sensibility of the apparatus it was connected to an antenna 257 metres in length, placed 227 centimetres from the sending antenna. With a distance of 175 centimetres from the mirror to the scale, a deflection of 250 millimetres was caused when a potential of fourteen volts was applied to the induction coil, the spark being allowed to pass through air.—*Translated and abstracted from the Physikalische Zeitschrift (Leipsic), September.*

Good Telephone Talking.

To be a good telephone talker is something of an art, but in these days it should, by all means, be cultivated as much as any of the methods of polite conversation. The first requisite is the proper pose. In all cases the transmitter should be as nearly vertical as possible, with the voice funnel so adjusted that it is on a level with the lips when the head is in the ordinary arched position of conversation. Then the lips should be held about an inch away from the funnel and directly opposite its centre. The speaker should talk in a tone slightly above the ordinary conversational pitch, about in the same way as if he were speaking to a person across the room.

But more than all, care should be taken to talk slowly and to articulate with the greatest distinctness. To be deliberate in what one says, and to make ample pause at the end of each sentence. The telephone is such a time saver that one even over a toll line need not be unduly worried in being in too much of a hurry to get through. On the contrary, time and annoyance for one's self and one's correspondent will be saved by talking slowly and allowing a little time for the mental reception of the ideas that one wishes to transmit. Nothing can be more erroneous in the use of a solid back than to stand at a distance from the instrument and endeavor to effect it by shouting at the top of one's lungs.—*American Telephone Journal.*

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INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Twenty-two Thousand Horse-Power in Steam Turbines for Pennsylvania Railroad.

An order for three steam turbines of the largest size has recently been placed with the Westinghouse Machine Company, East Pittsburg, Pa., by Westinghouse, Church, Kerr & Company, acting as engineers and constructors for the Pennsylvania Railroad in connection with the New York terminal equipment.

These machines will form the initial installation in the new Long Island power-house, on which construction is just beginning and which will serve the traction in the tunnels for the Hudson and East rivers and the New York terminal at Thirty-second street and Seventh avenue, and also such part of the Long Island Railroad system as is in process of conversion to electric traction.

The turbines will be of the Westinghouse horizontal short barreled type, mounted upon a single bed-plate, resulting in a particularly compact arrangement and great economy of floor space; they will have a capacity of approximately 7,400 electrical-horse-power each, and will drive 5,500-kilowatt, three-phase, alternating-current generators, operating in parallel. Their overload capacity will be over 11,000 horse-power and each turbine will be provided with a by-pass automatically controlled by the governor to accommodate abnormal fluctuations in load. This will also permit operation at full load, non-condensing.

The turbine equipment will operate under conditions favorable to the attainment of high economy, *viz.*, 200 pounds steam pressure at the throttle, twenty-eight inches vacuum and 175 degrees Fahrenheit superheat.

The generator will be direct-connected to the turbine shaft through a flexible coupling, each section of the unit having two bearings of ample proportion, thus avoiding shaft stresses. The three-phase winding will deliver current directly to the distribution system at 11,000 volts, no step-up transformers being employed. The machines will be separately excited and will carry full load continuously at 100 per cent to eighty per cent power-factor, with a rise in temperature of thirty-five degrees centigrade, or fifty per cent overload for two hours with an increase in temperature rise of slightly over fifty per cent. Each turbo-unit will thus be capable of delivering 8,250 kilowatts for reasonable intervals and considerably in excess of this figure during momentary load fluctuations.

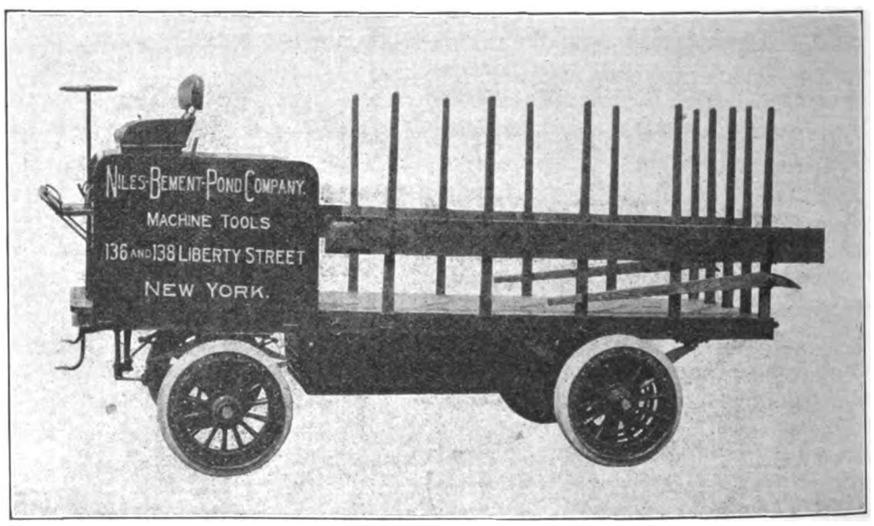
The entire equipment will be delivered by July, 1904, one year from the date of contract. It is somewhat significant of the state of the turbine industry that eleven Westinghouse turbines of approximately the same size are under construction for heavy electric railway service, both in this country and abroad.

A Heavy Service Electric Truck.

The Niles-Bement-Pond Company, New York city, N. Y., one of the largest machine tool companies in the world, obviously has a great amount of trucking to be done. The interesting features in connection with this is, that the greater part of this trucking is accomplished by means of an electrically driven truck which was built by the Rainier Company, of New York city. The advantages which the electric truck possesses over the ordinary truck drawn by a team of horses are many. One of the many advantages peculiar to this style of truck, which is an important one, as it is also labor-saving, is the electric windlass which is placed under the seat. This is operated by an independent motor and controller, the power being derived from the storage battery. This apparatus will hoist five tons at a rate of eight feet per minute, and has all safety appliances, including break, ratchet-pawl and reverse controller.

The body of the truck is sixteen feet long by five and a half feet wide. It is built on the "Gibbs" system of steel frame construction, with what is known as "pedestal" running gears, instead of the "reach" system heretofore used on electric vehicles. The "pedestal" is a single steel casting fastened to I-beam body frame and has diagonal brace bars for support. The axles are placed in the jaws of this "pedestal" and have absolute freedom vertically, but none whatever laterally. This overcomes the intricate mechanism resulting from split axles, differential gears, etc.

The I-beam steel frame relieves the vehicle body of any strain and tendency to buckle, and at the same time offers substantial support for suspending the battery, and leaving the inside of the wagon body absolutely clear. The battery is made in sectional trays which slide out at either side and are of the type used in the Rainier Company's equipment. The power is furnished by two motors of General Electric make, and operate independently on rear wheels. The tires are six inches, solid rubber. Forward springs are full eliptic, the rear, one-half eliptic. A double brake operates on the inside of rear wheels, being worked by foot power. The controller has four speeds ahead and two reverse, the maximum speed of truck being five and a half miles per hour. The battery has a capacity of twenty-five miles on a single charge.



HEAVY SERVICE ELECTRIC TRUCK.

Every passenger coach now being built in the shops of the Pennsylvania Railway Company, in Philadelphia, Jersey City, Altoona and Pittsburg, is wired for electric lights, in addition to having an illuminating gas installation.

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Motor-Driven Bolt Cutters.

The accompanying illustrations show two new bolt cutters which have been designed by the Reliance Machine and Tool Company, of Cleveland, Ohio. These machines are a distinctive departure from the heretofore standard type.

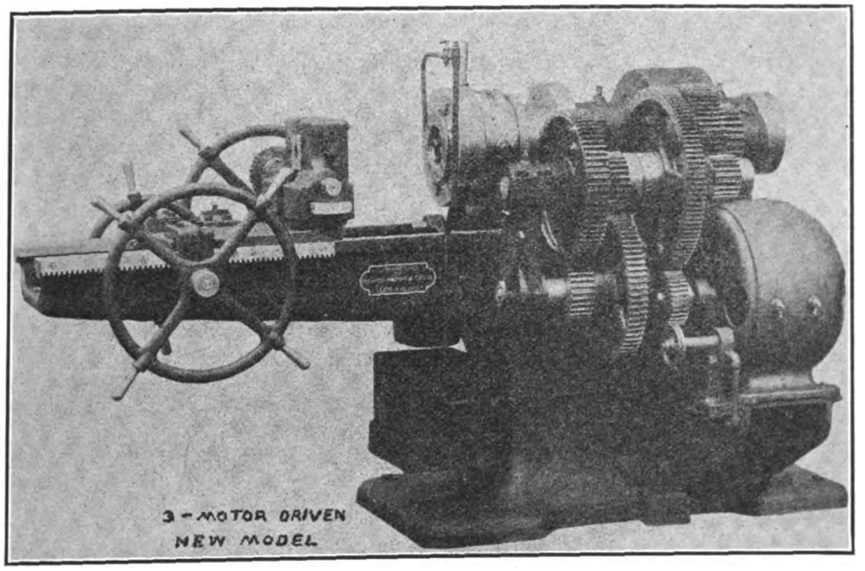

FIG. 1.—THREE-INCH BOLT CUTTER, EQUIPPED WITH ELECTRIC MOTOR AND CONTROLLER.

Fig. 1 shows a three-inch bolt cutter equipped with a Crocker-Wheeler motor and controller. A new and significant feature is found in the method of driving the head spindle or shaft, the driving gear of which is located centrally between the bearings of the spindle, instead of being at its extreme end. A system of compound gearing makes it possible to obtain greater power without having an unduly large driving gear. This method of driving the head spindle eliminates all torsion, producing a smoother and more rapid cut without chattering.

The oil and chips which work through the hollow spindle do not prove a source of trouble by falling upon the belt and pulley. The working parts are all accessible, and the floor space has been reduced by the compact design of the machine. In the belt-driven machine a four-step cone pulley takes the place of the gear meshing with the motor pinion.

Fig. 2 shows the standard type of motor-driven bolt cutter manufactured by this company. This machine is a two-inch single-bolt cutter equipped with a Crocker-Wheeler variable speed reversible motor. The speed variation obtained by field control is as one to three, and the motor is connected by means of spur gearing directly to the machine.

The motor, being fastened to the back of the machine, is readily accessible, free from grit and oil, and occupies very little floor space. Gear covers are furnished if desired.

The Reliance Machine and Tool Company reports a strong demand for this class of tool, and states that a general and growing tendency toward electrically driven machinery is very evident.

An Electric Car Lighting System.

The Kinsman Electric and Railway Supply Company, New York city, has developed an electric car lighting system which keeps the headlight and also the interior lights working, whether the trolley is on or off, or the power stopped for an indefinite time. This work is accomplished, it is stated, at a low cost for installation and maintenance. In installing the car lighting system the present method of lighting (by five lamps in series, usually) is not interfered with, except by the introduction into the lamp circuit of an automatic shunt and a small secondary battery placed under the car seat, the latter being connected in multiple with supplementary low-voltage lamps in the car or headlight, or both. A switch such as now used serves to bring the present as well as the supplementary systems into service. The secondary batteries are long-lived, owing to the fact that under ordinary circumstances comparatively light service is required of them, and the same is true of the supplementary lamps for the same reason.

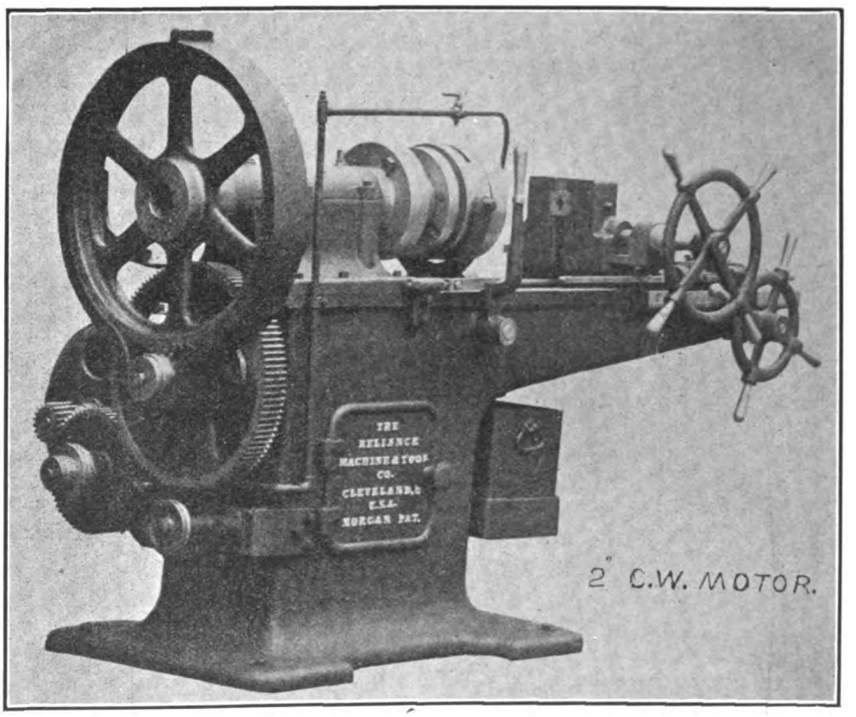

FIG. 2.—TWO-INCH BOLT CUTTER, EQUIPPED WITH VARIABLE SPEED ELECTRIC MOTOR.

Paper-Insulated Cables.

The life of paper-insulated cables is generally considered to be longer than those having rubber insulation. This consideration, however, may be changed by the character of the ingredients composing the rubber compound. It is stated that the dielectric strength to resist high voltages becomes greater with increasing proportions of pure Para or other high-grade rubber, and with lead-covered cables increasing the percentage of high grade rubber lengthens the life of such cables. The paper for paper-insulated cables must be very carefully selected and impregnated with insulating compound. An oily compound is best, as it permits the cable being handled without injury, and it also has the power of resisting high voltages better. The oily compound, however, gives the cable a low insulation resistance. Specifications, therefore, which aim to secure a good cable by requiring a high insulation resistance miss the mark in excluding the oily compound impregnated paper insulation and securing an inferior style of cable.

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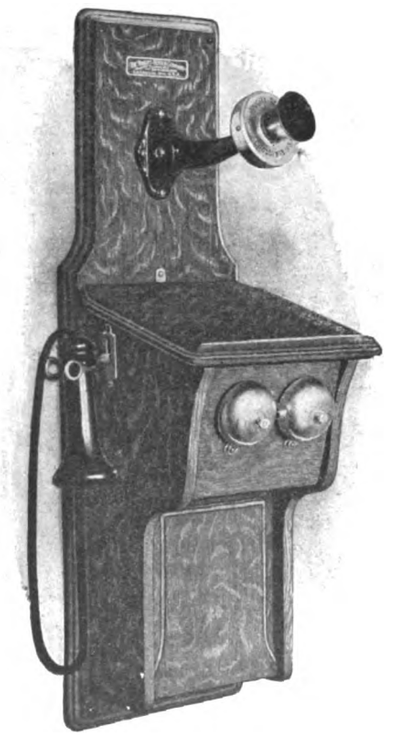
New Magneto Series or Bridging Telephone.

The Vought-Berger Company, of La Crosse, Wis., has placed on the market a new magneto telephone, for series or bridging systems. The accompanying illustration shows the wall set, enclosed.

The instrument is equipped as follows: Bell type solid back, long-distance transmitter mounted on hollow adjustable arm with double concealed cord. Bipolar receiver, concealed cord connections. Silk-wound long-distance induction coil. Long lever switch hook. Ringing circuit thoroughly well installed. Equipped with either three or four-bar series generator, or four or five-bar bridging generator. All binding-posts concealed. No bare wires used. Ringer striker is protected by nickel-plated guard. Combined saw-toothed plate and carbon block lightning arresters. Columbia dry batteries.

The transmitter arm is mounted on solid backboard, preventing bell reverberations. Looped hinging of flexible transmitter cord is done away with.

A swing-down shelf makes ringers readily accessible for inspection and adjustment—both gong-side and coil-side can be viewed simultaneously. Generator springs are easily reached. All working



NEW MAGNETO SERIES OR BRIDGING TELEPHONE.

parts can be inspected both from the front and the top.

Batteries are placed in compartment in lower portion of cabinet, and are covered by sliding panel. They can be reached without opening balance of telephone.

When the telephone is closed, the shelf is screwed firmly to backboard, obviating the necessity of a lock, and, at the same time, effectually protecting telephone from meddlers.

The backboard is kept from coming into close contact with wall, by small wooden bushings, which are inserted in back at points where wall screws go through.

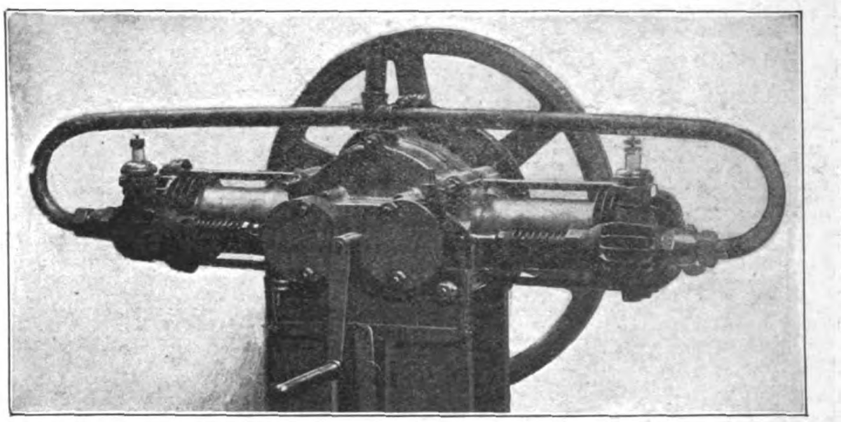
It is but a simple matter to change this telephone from series magneto to bridging, or *vice versa,* as cabinet will fit either generator.

This instrument is designated as No. 45 and is made up in either walnut or quarter-sawed oak. The Vought-Berger Company manufactures its own woodwork, and special attention is paid to finish.

A Light-Weight Motor.

The problem of aerial navigation has brought about many endeavors to obtain motive power with extreme light weight, and this has resolved itself into the question of how light can a motor be built consistent with strength of parts necessary to stand the energy exerted to be practical for the purpose of propelling a resistant body through space. The illustration herewith shows a gasoline motor, constructed by the Walters Power Company, 62-66 Van Winkle avenue, Jersey City, N. J., on an order for parties in St. Louis, Mo., as an experimental machine, to be supplemented later by a larger horse-power motor for practical use and proportionally as light in weight.

The motor is of the four-cycle, two-cylinder, opposed crank type, having a flywheel external of the crank case. The periphery of the flywheel is beveled and receives a clutch fastened to a scored pulley, seen in the rear of the illustration. This pulley is connected by a belt to a smaller pulley on the propeller shaft of the aeroplane. As this is only to be used on an experimental machine, a small device has been added, having a small cord leading from it, which releases the hold of this clutch and stops the action of the motor upon the propeller, when it is desired to stop it and let it descend. The spark shifter is shown in the front of the illustration and permits a variation of the motor speed.



A LIGHT-WEIGHT MOTOR FOR AEROPLANE DRIVING.

The motor with flywheel and spark plugs weighs but twenty-four and a quarter pounds, by adding the carbureter and friction clutch its total weight is thirty-two and a half pounds. It was fully run upon the testing block for part of a day and a brake test applied showing an efficiency of two and three-tenths horse-power. This design of motor lends itself to lighter weight than the vertical motor of the same size. The material used in this machine is the best obtainable, respective to each part. Aluminum was used wherever permissible, owing to its light weight, with the above result. The manufacturers of this motor claim that they can produce a larger motor at even lighter weight per horse-power than the one here shown.

The Manhattan Railway Company, of New York city, has 120 miles of three-phase underground cable operating at a pressure of 11,000 volts. The test employed to detect any fault is to apply a pressure of 22,000 volts for a thirty-minute period. Several breakdowns have occurred during the past year, and these, it is thought, have not been due to faults in the insulation, but to faults in the lead sheath of the cable caused by stray currents from other properties passing along this sheath as a conductor. To prevent these troubles it has been decided to thoroughly insulate the lead sheaths of the cables in all the manholes, the portions of the cables in the conduits being already insulated by the conduits themselves.

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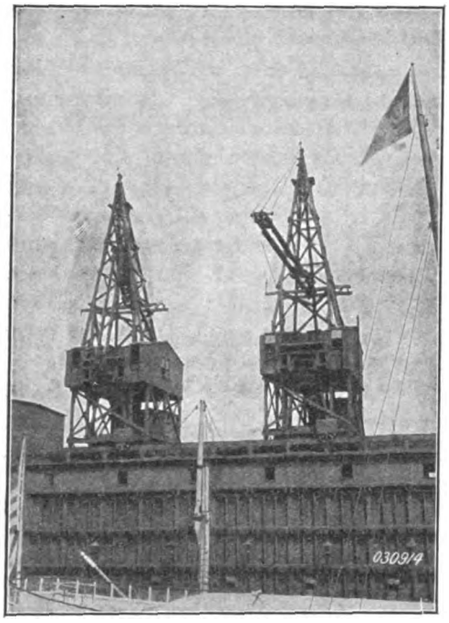
A World's Record in Coal Hoisting.

The steadily increasing bulk in which coal is conveyed by sea and rail, and stored for boiler service in high pockets at power stations and plants, has led to a demand for increased speed in the necessary hoisting and handling machinery.

Demurrage on steamships and cars is an item to be carefully avoided in economical management, and the large cargoes now shipped to terminals can only be handled with success by specially designed high-speed machinery. The problem is different from, and more difficult than, the familiar one of bulk unloading and storage of coal, ore, or similar materials on the ground level from vessels. The element of height materially affects the machinery design. With a single tower, hoisting to about fifty feet above tide water, forty to sixty tons an hour was, until recently, the common speed, and ninety to one hundred tons was only attained with difficulty in exceptionally favorable circumstances.

The work demanded of coal-hoisting towers and their machinery is of the hardest description, both from the unskilled nature of the labor employed, and the shocks to the machinery incidental to the service, and it changes constantly with the nature and size of the coal, which may vary from a soft pea variety contained in open wooden barges to a hard foreign product in cubes, two feet square, loaded in steel vessels with small hatches. A great advance in the speed of handling coal from freight vessels and barges calls to be recorded a world's record for rapid unloading which has been recently established by the C. W. Hunt Company, West New Brighton, N. Y., at the Lincoln wharf power station of the Boston Elevated Railway.



COAL-HOISTING APPARATUS AT LINCOLN POWER STATION, BOSTON, MASS., ELEVATED RAILWAY COMPANY.

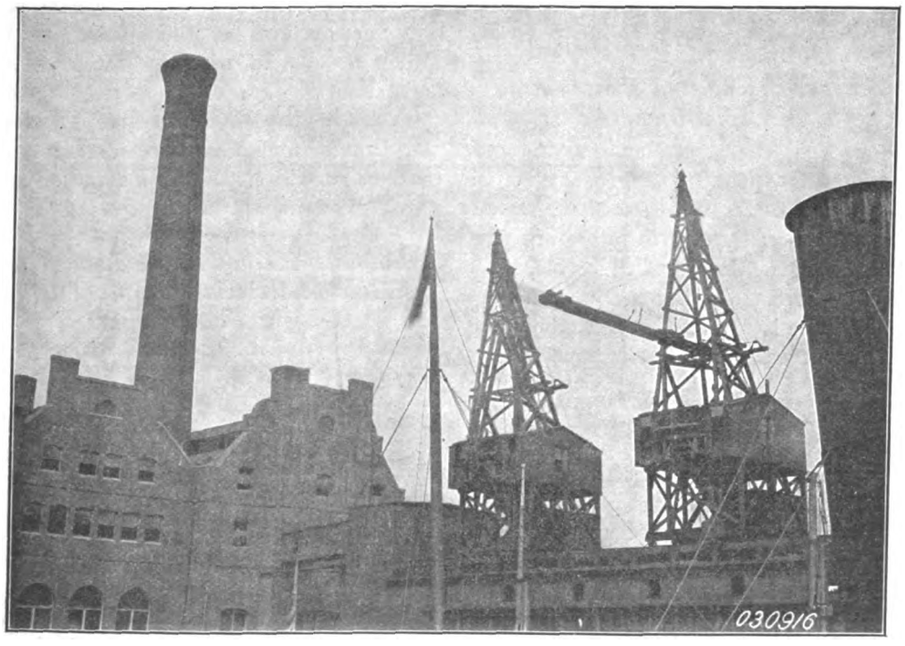
Run of mine bituminous coal was raised ninety feet above the tide water from one hatch of a vessel and delivered to the storage pockets, cracked to mechanical stoking size, at the rate of 320 tons per hour, by one tower. This is an advance of about 200 per cent upon the previous best, and marks an important mechanical engineering achievement.

To attain this end, the steam engines of fifty to one hundred combined horse-power, in common use, have been replaced by machinery of 300 horse-power, and the coal-cracking machine attached to the tower cracks to the proper dimensions for automatic stokers before passing to the pocket the enormous quantity of coal, over five tons per minute, delivered to it from the hoisting machinery. The ordinary small steam shovel has been supplanted by an automatic one of two tons capacity at each lift.

The time occupied in raising two tons of coal from the hold of a vessel to the discharging hopper, nearly 100 feet above, is only six seconds, while the round trip, involving the operations of lowering and moving the shovel out of the boom, opening the former, digging up two tons of coal, raising it to the level of the hopper and discharging it therein, is frequently performed in twenty-two seconds.

The installation, shown in the illustration, follows in general design, but in heavier proportion, the standard Hunt steeple tower rig, the moving gear and coal cracker being electrically driven and the hoisting engine direct-connected. The towers have to traverse overhead the whole length of the coal storage pocket and to move thirty feet at a time without changing steam connection. In this way a single tower can operate on each hatch of a vessel in turn, or several towers can work simultaneously.

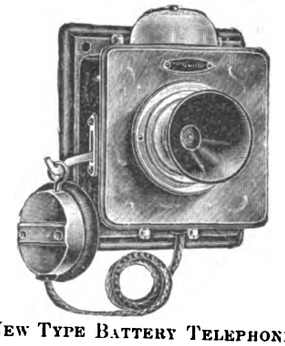
The boom, made to fold up, for the free manipulation of vessels with their rigging, has an overhang of forty feet, and enables the tower to operate on coal steamers of the widest beam and largest dimensions.



COAL-HANDLING APPARATUS AT WHARF OF LINCOLN POWER STATION OF THE BOSTON, MASS., ELEVATED RAILWAY COMPANY.

New Type Battery Telephone.

J. H. Bunnell & Company, 20 Park place, New York city, have designed a new type of battery telephone which is designated as the "Beeko-Phone." This instrument is equipped with a solid-back transmitter, double-pole receiver, vibrating bell and call-button, and the apparatus is guaranteed by the company to give satisfaction on all short lines. The instrument makes a handsome appearance and is well constructed throughout, it being designed with such simplicity that any one can set it up. Copper wire is recommended for the lines.



NEW TYPE BATTERY TELEPHONE.

The instruments are very low in cost, and as they are intended for short-line intercommunication the equipment is very inexpensive.

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The American Electrotherapeutic Association.

The American Electrotherapeutic Association opened its thirteenth annual convention in the marine parlor of the Hotel Windsor, on September 22. The delegates were welcomed by Mayor Franklin P. Stoy, who expressed the hope that the physicians would have a very pleasant time while meeting in Atlantic City, but, at the same time, he hoped that they would not have any opportunity to use any of their professional knowledge while in the city. Dr. Dickson, of Toronto, Canada, responded to the Mayor's welcome. Dr. B. C. Pennington welcomed the delegates on behalf of the local Academy of Medicine, and Dr. William James Herdman, of Ann Arbor, Mich., responded.

After the meeting had been called to order by Dr. Brower, the president, reports of the various committees were received and several honorary members were elected. The executive session was held from nine to ten o'clock, after which the scientific session was held. Resolutions of respect were adopted upon the death of Dr. Robert Newman, of New York city. Dr. Newman was to have read a paper on "Retrospect of the Second International Congress of Electrotherapeutics at Berne."

After the reading of a number of scientific papers, all of which treated of the use of electricity in various diseases, the members witnessed a special drill of the United States Life Saving Corps, after which the business of the afternoon session was taken up, when several other papers upon the use of electricity in the practice of medicine were read and discussed.

The entire morning of the second day's session was taken up with a discussion of the problems which arise in electrotherapeutic practice. At ten o'clock a number of the physicians made a visit to the United States Signal Station and inspected these quarters.

One of the most interesting papers of the afternoon session was that read by Dr. Margaret Abigail Cleaves, of New York city, which treated upon radium. This detailed exhaustively the use of radium rays in the treatment of cancer. Dr. Cleaves had a small phial which was exhibited. This was about an inch in length and as large around as the lead in a drafting pencil. This was viewed with great interest.

Following the reading of the resolutions of respect upon the death of Dr. Newman, reported by a committee composed of Dr. G. Betton Massey, chairman, and Drs. Charles R. Dickson and Frederick H. Morse, the officers for the ensuing year were chosen. The report of the nominating committee was received and adopted, and the secretary cast the ballot which named the following executives for the next fiscal year:

President, Dr. A. I. Rockwell, of New York; Vice-presidents—First vice-president, Dr. Willis P. Spring, of Minneapolis, Minn.; second vice-president, Dr. William W. Eaton, of Danvers, Mass.; treasurer, Dr. Richard J. Nunn, of Savannah, Ga.; secretary, Dr. Clarence Edward Skinner, of New Haven, Ct. Executive committee: Dr. Francis B. Bishop, of Washington, D. C., one year (to complete the term of Dr. Robert Newman, deceased); Dr. Daniel R. Brower, Chicago, Ill., three years; Dr. Maurice F. Pilgrim, New York, N. Y., three years.

There were several places suggested in which to hold the next meeting of the association, and the nominating committee did not make any recommendation. St. Louis was mentioned as one of the places, however, and that city received the unanimous vote of the association as the site for its next session.

The business meeting was short and following that a reception was tendered the members of the association and their wives by the profession of Atlantic County and the Atlantic City Academy of Medicine in the marine room of the Windsor.

Vacuum-Drying and Evaporating Apparatus.

The Emil Passburg vacuum-drying and evaporating apparatus is represented in the United States and Canada for manufacture and sale under the Passburg patents by Mr. Joseph P. Devine, 312 Mooney-Brisbane Building, Buffalo, N.Y. Mr. Devine is well known throughout the electrical field through his connection as vice-president of the National Battery Company, Buffalo, N. Y.

Mr. Emil Passburg, of Berlin, Germany, is a well-known authority on the subject of vacuum-drying and evaporating apparatus, and the Passburg system of drying and impregnating for dynamo and motor armatures, electric cables, field and transformer coils, etc., is used extensively in Europe by a number of the most representative companies.

It is claimed that this system will dry out absolutely all the moisture in armature and field coils. In fact, this system has its ramifications bearing in almost every industry where a rapid drying process is necessary.

The American Telegraphers' Tournament Association.

The American Telegraphers' Tournament Association will hold a tournament on October 30 and 31 in the auditorium of the National Export Exposition Buildings, Philadelphia, Pa. The primary feature of the tournament will be the speed contests in different branches of telegraphy. The most important event is the speed contest for the best "all-around" telegrapher in the world, for which Mr. Andrew Carnegie presented a handsome gold medal studded with diamonds, to be competed for annually. The medal was won last year by Mr. F. M. McClintic, of Dallas, Tex., who attained the record-breaking speed of sending 517 words in ten minutes and receiving on a typewriter 500 words in the same time. Other prizes will be awarded for speed by railway operators, broker operators, women operators, the "Old Timers" and a championship class. The "Old Timers" event is for operators over sixty years of age.

Through the courtesy of the Commercial Cable Company a siphon recorder—the instrument used on the Atlantic and Pacific cables—will be connected and an exemplification given of its workings. Wireless telegraphy will be one of the attractions which will be not only interesting, but instructive.

The expenses of the tournament have been raised by the Philadelphia operators, and no profit will accrue to the association, inasmuch as all the money raised will be devoted to prizes for the contestants. Entries are being received from operators in all parts of the United States and Canada, and it is expected that this tournament will surpass in magnitude all previous affairs of the kind.

A Possible Method of Reducing the Time of Exposure in Making X-Light Photographs.

To the Editor of the Electrical Review:

Recently in California a new variety of spodumene has been found and named Kunzite. Dr. Kunz and Professor Baskerville have found the mineral, after exposure to X-light, retains energy which it gives out for several minutes in the form of very short ether waves (phosphorescence). If in a finely divided form the spodumene retains this property it will be very valuable for use in the form of screens or mixed with the photographic emulsion for use in taking instantaneous photographs by X-light, as the action on the plate from the X-light would be carried on afterward by the spodumene.

William Rollins.

Boston, Mass., September 25.

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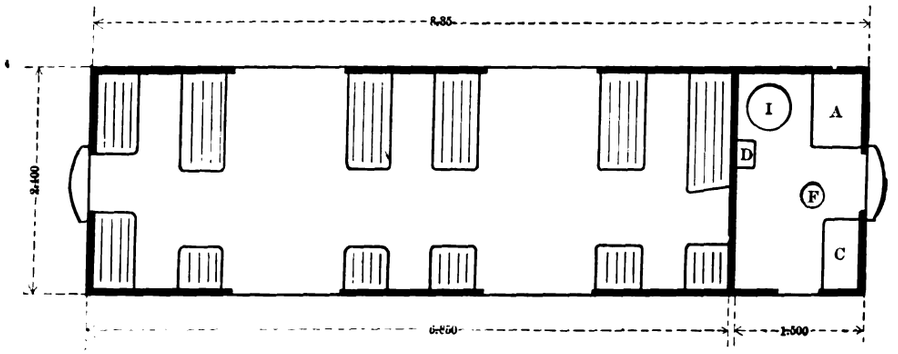
NEW FIREPROOF CAR FOR THE PARIS METROPOLITAN.

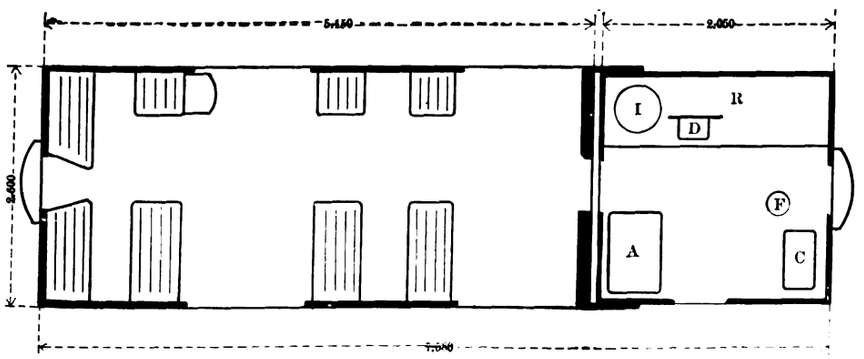
BY C. L. DURAND.

After the recent disaster on the Paris Metropolitan the city authorities had a consultation with the engineers of the road as to what would be the best measures to take in order to avoid such accidents in the future. One of the first improvements will be to make the cars as nearly fireproof as possible as they are now built of pitchpine which, while it is of ornamental appearance, is highly inflammable and as was proved in the present disaster a spark or a heating up of the wires can easily set fire to a car, and the whole train is soon in flames. The cars are already provided with fusible plugs and automatic circuit-breakers so as to cut off the current and avoid the possibility of the overheating of the wires, which would set fire to the woodwork. But as these may fail to work in spite of all the precautions, the wires are liable to become red-hot and thus cause great danger. It thus becomes necessary to make all the parts of the car, and especially those portions lying near the circuits, as nearly fireproof as possible.



THE OLD STYLE CAR ON THE PARIS METROPOLITAN.

With this end in view the Metropolitan Company has been studying a new type of fireproof car which will no doubt replace the present car. The form which was finally adopted by the company is shown in the diagram, and alongside of it is the plan of the old car, so as to show the improvement which has been made. Above is the present car, while the new design is shown below. In the new car the body will be made entirely of incombustible material; it will be built of metal and fibro-cement or sheet asbestos. Besides, as will be observed, the motorman's cab, which is seen on the right of the diagram, is now made considerably larger and is separated from the main body of the car by two fireproof partitions with an air-space between them. As the size of the cab is now increased, it gives room for installing the resistances of the motors. These resistances were formerly placed underneath the car, but in this case it will be easier to keep them in order and inspect them, thus avoiding another source of trouble. Besides, as the resistances are now placed much nearer the controlling apparatus, this suppresses a considerable quantity of the cables which were placed underneath the floor and were exposed to wear and consequent short-circuits.



THE NEW CAR ON THE PARIS METROPOLITAN.

The new car is considerably shorter than the old type, so as to shorten up the distance between the axles and allow the car to pass more easily around the sharp curves which are quite numerous on the Metropolitan road.

These projects have been submitted to the city authorities who will no doubt approve them at once and take measures to have the new cars substituted for the old form as soon as possible. In such case a short-circuit will no longer offer any danger to the train, as there will be no combustible material to be attacked. The position of the various controlling apparatus in the cab is indicated in the diagram; the same letters apply to the old and the new car.

At A is the air compressor, C the controller, D the automatic circuit-breaker, F the brake handle, I the reversing switch. The resistances are now placed in a large case R, which will be well ventilated.

Artificial Niagara at St. Louis.

An immense artificial cascade has been determined upon by the authorities of the Louisiana Purchase Exposition as the centrepiece of the semi-circular layout of the principal buildings. The cascade itself will be divided into three parts; a large middle cascade with a smaller one at each side, the water flowing directly into the head of the grand basin. In all, about 90,000 gallons of water per minute will be supplied at a head of 159 feet, forming the greatest artificial water effect ever attempted.

The water will be taken from the grand basin itself and will be raised to the top of the cascade by a pumping station located under Festival Hall. The pumping machinery will consist of three thirty-six-inch single-stage, turbine centrifugal pumps purchased from Henry R. Worthington, of New York city, each driven by a 2,000-horse-power Westinghouse alternating-current motor. The total horsepower utilized will thus be 6,000, making this the largest electric pumping station in the world. The pumps and other pieces of machinery for this plant are now being installed at St. Louis.

The new marine barracks at the Naval Academy, Annapolis, are to be lighted by electricity, generated by a motor-generator set, consisting of a 100-horsepower, direct-current motor mounted on the same bed-plate with and direct-connected to a sixty-kilowatt, two-phase alternator. The current will be generated at 1,100 volts and transmitted across the river and there transformed to 440 volts. These machines have recently been ordered from the Westinghouse Electric and Manufacturing Company, together with the usual switchboard and auxiliary apparatus.

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CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

A CUBAN MUNICIPAL LIGHTING PLANT—The municipality of Cienfuegos is about to install a plant for the purpose of electrically lighting that Cuban city.

MILWAUKEE, WIS., TROLLEY PLANS—The Milwaukee Electric Railway and Light Company, one of the subcompanies of the North American Company, is projecting improvements which will cost millions. The work of the $600,000 central station will be pushed to completion, and in addition the company will erect stations at each corner of the city and will build a belt line from the lake shore on the northeast side to the lake on the southeast. The belt line will tap all of the suburban lines and connect with each line from the centre of the city. Viaducts will be built over the Kinnickinnic, Menominie and Milwaukee rivers. In addition to these improvements, work will be rushed on three interurban roads. A line to Port Washington, forty miles north, to connect with lines under construction from that point ninety miles beyond to Green Bay, will be rushed. This line will also by side lines tap Fon du lac and Oshkosh, thirty miles from the through line. Extensions of the suburban system fifteen miles to Oconomowoc and ten miles to Muskeo lakes are also projected.

A TELEPHONE COMBINATION—General Manager Webb, of the Maryland Telephone and Telegraph Company, in announcing the conclusion of a traffic agreement with the United Telephone and Telegraph Company of Pennsylvania, says: "Under the agreement the Maryland company gets a connection with Hagerstown, Md.; Winchester, Va.; Chambersburg, Carlisle, and Harrisburg, Pa., and many other places through a large territory." The Pittsburg and Allegheny Telephone Company, in which the Maryland company is largely interested, and the Johnstown Telephone Company have nearly completed a line between Johnstown and Pittsburg, while the United company is building a fourteen-mile line into Johnstown. When this work is finished the Maryland's service will be extended to Johnstown and Pittsburg, and will open up the western territory in Pennsylvania and into Ohio, Illinois and Michigan, where the Pittsburg & Allegheny company has lines in operation. The United States Long-Distance Telephone Company has just built a line into Cincinnati, and the Maryland will connect with it through the Pittsburg and Allegheny.

MANILA, P. I., POWER PLANTS—Governor Taft has cabled the War Department details of the franchise which is to be granted for furnishing power for various enterprises in Manila and elsewhere. He says the commission has surveyed the territory embracing Botocan falls at Mahihi, Province of Maguna, and Lamot and Caliraya rivers, near by, and that it has been discovered that at least 10,000 horse-power may be developed from these sources. The distance from Manila to the point in question is fifty-five miles, and Governor Taft says few engineering difficulties will be encountered. The local electric lighting company of Manila, backed by strong capital, desires to develop the power of the Angat river in Bulucan, a distance of thirty-five miles. The Philippine Government, however, should it decide to grant the franchise for furnishing power from this point, will give it to the highest bidder. The franchise will provide for the sale of power to all alike on reasonable terms fixed with reference to the cost of the plant. An opportunity probably will be given American investors to bid on the franchise, which Governor Taft states will be most valuable.

TELEGRAPH COMPANIES' EARNINGS—Stockholders of the Mexican Telegraph Company have received notices informing them of the declaration of the usual quarterly dividend of two and a half per cent and a statement and estimate of earnings for the quarter ending September 30. The statement shows an estimated surplus, after paying the October dividend, of $1,354,382. The estimated net earnings for the quarter are $94,000, not including interest on investments and deposits. This is the seventy-ninth dividend on the stock of the Mexican Telegraph Company. From the same office the report of earnings of the Central & South American Telegraph Company is sent out. President James A. Scrymser, who is also president of the Mexican Telegraph Company, calls attention to the fact that after the usual quarterly dividend of one and a half per cent is paid, there will be added $35,816 to the surplus fund. Mr. Scrymser adds: "In this company's report dated May 6, 1902, the views of experts on the limited possibilities of wireless telegraphy were published. Since that time nothing has occurred to change the views then expressed, and experts still hold to the opinion that wireless telegraphy can not rival submarine telegraphy for commercial purposes."

ILLINOIS INTERURBAN LINE—The contract for the building of the Dixon, Rock Falls & Southwestern Electric railway has been let, and it is expected to have the road entirely built and ready for business by September 1, 1904. The road, starting at Dixon, Ill., will pass through Nelson township and Rock Falls, thence southwest, striking Tampico, Hooppole, Atkinson and Geneseo. Several extensions are contemplated for the road and the main line will be a connection from Geneseo to Rock Island, a distance of twenty-three miles. Several towns, ten to twenty miles from the main line, are petitioning the officers of the company to build spurs of the road connecting with their towns. The Dixon, Rock Falls & Southwestern Electric Railroad Company was incorporated March 21, 1903. Over three-fourths of the right of way has been secured and the franchises have been obtained wherever the road is to go. The road, as far as the main line goes, will be sixty miles in length and will cost $1,500,000. A large share of this money will be spent in Rock Falls and vicinity in the erection of a large power-house and car barns. The main offices of the company will also be established in Rock Falls. The power-house and car barns will also be located there. The building of the road between Dixon and Rock Island will be the completion of a through line from Chicago to Rock Island, and when completed this road will be the shortest route between these two important points. It will do a large amount of business that other lines will not have the chance to do. The Northern Illinois road is being built to Dixon, and the Dixon, Rock Falls & Southwestern will connect it with Rock Island.

TELEPHONE AND TELEGRAPH.

CHATTANOOGA, TENN.—New machinery has been purchased in St. Louis for the electric plant at Ironton.

COLUMBUS, OHIO—The Tremont Home Telephone Company has increased its capital stock from $60,000 to $100,000.

ONAGA, KAN.—A franchise has been granted to R. G. Guffy and H. H. Benton for a second telephone exchange here.

HARRISBURG, PA.—The Pennsylvania Telephone Company has filed notice of an increase in its capital stock to $2,500,000.

LA CROSSE, WIS.—The village of Arcadia will install an electric light plant to be operated by the city, at a cost of about $6,000.

AKRON, OHIO—The Summit Rural Telephone Company has been incorporated to build a telephone line to Montrose, Ghent and Hammonds Corners.

CARROLLTON, GA.—The Gainesboro Long-Distance Telephone Company, of this city, has applied for permission to increase its capital stock to $150,000.

LIGHTSVILLE, OHIO—The Lightsville Telephone Company has been organized by David Minnich, J. L. Spring, E. Riegel, C. M. Ripp and D. P. Livingston.

POUGHKEEPSIE, N. Y.—It is announced that the New York State Telephone Company is about to begin work of stretching lines through Dutchess County.

CRAWFORDVILLE, IND.—The stockholders of the Waynetown Union Telephone Company, of Waynetown, have organized with W. S. Fowler as president.

NEWBURGH, N. Y.—The Highland Telephone Company is

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about to construct a line from Little Britain to Coldenham through the Drury Lane neighborhood.

SOUTH LYONS, MICH.—The South Lyons Telephone Company has been organized with K. Calkins as president, and will build an independent telephone exchange here.

PORT CLINTON, OHIO—The new direct line of telephonic communication between Port Clinton and Toledo has been opened by the new Ottawa County Telephone Company.

HEMPSTEAD, L. I.—All the wires of the New York & New Jersey Telephone Company from the city line of Queens to Hempstead and to Babylon will be placed underground.

BANGOR, ME.—At a recent meeting of the Mungunsaw Telephone Company the following officers were elected: S. S. Thornton, president; Miles D. Arbo, vice-president; C. S. Newcomb, treasurer.

OLLIE, IOWA—The citizens have purchased the local telephone exchange from the Southeastern Iowa Telephone Company and reorganized under the name of the Ollie National Telephone Company.

KENTON, OHIO—The directors of the Citizens' Telephone Company, of Paris, Tex., have decided to erect a line to Honeygrove from Clarksville, and another from Sherman to Honeygrove.

KINGSTON, N. Y.—At a meeting of the Citizens' Standard Telephone Company, M. E. Drake was elected president; Jay E. Klock, vice-president; and Charles Reynolds, Jr., secretary and treasurer.

SCRANTON, PA.—The Wayne & Pike Independent Telephone Company elected the following directors at its annual meeting: B. F. Killam, H. W. Clark, Charles Killam, Ava Quick, D. Bingham, F. G. Hames.

POND CREEK, O. T.—A deal has been completed by which the Oklahoma & Kansas Telephone Company has purchased all the business, property and corporate rights of the Grant County Rural Telephone Company.

NORFOLK, VA.—The Southern Bell Telephone Company will erect a new exchange in this city which it is said will be one of the largest in the South, and will also make many improvements to its local service.

MILWAUKEE, WIS.—The Burlington, Rochester & Kansasville Telephone Company, of the town of Rochester, Racine County, has filed an amendment to its articles of incorporation increasing its capital stock from $2,500 to $5,000.

WILKESBARRE, PA.—The Bell Telephone Company is rebuilding its line from Berwick to Nanticoke. New poles will be erected and wires strung, and two additional pairs of wires will be added to accommodate the increasing business.

DAVENPORT, IOWA—On January 1 the general offices of the Iowa Telephone Company will be removed from Davenport to Des Moines, for the reason that the latter city is more centrally located in the company's field of operations.

LOS ANGELES, CAL.—Contracts have been let by the Kern River Company for a new power-house to be erected about forty miles from Caliente. The building will be a concrete and iron structure, 60 by 170 feet in size, with walls two feet in thickness.

BALTIMORE, MD.—The new exchange of the Maryland Telegraph and Telephone Company, at Forest Park, has been completed and placed in operation. The exchange cost $20,000 and will give much improved service to the people at Forest Park, Walbrook, West Arlington and the surrounding territory.

PORTERVILLE, WIS.—Work on the new brick substation for the Mount Whitney Power Company has been commenced by Manning & Sons, of Lemoore, who were awarded the contract for $2,340. It will be forty-two and one-half by twenty-six and one-half feet, wholly of brick, with concrete floor and corrugated iron roof.

WEST BROOKFIELD, MASS.—The Massachusetts Electric Light Company, of Palmer, which recently petitioned the selectmen for the right to erect poles and string wires in West Brookfield for the maintenance of electric lights in private residences in this vicinity, has been granted the privilege asked and will begin work at once.

McCONNELLSVILLE, OHIO—The Millgrove-Neelyville Telephone Company has been organized with the following officers: President, James Singree; vice-president, B. F. Wells; secretary, J. W. Harper; treasurer, A. M. McIntire. The survey for the line has been made and the company will erect the line from Millgrove to Neelyville very soon.

CADILLAC, MICH.—Messrs. Cornwell, Gaffney and Orr, who are planning to build an electric railway in this city, have secured an option on the property of the Cadillac Electric Light and Water Company, supposed to be valued at about $20,000. The option is good for thirty days. The syndicate is also securing options on all the desirable land in the vicinity of lakes Cadillac and Mitchell.

WASHINGTON, PA.—The Federal Telephone Company, which operates extensively in this section, is securing rights of way from Waynesburg by way of Graysville, Burdette and Burnsville, for a line to Dallas, W. Va., to meet a line already constructed from that place to Wheeling. The same company has completed a line from Waynesburg to Rutan, and with the proposed connecting link completed will have a thorough line ready for operation.

SODUS, N. Y.—The Empire State Telephone Company will enlarge and better its service in this section. For the benefit of Rochester, Williamson, Sodus and Wolcott patrons, a direct line of two copper wires is being installed. Williamson will be connected with Sodus Bay, and a series of wires will be run from Clyde to North Rose, and then west and south to Palmyra. Another line of wires will run to North Rose from Clyde and then east to Wolcott.

MINNEAPOLIS, MINN.—Both the Minnesota and Wisconsin companies owning power rights at the falls of the St. Croix have disposed of controlling interests to Stone & Webster and Lee, Higginson & Company, of Boston, for the Minneapolis General Electric Company, which is also controlled by Boston parties. The purchase price is given as $325,000 and the guaranty by the General Electric Company of the outstanding bonds of the St. Croix companies. Judge M. B. Koon, of this city, arranged the plan of purchase.

SPRINGFIELD, MASS.—The state board of gas and electric light commissioners has approved the petition of the Greenfield Electric Light and Power Company and authorized it to issue first mortgage twenty-year five per cent bonds to the amount of $100,000. With the money received from the sale of these bonds the company is to refund $25,000 of bonds outstanding and to pay the expense of developing the water power privilege recently obtained on the Deerfield river, near the Buckland and Shelburne line.

SALT LAKE CITY, UTAH—The contract for the construction of the proposed power plant for the Columbus Consolidated Mining Company has been let. Work is to begin at once and be completed by January 1 next. The plant, when completed, will represent an investment of about $40,000. It is proposed to generate sufficient electricity to drive the machinery of a mill to be erected later, and also for the machine drills in the mine. The company, in addition to this, expects to derive considerable revenue by furnishing lighting facilities for the citizens of the camp.

GRAND RAPIDS, MICH.—The Boyne City Electric Company has been organized in this city and articles of association have been forwarded to the secretary of state at Lansing. The company is capitalized at $10,000 and the following are the officers: President, E. A. Stowe; vice president, Henry Idema; secretary and treasurer, C. C. Follmer. The company will engage in lighting Boyne City by electricity. For a time a steam plant will be used and is to be located on land owned by President Stowe and Secretary-Treasurer Follmer. Later power will be secured from the Boyne river.

WESTFIELD, MASS.—Work has been commenced by Cosby & Gilmore, the contractors, on the new building that will form an addition to the Woronoco Street Railway Company's power-house. The company has been making preparations for this enlargement of its power facilities all summer, the building of the Holyoke line making it necessary. The contracts for machinery were let several weeks ago and it will be ready to install as soon as the building is finished. The addition will include a boiler room twenty-nine by forty-two feet in size and a condenser room twelve by nineteen feet. Machinery that will be powerful enough to care for any load the lines are likely to be called upon to carry will be put in place. The building is to be completed by November 1.

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PERSONAL MENTION.

MR. W. W. BIRD has been appointed professor of mechanical engineering and director of the Washburn shops at Worcester Polytechnic Institute.

MR. JOHN RICE, sales manager of the Standard Electrical Manufacturing Company, Niles, Ohio, has been in New York city for the past week.

MR. HOWARD E. HUNTINGTON, formerly assistant general manager of the Pacific Electric Railway Company, of Los Angeles, Cal., has been appointed superintendent of electrical construction.

MR. S. D. CUSHING has been appointed signal and electrical engineer of the Southern Railway, with headquarters at Washington, D. C., in charge of electric block signals and electric power plant.

MR. CHARLES HENRY DAVIS, the well-known consulting engineer of New York city, was married on Wednesday, September 2, in the First Parish Church of Cambridge, Mass., to Miss Grace Bigelow.

MR. EUGENE H. ABADIE, the well-known electrical manufacturer, and vice-president of the Elblight Company of America, will be married on the evening of October 5, in St. Paul's Church, Louisville, Ky., to Miss Alice Bolling.

SIR DAVID BARBOUR, Lord Ribblesdale, George Gibb and Sir J. Dickson, members of the royal commission of London street traffic, which was appointed last July to study American street railway systems, recently sailed for New York.

MR. STEPHEN D. FIELD, of Stockbridge, Mass., the well-known electrical engineer, was a New York visitor this week. Mr. Field is at present engaged in a number of electrical experiments, and takes a deep interest in the developing field of wireless telegraphy.

MR. THOMAS D. LOCKWOOD, electrical engineer and patent expert of the American Bell Telephone Company, Boston, Mass., was a New York visitor during the present week, renewing numerous friendships in the metropolis and conferring with other electrical engineers in his field of work.

PROFESSOR H. T. PLUMB, a graduate of the University of Wisconsin, who for the past two years has been in charge of the electrical department of Pratt Institute, Brooklyn, N. Y., will take up the alternating-current work of Professor Matthews, at Purdue University, during the latter's year of absence.

MESSRS. JAMES O. CARR, J. S. Coles, E. J. Ryon and E. Reichtmyer composed the committee which welcomed the guests at the opening of the clubrooms of the Schenectady Railway Benefit Association, at the Fuller street station, Thursday evening, October 1. There was a reception and entertainment, followed by dancing.

MR. FRANCIS GRANGER has been appointed eastern sales manager for Mr. Leo Kaufman, of Pittsburg, Pa., manufacturer of coloring compounds as well as frosting for incandescent lamps. Mr. Granger is one of the most popular agents in New York city, and is already the sales manager for a number of high-class specialties.

MR. J. D. HOUSEMAN, JR., general manager of the St. Louis, St. Charles & Western Electric Railroad, of St. Louis, Mo., was presented. September 4, with a silver loving cup by the employés of the company. The presentation was made at a banquet given in celebration of the completion of the second anniversary of the road to the Missouri river.

MR. HUGH PATTISON has recently become associated with Westinghouse, Church, Kerr & Company, and is now engaged in engineering work in the office of the company's electrical engineer, Mr. O. S. Lyford. Mr. Pattison for some years past has been with Dr. Cary T. Hutchinson, and previous to that was actively identified with Mr. Frank J. Sprague in his multiple-unit work in Boston and Brooklyn.

MR. HUGH L. COOPER, chief engineer of the Mexican Light and Power Company, Limited, which concern is building a power plant at Necaxa for the generation of energy for transmission in the first instance to Mexico City, ninety miles distant, has left New York for Mexico. The initial capacity of the plant will be 45,000 horse-power. The turbine contract has been let abroad and it is expected that the generators will also be built in Europe. Nothing definite, however, has been decided upon.

MISS MARGARET E. MALTBY, Ph. D., who is a graduate of Barnard College, will be installed at the beginning of the academic year as adjunct professor of physics, at Columbia University, New York. Miss Maltby is also a graduate of Wellesley College and Oberlin College, and also worked in physics at the Massachusetts Institute of Technology at Boston. Miss Maltby was sent abroad as a fellow of the institute, and received the degree of Ph. D. at the University of Gottingen, Germany. This is the first time in the history of Columbia University that a woman has been appointed to a professorship.

MR. G. H. BARBOUR, of the De Forest Wireless Telegraph Company, has been in St. Louis completing arrangements for the installation of the World's Fair long-distance station, work on which will be begun in the course of a few weeks. This station will be located just east of the Agricultural Building. Mr. Barbour has just concluded negotiations which resulted in his securing the tower of the Electricity Building at Buffalo complete with its complement of elevators. The tower will be brought to St. Louis at once and the work of erection will be pushed. In the power-house at the base of this tower will be installed a ninety-kilowatt transformer, and with this amount of energy available, Mr. Barbour believes that messages will be transmittable to Chicago, Milwaukee and Buffalo.

NEW INCORPORATIONS.

COKATO, MINN.—Cokato Telephone Company. $10,000.

AUGUSTA, ME.—Boston Phœnix Lighting Company. $200,000. Directors: C. M. Drummond and W. G. Chapman.

CHICAGO, ILL.—Clinton Power Company. $50,000. Incorporators: Robert F. Pettibone, Frederick Pettibone and C. B. Swigart.

NEWHALL, IOWA—The Farmers and Merchants' Telephone Company. $1,600. Incorporators: James Harrington, F. G. Bryner.

PARIS, MO.—Monroe County Mutual Telephone Company. $4,500. Incorporators: W. Jones, W. S. Wiley, J. M. Grigsley and others.

BOSTON, MASS.—The Century Light Company of America. $500,000. Incorporators: Robert M. Bucknam, Harlem W. Leighton, Herbert R. Patee, Daniel S. Knowles and George E. Waring.

HARRISBURG, PA.—The Germantown & Chestnut Hill Belt Line Street Railway Company; to build twenty miles of road. The Johnstown, Woodvale Heights & Conemaugh Street Railway Company; $30,000. The Northern Street Railway Company; to build five miles of road in Beaver County; $30,000. The Washington & State Line Railroad Company; to build fifteen miles of road in Washington County; $150,000. The Dubois Southwestern Railroad Company; to build fifty miles of road through Jefferson, Indiana and Armstrong counties; $500,000. The Lancaster & Coatesville Street Railway Company; to build twenty-five miles of road, beginning at Mitmers Bridge, Lancaster County, and extending to Coatesville.

AUTOMOBILE NOTES.

ANNUAL RUN OF THE BUFFALO AUTOMOBILE CLUB—Buffalo Automobile Club, Buffalo, N. Y., on Saturday, September 19, held its third and greatest run of the season. There were eighty-four automobiles started, the run being from City Hall, Buffalo, to the International Hotel, Niagara Falls.

CALENDAR OF AUTOMOBILE DATES AND EVENTS—October 3—Race meet at Empire City Trotting Club, Yonkers, N. Y. October 5—Paris cab and delivery wagon trials. October 6 to 14—New York-Pittsburg endurance contest. October 10—Race meet of Automobile Club, of Philadelphia. October 31—Brighton Beach, New York, race meet. December 10 to 25—Paris automobile exhibition.

AUTOMOBILES AS FREIGHT CARRIERS—Professor John H. Gray, of Northwestern University, and Robert O. Vandercook, editor of an Evanston, Ill., newspaper, have gone on an extended trip through the wilds of Wyoming. While there they will investigate the possibility of establishing a line of freight automobiles in the region where no railroads exist, to take the place of the caravans now in operation.

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ELECTRICAL SECURITIES.

There was increased activity in the market last week, but this was largely at the expense of values, and a number of prominent issues reached new low levels for the year. United States Steel securities which were anticipated by many to have reached the lowest posible figure the week before last, declined still further, and tractions were also on the list of securities which showed net declines of several points for the week. Brooklyn Rapid Transit was one of the principal sufferers, and while it closed strong at the end of the week there was still a noticeable lack of support.

The money market continues to grow firmer in tone, and last week rates made an appreciable advance. It is consoling at this time to realize that the government financiers are paying strict attention to the possibility of helping local options in case of severe monetary stringency. At the same time, the $40,000,000 fund which Secretary Shaw has in sight would not go a very great way in an extreme emergency; but it is very probable that such an amount would be only the initial help which the government is prepared to put forward if the necessity should arise.

The troubles of the Lake Superior Company, which is more popularly known as the Clergue industry, and which is very intimately connected with some of the large electrical developments at the "Soo," practically culminated last week through the company's inability to pay the $5,000,000 loan under which it has been laboring.

ELECTRICAL SECURITIES FOR THE WEEK ENDING SEPTEMBER 26.

New York:	*Closing.*
Brooklyn Rapid Transit	31¾
Consolidated Gas	168
General Electric	145
Kings County Electric	150
Manhattan Elevated	128¾
Metropolitan Street Railway	104¼
New York & New Jersey Telephone	140
Westinghouse Manufacturing Company	160

The directors of the Westinghouse Electric and Manufacturing Company have declared a quarterly dividend of 2½ per cent on the preferred and the assenting and the non-assenting stocks of the company. The dividend is payable October 10. Books close September 30 and reopen October 12.

Boston:	*Closing.*
American Telephone and Telegraph	125¾
Edison Electric Illuminating	230
Massachusetts Electric	77½
New England Telephone	124
Western Telephone and Telegraph preferred	80

The August instrument output of the American Telephone and Telegraph Company shows the smallest net output since November, 1900. The August net output was only 17,429, which compares with 15,796 in November, 1900, and with 72,220 in May, 1902, the latter being the largest in any single month. The total output since December 20 last was 407,430. The output and the number of instruments outstanding for the last five years are as follows: 1898, total outstanding, 1,124,846, an increase of 205,725, or 22.3 per cent; 1899, 1,580,101, an increase of 455,255, or 40.4 per cent; 1900, 1,952,412, an increase of 372,311, or 23.5 per cent; 1901, 2,525,606, an increase of 573,194, or 29.3 per cent; 1902, 3,150,320, an increase of 624,714, or 24.7 per cent. The increase in the eight months of 1903 was 12.9 per cent, as compared with 17 per cent in the same eight months of 1902.

It is officially stated that the gross earnings of the subcompanies of the Massachusetts Electric Companies will show an increase for the month of September of between $70,000 and $75,000. It is also estimated that for the year ending September 30 the gross earnings of the Massachusetts Electric Companies will show an increase over last year of about $350,000, but net earnings are not likely to show any increase by reason of the heavy increase in the cost of labor, fuel and other supplies. The subcompanies will, however, show a surplus above dividends paid to the Massachusetts Electric Companies, and the latter will show a surplus above fixed charges and preferred stock dividend requirements.

Philadelphia:	*Closing.*
Electric Company of America	7 15/16
Electric Storage Battery common	52
Electric Storage Battery preferred	52
Philadelphia Electric	5 1/8
Union Traction	43⅝
United Gas Improvement	81¾

Chicago:	*Closing.*
Chicago Telephone	117
Chicago Edison Light	145
Metropolitan Elevated preferred	54
National Carbon common	18
National Carbon preferred	88½
Union Traction common	4½
Union Traction preferred	30

ELECTRIC RAILWAYS.

WINONA RAILWAY AND LIGHT COMPANY, Winona, Ind., has started rebuilding its power plant at a cost of $100,000.

ATLANTA, GA.—The Atlanta & Marietta Electric Railway has applied to the county board for a franchise to build an electric line about twenty-five miles long.

GENESEO, ILL.—The Kewanee, Cambridge & Geneseo Electric Railway has been granted a fifty-year franchise. During the life of the franchise the company must light and pave the streets it occupies.

FORT SMITH, ARK.—President S. A. Williams, of the Sebastian Electrical Company, announces that his company will soon build an electric interurban railway fifty miles long to connect with the coal-mine towns of Sebastian County.

BOSTON, MASS.—Plans are said to have been completed for a through trolley line from New York to Boston. The line is to be by way of Worcester, Hartford and New Haven, and it is proposed to have through service between the two cities.

THE EXCELSIOR SPRINGS & MISSOURI STREET RAILWAY COMPANY has been granted a certificate of incorporation. The new company is capitalized at $200,000 and purposes to build a standard gauge electric railway from Excelsior Springs to Missouri City.

MEMPHIS, TENN.—It is reported that rights of way are being acquired by the Southern Kentucky Interurban Traction and Power Company for its proposed line from Russellville to Bowling Green and Hopkinsville. The line was recently incorporated by C. W. Courts, J. N. McCutcheon and others.

CLEVELAND, OHIO—The Westinghouse Electric and Manufacturing Company has commenced the erection at the Elyria power station of the Cleveland & Southwestern Traction Company of the two 1,000-kilowatt alternating-current Parsons turbine sets ordered some time ago. Three 500-horse-power boilers, a new switchboard and static transformers are to be installed.

SAN FRANCISCO, CAL.—Representatives of the Standard Oil Company purpose to build an electric railway to connect Point Richmond with West Berkeley. The franchise, for which application has been made, calls for a road from San Pablo *via* Richmond, Barrett Station and Steege to West Berkeley, where connections can be made with other steam and electric lines for San Francisco.

PHILADELPHIA, PA.—The Pennsylvania Railroad will test the practical value of a new system of electric signaling, and an arrangement has been made by the West Jersey & Seashore Railroad with the Leon W. Pullin Electric Company, by which the latter will equip with its wireless, broken-current system the section of West Jersey tracks at Atlantic City, from the drawbridge to Chelsea, about a mile.

GENERAL TRACTION COMPANY, Camden, N. J., has filed articles of incorporation in the county clerk's office with a capital stock of $1,000,000, of which $26,000 is said to be paid in, is formed for the purpose of building an operating trolley line between Camden and seashore resorts. One of the lines, it is said, will run to Atlantic City and another to Cape May, passing through other resorts along the South Jersey coast.

LITTLE ROCK, ARK.—The Sebastian County Electric Company, of Fort Smith, has filed articles of incorporation with the secretary of state. The incorporators are S. A. Williams, president; Wharton Cormall, secretary, and H. G. Bollinger, treasurer. The capital stock is $1,000,000. The purpose is to connect Fort Smith with Jenny Lind, Greenwood, Huntington, Mansfield and Hartford, all mining towns, and also to connect with branches to Montreal and Burma, for the purpose of furnishing these towns with light and power.

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INDUSTRIAL ITEMS.

THE OTIS ELEVATOR COMPANY, New York, N. Y., is sending out a circular descriptive of its "New Type of Escalator," which will be sent upon request.

THE EMPIRE ELECTRIC SUPPLY COMPANY, 57 West Jackson Boulevard, Chicago, Ill., is receiving numerous enquiries for the "Chicago" incandescent lamp and the "Hamblin" 1903 arc lamp, and will be glad to quote special prices to any one interested.

THE FIDELITY ELECTRIC COMPANY has been organized with a capital of $50,000. This company is the reorganization of the George C. Towle Manufacturing Company, Lancaster, Pa., manufacturer of electric motors, generators, desk fans, ceiling fans. etc.

EDWARD S. HALSEY, Chicago, Ill., manufacturer of the Halsey direct-current integrating meter, will be pleased to send a new catalogue which has recently been published to any one interested. This catalogue describes and illustrates the Halsey meter, and shows several views of the assembly of the different parts of the meter.

THE UNITED STATES LIGHTING AND HEATING COMPANY, New York city, manufacturer of the "Moskowitz" system of train lighting from the axle, announces that it has had a complete equipment in operation on the New York Central flyer, the "Empire State Express," for the past six months, and that it has given constant and satisfactory service.

THE ELECTRICAL APPLIANCE COMPANY, Chicago, Ill., has just distributed two handsome catalogues, Nos. 19 and 20. No. 19 is the telephone catalogue and is very complete in everything pertaining to telephone work. No. 20 lists a complete general line of electrical supplies for electric lighting, street railway and other construction. Catalogues will be sent upon request, together with an up-to-date price list.

THE PEERLESS ELECTRIC COMPANY, Warren, Ohio, is distributing a unique folder entitled "100 Per Cent Overload." This describes in detail a test which has recently been made of two standard Peerless transformers, both 125-cycle 500-watt machines, one air-cooled and the other oil-cooled. The folder gives a description of the manner in which the tests were carried out and the results, which were highly satisfactory, and showed a very commendable rating for the Peerless apparatus.

THE BUFFALO STEAM PUMP COMPANY, Buffalo, N. Y., manufacturer of electric pumps and condensers, is distributing a new catalogue descriptive of its apparatus. This catalogue contains in compact form sufficient information to enable selections to be made of the type and size of pumps for ordinary or special service. The company will be pleased to receive communications with regard to special installations, and will also send on request a general catalogue or any special catalogue bearing on some particular design.

THE STANDARD VITRIFIED CONDUIT COMPANY, 39-41 Cortlandt street, New York city, announces that it has on hand a large stock of multiple and single-duct conduit in all sizes, and can make immediate shipments. Its factories are in full operation, producing over 80,000 duct feet of conduit per day. The Continental Trust Company, of the city of New York, has been appointed receiver for the Standard Vitrified Conduit Company pending certain settlements. All statements, however, are made over the signature of Mr. B. S. Barnard, president of the company.

ATWATER KENT MANUFACTURING WORKS, Philadelphia, Pa., is sending out an attractive circular descriptive of its "automatic volt-ammeter." This instrument is designed and calibrated especially for testing batteries in connection with gasoline automobiles and launches, and for any other use of like capacity. The needle is delicately pivoted and the readings are accurate. Flexible leads of ample capacity are provided with each instrument. No change is made in the connection to the battery for the two readings, as that in amperes is obtained by simply pressing the button.

ROSSITER, MacGOVERN & COMPANY, Incorporated, Whitehall Building, 17 Battery place, New York city, advise that they have ready for immediate delivery several pieces of Westinghouse and General Electric apparatus of the latest types. Although these have already been put in use, they are practically new. There are two direct-connected units, one a 200-horse-power alternating-current motor; several alternating-current motors, one of two-phase and several of three-phase type; a number of belted generators and a number of induction motors and transformers.

THE GOULD STORAGE BATTERY COMPANY, New York city, announces the following recent contracts: Lexington Street Railway, Lexington, Ky., 256 cells, with a capacity of 640 amperes, and an automatic regulating booster of the Gould type, to be installed with the battery; Easton Power Company, Easton, Pa., 255 cells, with a capacity of 960 amperes, also switchboard and regulating booster (this plant is the second installation made for this company); Northampton Power Company, Easton Pa., floating battery, with a maximum discharge of 360 amperes and 600 volts.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, Pa., manufacturer of the "chloride accumulator," has closed contracts with the New York Edison Company, and the Chicago Edison Company for additional batteries. These are in addition to the installation mentioned in a recent issue. The battery for the New York Edison Company consists of 150 cells with a capacity of 4,480 ampere-hours, and makes the twenty-third installation for this company. The battery for the Chicago Edison Company makes the fourteenth battery operated by this company, and has a capacity of 2,813 kilowatt-hours.

THE STURGESS GOVERNOR ENGINEERING COMPANY, West Troy, N. Y., is distributing a new edition of its catalogue descriptive of its specialties. This catalogue describes and illustrates turbine wheel governors, impulse wheel governors, variable speed power-transmission apparatus, and high-speed air pumps. Supplementing the matter descriptive of the apparatus manufactured by this company are several chapters detailing "Methods of Connecting Governors to Water-Wheel Gates," "The Size Governor Required for Different Power Water-Wheels," and "A Few Broad Principles Concerning the Speed Regulation of Water Power Plants."

HARVEY HUBBELL, Bridgeport, Ct., is distributing an attractive series of advertising circulars descriptive of the Hubbell improved screw slotter, which has a capacity of 30,000 brass or 15,000 iron screws per day; the Hubbel horizontal tapping machines, the Hubbell riveting machines, a price list of machine screws, a card showing screws for electric goods, cutlery goods, plumbers' goods, stove trimmings, piano hardware, bicycle fittings, and the Hubbell pull socket with lamp base attachment. This device can be attached to any ordinary key socket or receptacle without disturbing any part of the fixture already installed. The Hubbell universal attachment plug is particularly adapted for desk and table lamps, fans, surgical instruments and other light apparatus. The base screws in without twisting the cord, after which the cap, with the cord attached, may be inserted with a slight push. This plug can be separated with a straight pull.

THE AUTOMATIC ELECTRIC COMPANY, Chicago, Ill., is distributing a new edition of its splendid catalogue descriptive and illustrative of the automatic telephone system manufactured by this company. Desk telephones, wall telephones, pedestal telephones, calling devices and ringers and all parts of the assembly of its automatic instruments are carefully described in this catalogue. The first large telephone exchange in the world to adopt the automatic system was opened recently in Dayton, Ohio, by the Home Telephone Company. It is estimated that some 7,000 people passed through the building on the opening day, all of whom were given an opportunity to see the automatic exchange in operation. The Automatic Electric Company secured the contract some time ago for a complete central office equipment to take care of a present capacity of 6,000 subscribers, with an ultimate capacity of 19,000. This exchange is now complete and the telephones are rapidly being connected to the switchboard. It is stated that the subscribers are entirely satisfied with the precision and promptness with which the Automatic company's apparatus does the work. Smaller exchanges have been in operation for several years in Augusta, Ga.; Fall River and New Bedford, Mass.; Berlin, Germany; Auburn, N. Y., and a number of smaller towns. Dayton is the first city to install so large an equipment. An automatic switchboard of 10,000 stations and a capacity for 100,000 has been completed and is now being put into service at Chicago, Ill. There are a number of large cities, however, which are following the lead of Dayton and Chicago, and which have contracted for the equipment of the Automatic Electric Company. Among the orders secured by the company are the following: A 7,000-station exchange for Columbus, Ohio; a 5,000-station exchange for Grand Rapids, Mich.; a 2,500-station exchange for Portland, Me.; a 3,000-station exchange for Lincoln, Neb., and a 1,200-station exchange for Burlington, Iowa.

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CHARLES W. PRICE . . . . . PRESIDENT AND EDITOR
STEPHEN H. GODDARD . . . . . SECRETARY AND MANAGER
WM. HAND BROWNE, JR. . . . . TECHNICAL EDITOR
AINSLIE A. GRAY . . . . . ASSISTANT EDITOR

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CONTENTS

EDITORIAL 497, 498, 499
A Fuel and Boiler Exhibit 497
The Meeting of the British Association 497
Electrically Operated Mine Hoists 497
The Energy of Electrolysis 497
Best Conditions for Refining Copper 498
Judicial Protection Against Legislative Regulation of Rates for Public Service 498
Lightning Arresters on Transmission Lines, by Alton D. Adams 500
Production of Zinc in 1902 503
The Permanency of the Atom 504
Automobile Club Trials 504
Production of Lead in 1902 504
Electric Signaling on Railways 504
Steam, Gas and Fuels Building, World's Fair, St. Louis, Mo 505
Purchasing a Play by Wireless Telegraphy 505
Mountain Electric Road in Switzerland and the Sublin Hydraulic Plant, by C. L. Durand 506
Electric Railway Possibilities in South Africa 511
Electric Notes from India 511
Electric Motors for Centrifugal Pumps and Fans, by Aug. J. Bowie, Jr. 511
The British Association for the Advancement of Science 514
The Parallel Working of Alternators, by B. Hopkinson 517
A Method for Finding the Efficiency of Series Motors, by Ernest Wilson 521
Annual Meeting of the Indiana Electrical Association 521
Breakdown of Electrical Machinery 521
World's Fair and the Technical Press 521
Electrical Patents 522
American Institute of Electrical Engineers 523
REVIEWS OF CURRENT ENGINEERING AND SCIENTIFIC LITERATURE 524
INDUSTRIAL SECTION.
A New Type of Field Regulator 526
Test Run of Combination Gasolene-Electric Truck 526
A New Type Reflector Lamp 526
The Westinghouse "Turret" System of Electropneumatic Control 527
A New "Duplex" Telephone 529
A Large Shipment of Wattmeters 529
Quick-Break Switches 530
Incandescent Lamp Catalogue 530
Adjustable Desk Telephone Device 530
New Type Incandescent Lamp 531
The Advantages of Steam Turbines for Textile Mills, by Austin Dodge 532
CURRENT ELECTRICAL NEWS 535

A FUEL AND BOILER EXHIBIT.

A very interesting exhibit at the St. Louis Exposition will be that in the Steam, Gas and Fuels Building. Here will be shown in operation all the machinery employed in connection with a modern boiler house. Coal will be brought in automatic self-cleaning cars to the building, where it will be taken in hand by the various types of coal-handling machinery. The boilers will burn coal, briquettes and oil, and they will be fitted for mechanical and hand stoking. The types shown will include foreign as well as American makes, and they will be fitted with all appliances. Unquestionably the exhibit made here will be a revelation to by far the greater number of visitors to the boiler houses, who probably imagine a boiler room to be a room containing a number of round kettles with fires under them, instead of what it actually is to-day—one of the most completely equipped shops for handling special materials; in this case, coal and water.

THE MEETING OF THE BRITISH ASSOCIATION.

In this issue we publish a report of the annual meeting of the British Association for the Advancement of Science. This meeting, which was held at Southport, was well attended, those taking part in the proceedings including some of the most distinguished men in the scientific world. The work done by the association covers all branches of theoretical and applied science. A number of very interesting papers on electrical topics were presented, several of which appear in this issue and others will be published shortly.

ELECTRICALLY OPERATED MINE HOISTS.

The electric motor is surely and steadily making its way in mining work. It has been used for a number of years for mine lighting and haulage and for operating coal-cutting machinery and drills. More recently, it has been applied with marked success for pumping and draining. But this application of the electric motor to mine hoisting has been retarded by a natural conservatism on the part of mining engineers. In work of this kind, safety and surety of control above all are the points to be considered. Mining engineers have been familiar with the performance of steam-hoisting apparatus, and have, perhaps naturally, felt some hesitation in changing to a new motive power however well this might be recommended. However, within the last year or so, the advantages offered by an electric drive have led a number of manufacturing concerns to turn their attention to this particular class of work with the result that they are now making hoisting machinery, electrically driven, which seems to offer all the surety of a steam-driven plant, and in addition is more economical and more easily controlled. It would seem from this that it should not be long before there will be a goodly number of mining plants operated entirely by electric power.

THE ENERGY OF ELECTROLYSIS.

An objection which is frequently raised against the dissociation theory of solution is that it seems paradoxical if the energy transfer during electrolysis be considered. The misunderstanding doubtless is caused by the usual method of describing the action which is assumed to take place during electrolytic decomposition. It is generally stated that the free ions carrying their respective charges move to the cathode and anode, there give up their charges to the electrodes, and become free atoms.

Mechanical Analogy Carried Too Far.

As has been clearly pointed out, the dissociation theory is nothing more than a model which is intended to give an idea of

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the mechanics of electrolytic action, and the difficulty encountered when considering the energy changes arise from adhering too strictly to the mechanical analogue. We are accustomed to speak of an electric current as flowing in a certain direction. We think of the positive ions as carrying a positively charged electron, and we think of positive electricity as flowing out of the electrolytic cell from the cathode. Naturally, one at first is led to speak of the positive ion as giving up its positive charge to the cathode, so that there apparently should be a transfer of energy from the ion to the cathode. This, of course, we know does not represent the actual condition.

Flow of Energy Not Necessarily from Positive Electrode to Negative.

This difficulty disappears, however, if we remember that when we say that a current is flowing in a certain direction we are only using a conventional expression. We think of energy being transferred by a flow of positive electricity in one direction through the circuit, but we might just as well think of an equal flow of negative electricity in the opposite direction. The result in any case would be the same. Indeed, at the present time one is inclined to the opinion that the latter statement more nearly represents our knowledge, because, while we are more or less familiar with the negative electron, the positive electron has not yet been discovered.

One Way of Describing the Action During Electrolysis.

Recognizing, then, that we must not interpret too literally the statement made to describe electrolytic action, the apparent paradox of the dissociation theory disappears. The reactions may be described in this way: In an electrolyte we have the two ions carrying the one a negative and the other a positive charge. Under the influence of the difference of electric potential existing between electrodes the positively charged ions move toward the cathode; the negatively charged, toward the anode. Arriving at the two electrodes, the positively charged ion receives an equal but opposite charge of negative electricity. It then becomes neutral, and while it has apparently given up its charge it has received energy. Further, the cathode has given up a charge of negative electricity. It therefore has apparently received a positive charge, although we know it has given up energy to the solution. At the other end of the cell the opposite reaction is taking place: The negatively charged ions move to the anode and there receive charges of positive electricity which neutralize the negative charges and supply them with the energy required to convert them into atoms. The anode has then given up a positive charge of electricity to the solution and transferred energy to it at the same time. So far as the external circuits is concerned, this is not affected by this method of describing the reaction, because the same result is brought about as described above, whether we assume positive electricity to flow in one direction or negative to flow in the other. Indeed, in this case we assume that negative electricity flows from the source of supply to the cathode, and positive from the same source to the anode. The electrical displacement is completed by the motion in opposite directions of oppositely charged ions in the solution. In fact, a static condenser, as usually described, gives us a very satisfactory model for an electrolytic cell, except of course the action is not continuous in the condenser.

BEST CONDITIONS FOR REFINING COPPER.

A paper upon copper refining, presented by Dr. Wilder D. Bancroft at the recent meeting of the American Electrochemical Society, at Niagara Falls, is an illustration of what can be accomplished in the laboratories of our technical schools. The object of the work described in this paper was to determine the most economical conditions for refining copper, and with this end in view a series of tests was made to ascertain what conditions of current density and temperature would give a pure deposit of copper with the least cost. These tests having been run, it was possible to plot curves showing the variation in cost with changes in current density or temperature, and from these curves the conditions for minimum cost are at once seen.

Valuable Deductions in the Paper.

A criticism which was made of this paper was that it did not consider the cost of labor and of other factors which depend largely upon local conditions, and that these conditions might, and in many cases would, change entirely the conclusions reached in the paper. On the other hand, although those factors which were not considered in the paper, and which vary with the locality, may be the controlling ones, this in no way detracts from the value of the paper. Dr. Bancroft's results are given in such a way that each refiner can apply the necessary corrections and determine for himself the best conditions for his plant; while had such factors as the price of labor been considered in preparing the paper, the results would have been applicable only to the particular case considered, and not been of general application. Dr. Bancroft's paper, besides being of value in itself, should stimulate our electrochemical laboratories to take up in the same way other processes, many of which to-day are conducted by rule-of-thumb methods.

JUDICIAL PROTECTION AGAINST LEGISLATIVE REGULATION OF RATES FOR PUBLIC SERVICE.

Under the Fourteenth Amendment the right to reasonable compensation for property used in public service is guaranteed by the Federal Constitution.

Question of the Validity of State Regulation.

The question of the validity of state regulation of rates may thus be raised in the Federal courts when this right is claimed to be violated. The degree of judicial protection against rate regulation is thus to be found, as a last resort, in the decisions of the Supreme Court of the United States.

State Regulation Upheld by Courts.

That the several states have power to fix rates for public service has been established by an unbroken line of Supreme Court decisions from Munn *vs.* Illinois, the first of the Granger cases (94 U. S., 113), decided in 1876, down to Smyth *vs.* Ames (169 U. S., 466), decided in 1898. The power of the Supreme Court under the Fourteenth Amendment is therefore asserted not to prevent or necessarily annul state regulation of rates, but to keep such regulation within reasonable limits. This position of the Court was clearly stated during the opinion

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in Chicago and Grand Trunk Railway Company *vs.* Wellman (143 U. S., 339), where it was said that:

"The legislature has power to fix rates, and the extent of judicial interference is protection against unreasonable rates."

Capital Entitled to Earn More than Going Rate of Interest.

Rates to be reasonable should yield a net return somewhat greater, as a rule, than the prevailing rate of interest on money loaned with good security. In other words, capital used in a public service is entitled to earn, under ordinary circumstances, the going rate of interest plus a greater or less percentage as compensation for the risks of a public calling, above all expenses of operation.

Effect of Risk on Legitimate Earnings.

If, for example, the degree of risk in a certain line of public service is such that a moderate issue of its bonds bearing interest at five per cent can be sold at par, then the capital invested in capital stock for that service may be entitled to earn eight per cent annually, more or less, after operating expenses and interest on the bonds are paid. Obviously, the greater the risks in a given public calling, the higher must be the interest on its bonds to ensure their sale at par, and the higher must be the rate of dividends on stocks to cover the element of risk.

Supreme Court Decisions.

This statement of the law is a little more definite than any on the point in decisions of the Supreme Court, but it is believed to embody the underlying principle of several of its later opinions. In Covington and Lexington Turnpike Road Company *vs.* Sandford (164 U. S., 578), it was decided that an act of the Kentucky Legislature, which reduced the rates of toll on the turnpike to a point where no dividends could be earned on the investment, was unconstitutional. The Turnpike company in this case was earning an annual dividend of four per cent on its capital stock before the legislation in question was enacted. As this legislation destroyed the prospect of any dividend whatever, the opinion in the case is only to the point that the company had a right to earn something above operating expenses, since this was all that it was necessary for the Court to decide. There is nothing in the opinion, however, to indicate that the Court thought that a dividend of four per cent was too high. A significant dictum in the case states that a corporation operating a public highway has a right to demand of a legislature, at the utmost, "that it receive what, under all the circumstances, is such compensation for the use of its property as will be just both to it and to the public."

The Ames Case.

Smyth *vs.* Ames (169 U. S., 466), decided in 1898, gives some additional light on the percentage of dividends that a public service company has a right to earn in spite of legislative regulation, but is far from conclusive on this point. A law of Nebraska fixing freight rates on railways was held to be invalid in this case, because it appeared that the enforcement of these rates would reduce the gross earnings of some of the roads affected to amounts that would not exceed operating expenses, and would permit only a small dividend on others. On several of the railways in question it was shown that the rates named by the legislature would permit some net earnings, amounting to as much as ten per cent yearly on the value of the road in at least one instance. Inasmuch as the Nebraska act was held to be invalid in relation to all of the railways concerned, the Court evidently held that ten per cent on the value of a railway is not as much as it has a constitutional right to earn above its operating expenses.

Company Entitled to a Fair Return.

The mere fact that rates prescribed by a legislature will permit nothing above operating expenses to be earned on some railways, does not render these rates invalid as to other railways where they permit adequate earnings. This proposition agrees with the well established rule that a legislative act is invalid only so far as it conflicts with the Constitution, and is supported by distinct dicta in the Sandford case already cited. No argument is necessary, however, to establish the conclusion that the earnings of each of the Nebraska railways under the rates fixed by the legislature would have been less than it was entitled to earn under the Constitution, for the Court said on this point: "in the exceptional cases above stated, when two of the companies would have earned something above operating expenses, in particular years, the receipts or gains, above operating expenses, would have been too small to affect the general conclusion that the act, if enforced, would have deprived each of the railroad companies involved in these suits of the just compensation secured to them by the Constitution."

As a general rule the opinion lays down that: "What the company is entitled to ask is a fair return upon the value of that which it employs for the public convenience."

In this case "a fair return" meant something more than five per cent per annum above operating expenses on one or more of the railways, but just how much more is not stated.

A Company Has a Right to Charge Profitable Rates.

On the authority of the Supreme Court, then, as laid down in the Sandford case and the Ames case, the rule is that a company engaged in a public service has a constitutional right to charge rates that will yield "something" above operating expenses, and apparently, also, that this something should be more than five per cent on the value of its property. The lower limit for net earnings of a public service is thus set; what the higher limit is, the Supreme Court has not yet decided.

From the standpoint of reason, however, it seems clear that a public service should ordinarily earn something to compensate stockholders for the risks of the business, over and above all expenses of operation as above stated.

The Two Most Definite Court Statements.

The Sandford case decided in 1896 and the Ames case decided in 1898, were both concurred in by the entire Court, and are believed to afford the most definite statements that the Court has thus far made touching the income that reasonable rates must yield. There are dicta in both of these cases to the effect that circumstances might exist under which a corporation engaged in public service would not be entitled to earn anything above operating expenses. What these circumstances are is not clearly indicated, however, and it seems certain that they must be of a very exceptional character.

A number of cases involving the reasonableness of rates and the percentage of net earnings in public callings have reached the Circuit Courts of the United States, and these Courts have carried the protection of property in such callings quite as far as the Supreme Court.

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LIGHTNING ARRESTERS ON TRANSMISSION LINES.

BY ALTON D. ADAMS.

Long electrical transmission without protection from lightning would be very unreliable. A wire scores of miles long and with elevations in its different parts that sometimes vary several thousand feet may act as both a conductor and condenser of atmospheric electricity. If a direct stroke of lightning, that is an electric current passing between clouds and the earth, chooses the line for its path the line acts as a conductor. So again when there is a lightning discharge either between two clouds or between clouds and the earth, near to but not by way of the transmission line, the lightning discharge may induce a very high voltage in the line wires acting as secondary conductors. When there is no passage of electric current between clouds and the earth or between cloud and cloud the movements of charged clouds may induce static charges in line wires like the charges of a condenser. If the pressure of this static charge becomes great enough it will find its way to earth at some point where the insulation of the line or the apparatus to which it is connected is low. The danger from either form of atmospheric electricity is thus that in its passage from the line to earth the insulation of the line or of some connected apparatus will be destroyed.

Dangers of this sort are of a very real and present character. The annual reports of the United States Weather Bureau show a maximum number of about seventy thunder-storm days per year in Florida and an average of about thirty such days per year for the entire country. Some mountainous states like the Carolinas and Colorado are particularly subject to frequent thunder-storms. Times of thunder-storm are not the only periods during which the effects of atmospheric electricity are to be feared in transmission systems. In many parts of the country and especially where long transmission lines vary greatly in altitude during their course the wires often become charged at high pressure under a clear sky, and this pressure is sometimes great enough to do serious personal injury and to pierce the insulation of generators and transformers. According to a report of a plant at Telluride, Col., where a line ten miles long varied between 8,000 and 12,000 feet in elevation, forty fuses used with one type of lightning arrester were on a certain occasion burned out within an hour and five armature coils were destroyed in a single storm (XI, A. I. E. E., 346, 350). In this plant the insulation of the apparatus became perforated by lightning in many places so as to cause frequent grounds and short-circuits. The transmission line between Niagara Falls and Buffalo was struck five times by lightning during a single thunder-storm and five poles with their cross-arms were destroyed (XVIII, A. I. E. E., 537). It is not unusual to see the lightning arresters at a station connected to a long transmission line flash scores of times during a thunder-storm, often with loud reports, and for the flashing at the arresters to be continuous for several minutes at a time.

Lightning arresters are wrongfully named, for their true purpose is not to arrest or stop lightning, but to offer it so easy a path to ground that it will not force its way through the insulation of the line or of machinery connected to the system. The requirements of a lightning arrester are in a degree conflicting because the resistance of the path it offers must be relatively low as to discharges of atmospheric electricity to earth but relatively high as to any flow of current between the transmission lines. In other words the insulation of the line conductors must be maintained at a high standard in spite of the connection of lightning arresters between each conductor and the earth, but the resistance of the arrester must not be so high that lightning will pierce the insulation of the line or machinery at some other point. When a lightning discharge takes place through an arrester the resistance which the arrester offers to a flow of current is for the moment greatly reduced by the arcs which the lightning sets up in jumping the air-gaps of the arrester. Each wire of a transmission circuit must be connected alike to arresters and the paths of low resistance through arcs in these arresters to the earth would obviously short-circuit the connected generators unless some construction were adopted to prevent this result. In some early types of lightning arresters magnetic or mechanical devices were resorted to in order to break arcs formed by the discharge of lightning. The general objection to this class of arresters is that a serious short-circuit may be formed before the arc formed by the lightning can be broken by any mechanical movement.

The type of lightning arrester now in common use on transmission lines with alternating current includes a row of short, parallel, brass cylinders mounted in a row in a porcelain block and with air-gaps of one-thirty-second to one-sixteenth of an inch between their parallel sides. The cylinder at one end of the row is connected to a line wire and the cylinder at the other end to the earth, when a 2,000 or 2,500-volt circuit is to be protected. For higher voltages there are a number of these single arresters connected in series with each other and then the free ends of the series to a line wire and to the earth, respectively. Thus, for a 10,000-volt line four or, better, five single arresters are connected in series to form a composite arrester for each line conductor. For any given line voltage the number of single arresters going to make up the composite arrester for each line conductor should be so chosen that the regular working voltage will not jump the series of air-gaps between the little brass cylinders, but yet so that any large rise of voltage will be sufficient to force sparks across these gaps. A variation of this practice by one large manufacturing company is to mount the group of single arresters on a marble board in series with each other and with an adjustable air-gap. This gap is intended to be so adjusted that any large increase of voltage on the lines will be relieved by a spark discharge. An arrester made up entirely of the brass cylinders and air-gaps has the serious disadvantage that an arc once started between all the cylinders by a lightning discharge so lowers the resistance between each line wire and the earth that the generating equipment is short-circuited and the arcs do not cease with the escape of atmospheric electricity. To avoid this difficulty it is the practice to connect a conductor of rather large ohmic resistance in series with the brass cylinders and air-gaps of lightning arresters. This resistance should be non-inductive so as not to offer a serious obstacle to lightning discharge, and its resistance should be great enough to prevent a flow of current from the generators that will be large enough to maintain the arcs started in the arrester by the lightning discharge. Accurate data is lacking as to the amount of this resistance that should be employed with arresters for any given voltage. As a rough, approximate rule it may be said that in some cases good results will be obtained with a resistance in ohms in series with a group of lightning arresters that represents one per cent of the numerical value of the line voltage. That is, for a 10,000-volt line the group of arresters for each wire may be connected to earth through a resistance of, say, 100 ohms, so that if the generator current follows the arc of a

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lightning discharge through the arresters it must pass through a fixed resistance of 200 ohms in going from one line wire to another. It should be noted that this rule is given merely as an illustration of the resistance that will work well in some cases and should not be taken to have any general application. If the resistance connected in series with lightning arresters is high the tendency is a little greater for lightning to pass by the arresters and go to earth at some point in the apparatus where the insulation is low. If only a small resistance is employed to connect lightning arresters with the earth the danger is that arcs formed by lightning discharges will be followed and maintained by the dynamo currents. In one make of lightning arrester the row of little brass cylinders is connected at each end to a carbon rod which forms a resistance for the purpose just mentioned. Two of these carbon rods are contained in each arrester for 2,000 or 2,500 volts, and the resistance of each rod may be anywhere from several score to several hundred ohms as desired. This form of arrester may be connected directly from line to earth without the intervention of any outside resistance since the carbon rods may easily be given all the resistance that is desirable.

One of the most important features in the erection of a lightning arrester is its connection to earth. If this connection is poor it may render the arrester useless so far as protection from lightning is concerned. It need hardly be said that ground connections formed by driving long iron spikes into the walls of buildings or into dry earth are of no value so far as protection from lightning is concerned. A good ground connection for lightning arresters may be formed with a copper or galvanized iron plate, which need not be over one-sixteenth of an inch thick, but should have an area of, sav. ten to twenty square feet. This plate may be conveniently made up into the form of a cylinder and should have a number of half-inch holes punched in a row down one side into which one or more copper wires with an aggregate area equal to that of a No. 4 or No. 2 wire, B. & S. gauge, should be threaded and then soldered. This plate or cylinder should be placed deep enough in the ground to ensure that the earth about it will be constantly moist, and the connected copper wire should extend to the lightning arresters. It is a good plan to surround this cylinder with a layer of coke or charcoal.

A good earth connection for lightning arresters may be made through large water pipes, but to do this it is not enough to simply wrap the wire from the lightning arresters about the pipe. A suitable contact with such a pipe may be made by tapping one or two large bolts into it and then soldering the wire from lightning arresters into holes drilled in the heads of these bolts. A metal plate laid in the bed of a stream makes a good ground.

With some of the older types of lightning arresters it was the custom to insert a fuse between the line wire and the ground, but this practice defeats the purpose for which the arrester is erected because the fuse melts and leaves the arrester disconnected and the circuit unprotected with the first lightning discharge. The modern arresters for alternating-current circuits are made up of a series of metal cylinders and short air-gaps and are connected solidly without fuse between line and earth.

It was once the practice to locate lightning arresters almost entirely in the stations, but this has been modified by experience and consideration of the fact that as the line acts as a collector of atmospheric electricity, paths for its escape should be provided along the line. Consideration fails to reveal any good reason why lightning that reaches a transmission line some miles from a station should be forced to travel to the station, where it may do great damage before it finds an easy path to earth. It is, therefore, present practice to connect lightning arresters to each wire at intervals along the line as well as at stations and substations. The main purpose of arresters is to offer so easy a path to earth that lightning discharges along the lines will not flow to points of low insulation in generators, transformers or even the line itself. Practice is far from uniform as to the distance between lightning arresters on transmisssion lines, the distances varying from less than one to a large number of miles apart. In general the lines should be provided with lightning arresters at least where they run over hilltops and at any points where lightning strokes are unusually frequent. Where a long overhead line joins an underground cable arresters should always be connected and the same is true as to transformers located on the transmission line. The multiplication of arresters along pole lines should be avoided as far as is consistent with suitable protection, because every bank of arresters may develop a permanent ground or short-circuit, unless frequently inspected and kept clean and in good condition.

Arresters, besides those connected along the lines, should be located either in or just outside of stations and substations in every instance. If the buildings are of wood the arresters had better be outside in weather-proof cases, but in brick or stone buildings the arresters may be properly located near an interior wall and well removed from all the other station equipment. Transmission lines, on entering a station or substation, should pass to the arresters before connecting with any of the operating machinery.

To increase the degree of protection afforded by lightning arresters choke-coils are frequently used with them. A choke-coil for this purpose usually consists of a flat coil of copper wire or strip containing twenty to thirty or more turns and mounted with terminals in a wooden frame. This coil is connected in series with the line wire between the point where the top for the lightning arrester is made and the station apparatus. Lightning discharges are known to be of a highly ocsillatory character, their frequency being much greater than that of the alternating currents developed in transmission systems. The self-induction of a lightning discharge in passing through one of these choke-coils is great and the consequent tendency is to keep the discharge from passing through the choke-coil and into the station apparatus and thus to force the discharge to pass to earth through the lightning arrester. The alternating current employed in transmission has such a comparatively low frequency that its self-induction in a choke-coil is small. Increased protection against lightning is given by the connection of several groups of lightning arresters one after another on the same line wire at an electric station. This gives any lightning discharge that may come along the wire several paths to earth through the different groups of arresters and a discharge that passes the first group will probably go to earth over the second or third group. In some cases a choke-coil is connected into a line wire between each two groups of lightning arresters as well as between the station apparatus and the group of arresters nearest thereto.

An electric transmission plant at Telluride, Col., where thunder-storms are very frequent and severe, was equipped with arresters and choke-coils of the type described and the results were carefully noted (XI, A. I. E. E., 346). A small house for arresters and choke-coils was built close to the generating station of this system and they were mounted

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therein on wooden frames. Four choke-coils were connected in series with each line wire, and between these choke-coils three lightning arresters were connected, while a fourth arrester was connected to the line before it reached any of the choke-coils. These arresters were watched during an entire lightning season to see which bank of arresters on each wire discharged the most lightning to earth. It was found that, beginning on the side that the line came to the series of arresters, the first bank of arresters was traversed by only a few discharges of lightning, the second bank by more discharges than any other, the third bank by quite a large number of discharges, and the fourth bank seldom showed any sign of lightning discharge. Over the second bank of arresters the lightning discharges would often follow each other with great rapidity and loud noise. The obvious conclusion from these observations seems to be that three or four banks of lightning arresters connected in succession on a line at a station together with choke-coils form a much better protection from lightning than a single bank. At the plant in question, that of the San Maguel Consolidated Gold Mining Company, the entire lightning season after the erection of the arresters in question was passed without damage by lightning to any of the equipment. It would be very interesting to know what results would have been attained at this plant if the choke-coils had been omitted, but the conditions do not seem to have been varied in that way. During the two lightning seasons previous to that just named the damage by lightning to the generating machinery at the plant had been frequent and extensive.

A good illustration of the high degree of security against lightning discharges that may be obtained with lightning arresters and choke-coils exists at the Niagara Falls plants and the terminal house in Buffalo, where the step-up and step-down transformers have never been damaged by lightning though the transmission line has been struck repeatedly and poles and cross-arms shattered (XVIII, A. I. E. E., 527). This example bears out the general experience that lightning arresters, though not an absolute protection, afford a high degree of security to the apparatus at electric stations.

Lightning arresters are in some cases connected across high-voltage circuits from wire to wire so that the full line pressure tends to force a current across the air-gaps. The object of this practice is to guard against excessive voltages on the circuit such as might be due to resonance. In such a case, as in that where arresters are connected from line wire to earth as a protection against lightning, the number of air-gaps should be such that the normal line voltage will not force sparks across the air-gaps and thus start arcs between the cylinders.

The number and total length of air-gaps in a bank of arresters necessary to prevent the formation of arcs by the regular line voltage depends on a number of factors besides the amount of that voltage.

According to the report of the Committee on Standardization of the American Institute of Electrical Engineers the sparking distances in air between opposed sharp needle points for various effective sinusoidal voltages are as follows (XIX, A. I. E. E., 721):

Kilovolt Square Root of Mean Square.	Inches Sparking Distance.
5	0.225
10	0.47
15	0.725
20	1.0
25	1.3
30	1.625
35	2 0
40	2 45
45	2.95
50	3.55
60	4.65
70	5.85
80	7.1
90	8.35
100	9.6
110	10.75
120	11.85
130	12.95
140	13.95
150	15.0

It may be noted at once from this table that the sparking distance between the needle points increases much faster than the voltage between them. Thus, 20,000 volts will jump an air-gap of only an inch between the points, but seven times this pressure or 140,000 volts will force a spark across an air-gap of 13.95 inches. Two cylinders or other blunt bodies show smaller sparking distances between them at a given voltage than do two needle points, but when a number of cylinders are placed in a row with several short air-gaps between them, the aggregate length of these gaps that will just prevent the passage of sparks at a given voltage may be materially greater or less than the sparking distance of that voltage between needle points. It has been found by experiment that the numbers of three and one-thirty-second inch spark-gaps between cylinders of non-arcing alloy necessary to prevent the passage of sparks with the voltages named and a sine wave of electromotive force are as follows (XIX, A. I. E. E., 668):

Number of 1/32-Inch Air-Gaps in Series.	Normal Voltage Withheld.	Number of 1/32-Inch Air-Gaps in Series.	Normal Voltage Withheld.
5	6,800	50	22,600
10	10,000	55	23,900
15	12,500	60	25,000
20	14,500	65	26,000
25	16,400	70	27,000
30	18,200	75	28,000
35	19,300	80	29,000
40	20,500	..	....
45	21,700	..	....

According to this data only ten air-gaps of one-thirty-second of an inch each and 0.3125 inch combined length are required between cylinders to prevent a discharge at 10,000 volts, though opposed needle points may be 0.47 inch apart when a spark is obtained with this voltage. On the other hand, eighty air-gaps of one-thirty-second of an inch each between cylinders of non-arcing metal, or a total gap of 2.5 inches, are necessary to prevent a discharge at 29,000 volts, though 30,000 volts can force a spark across a single gap of only 1.625 inches between opposed needle points.

Under the conditions that existed in the test just recorded the pressure at which the aggregate length of one-thirty-second of an inch air-gaps that just prevents a discharge equals the single sparking distance between needle points seems to be about 18,000 volts.

The object of dividing the total air-gap in a lightning arrester for lines that carry alternating current up into a number of short gaps is to prevent the continuance of an arc by the regular generator or line current after the arc has been started by a lightning discharge. As soon as an electric spark leaps through air from metal to metal, a path of low electrical resistance is formed by the intensely heated air and metallic vapor. If the arc thus formed is, say, two inches long it will cool a certain amount as the passing current grows small and drops to zero. If, however, this total arc of two inches is divided into sixty-four parts by pieces of metal, the process of cooling as the current decreases will go on much more rapidly than with the single arc of two inches because of the great conducting power of the pieces of metal. As an alternating current comes to zero twice in each period, the many short arcs formed in an arrester by a lightning discharge are so far cooled during the small values of the following line current that the resistance rises to a point where the regular line voltage can not continue

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to maintain them, if the arrester is properly designed for the system to which it is connected. In this way the many gap arrester destroys the many small arcs started by lightning discharges that would continue and short-circuit the line if they were combined into a single long arc.

When an electric arc passes between certain metals like iron and copper a small bead is raised on their surfaces. If these metals were used for the cylinders of arresters the beads on their surfaces would quickly bridge the short air-gaps. Certain other metals like zinc, bismuth and antimony are pitted by the passage of arcs between their surfaces. By suitable mixture of metals from these two classes an alloy is obtained for the cylinders of lightning arresters that pits only slightly and is thus but little injured by lightning discharges. After long use and many discharges an arrester of the class here considered gradually loses its power to destroy electric arcs. This may be due to the burning out of the zinc and leaving a surface of copper on the cylinders.

Aside from the structure of an arrester and the normal voltage of the circuit to which it is connected, its power to destroy arcs set up by lightning discharges depends much on the capacity of the connected generators to deliver current on a short-circuit through the gaps, and upon the inductance of the circuit. The greater the capacity of the generators connected to a system the more trying are the conditions under which arresters must break an arc because the current to be broken is greater. So, too, an increase of inductance in a circuit adds to the work of an arrester in breaking an arc.

An arc started by lightning discharge at that period of a voltage phase when it is at or near zero is easily destroyed by the arrester, but an arc started at the instant when the regular line voltage has its maximum value is much harder to break because of the greater amount of heat generated by the greater current sent through the arrester. For this reason the arcs at arresters will hold on longer in some cases than in others, according to the portion of the voltage phase in which they are started by the lightning discharge. Lightning discharges, of course, may occur at any phase of the line voltage and for this reason a number of discharges must take place before it can be certain from observation that a particular arrester will always break the resulting arc. Between twenty-five and sixty cycles per second there is a small difference in favor of the latter in the power of a given arrester to break an arc, due probably to the fact that more heat in the arcs is developed per phase with the lower than with the higher frequency.

It will now be seen that while increase of the regular line voltage requires a lengthening of the aggregate air-gap in lightning arresters to prevent the formation of arcs by this voltage alone, the increase of generating capacity requires more subdivisions of the total air-gap in order that the arcs maintained by the larger currents may be cooled with sufficient rapidity. These two requirements are to some extent conflicting, because the subdivision of the total air-gap renders it less effective to prevent discharges due to the normal line voltage, as has already been shown. The result is that the more an air-gap is subdivided in order to cool and destroy arcs that have been started by lightning, the longer must be the aggregate air-gap in order to prevent the development of arcs directly by the normal line voltage.

Furthermore, the practical limit of subdivision of the air-gap is soon reached because of the difficulty of keeping very short gaps clean and of nearly constant length. As a resistance in series with an arrester cuts down the generator current that can follow a lightning discharge, such a resistance also decreases the number of air-gaps necessary to give an arrester power to destroy arcs on a particular circuit.

The increase of resistance in series with a lightning arrester as well as the increase in the aggregate length of its air-gaps subject the insulation of connected apparatus to greater strains at times of lightning discharge. On systems of large capacity the number and aggregate length of air-gaps in arresters necessary to destroy arcs must be greater than the number or length of these air-gaps necessary to prevent the development of arcs by the normal line voltage, unless a relatively large resistance is connected in series with each arrester. To reduce the strains produced on the insulation of line and connected apparatus under these conditions by lightning discharges a resistance is connected in shunt with a part of the air-gaps in one make of lightning arrester. The net advantage claimed for this type of arrester is that a lower resistance may be used in series with all the air-gaps than would otherwise be necessary. One-half of the total number of air-gaps in this arrester are shunted by the shunt resistance and the series and shunt resistance are in series with each other. Only the series air-gaps or those that are not shunted must be jumped in the first instance by a lightning discharge which thus passes to earth through these air-gaps and the shunt and series resistances in series. An arc is next started in the shunted air-gaps and this arc is in turn destroyed because the shunt weakens the current in these gaps. This throws the entire current of the arc through the series air-gaps and the shunt and series resistances all in series with each other. As the shunt resistance is comparatively large the current maintaining the arc in the series air-gaps is next so reduced that this arc is broken. Taking the claims of its makers just as they stand the advantages of the shunted air-gaps are not very clear. The series air-gaps alone must evidently be such that the normal line voltage will not start an arc over them, and these same series gaps must be able to break the arcs of line current flowing through them and the shunt and series resistances all in series. Evidently the greatest strain on the insulation of the line and apparatus occurs at the instant when the lightning discharge takes place through the series gaps and the shunt and series resistances all in series with each other.

Why develop subsequent arcs in the shunted air-gaps? Why not throw the shunted air-gaps away and combine the shunt and series resistances?

Production of Zinc in 1902.

In his report to the United States Geological Survey, now in press, Mr. Charles Kirchhoff says that the production of zinc in 1902 was greater than ever before, reaching a total of 156,927 short tons. The production in 1901 was 140,822 short tons, and in 1900 it was 123,886 tons. Of the output for 1902, the eastern and southern states contributed 12,180 short tons, Illinois, including Indiana, 47,096 short tons, Kansas, 86,564 tons, and Missouri, 11,087 tons. The statistics of the production of spelter include always the metal produced by several works that treat drosses exclusively. In 1902 these works made 2,716 short tons, and in 1902 they produced 2,675 short tons.

The consumption of spelter in 1902 was heavy, the principal industries in which it is a factor being extremely busy. The apparent home consumption in 1902 was 152,682 short tons as against 141,697 short tons in 1901 and 99,399 tons in 1900.

Prices were quite satisfactory during the year, and the demand was such that no ore was exported.

Colorado has become an important

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producer of zinc ore, the output for the year 1902 being placed at 26,241 short tons, valued at $2,544,993. The production of zinc ore in New Jersey in 1902 was 209,386 short tons, as against 191,221 short tons in 1901.

The total value of the zinc imported and entered for consumption in the United States in 1902 was $85,882, as against $76,059 in 1901 and $128,090 in 1900. The exports of zinc in 1902 were valued at $1,863,858, as against $1,538,636 in 1901 and $3,450,644 in 1900; and the exports of zinc ore in 1902 were valued at $1,449,104, as against $1,167,684 in 1901 and $1,133,663 in 1900. The world's production of zinc and the United States' percentage of the world's production, respectively, in 1902 are as follows: Total production, 538,784 long tons, percentage 26.0, as against 501,494 long tons, percentage 25.1 in 1901, and 470,937 long tons, percentage 23.5 in 1900.

The Permanency of the Atom.

Our chemical friends seem little inclined to abandon without a fight their belief in the immutability of the atom, a creed which for nearly a century has been shared by chemists and physicists alike. The modern chemist is, indeed, somewhat inclined to scientific Toryism; but this mental attitude is by no means uncommon among scientific men, as is well shown by the violent opposition which had to be conquered by the undulatory theory of light. It has, moreover, certain advantages. A new hypothesis must be compelled to prove that it has other claims to acceptance beyond its novelty and originality, and most useful work is done by the supporters of older theories in subjecting the newcomer to a searching criticism. Nevertheless, it would seem that the chemist has hitherto utterly failed to make any serious attack on the electrical theory of the atom, as now advanced by many physicists; an hypothesis which, as pointed out by Sir Oliver Lodge, involves the consequence that each and every atom is in a process of slow disintegration. Of course, the careful and painstaking work of the great chemists of last century only served to confirm the truth of Dalton's great generalization; but it has also to be remembered that for an equal period chemists had failed to detect in atmospheric air any trace of the new gases of the Argon group, and were indebted to a physicist for the hint which led to their discovery. Chemists claim that the known facts of radioactivity are capable of explanation on the lines of ordinary chemistry; but when their claims are more closely examined, it would seem that a truer statement of their case would be that some of the facts, in the absence of others, might be thus explained. Thus Dr. Lowry has suggested that the behavior of thorium X and thorium was precisely analogous to that of certain organic compounds, such as π bromo-nitro-camphor, which in its "normal" form is a neutral body and a dielectric, while in the "pseudo" form it is a strong acid and electrolyte. Either form is readily changeable into the other, the rate of change varying in the same manner as the radioactivity of thorium X and thorium. He entirely fails to take into account, however, the enormous amount of energy liberated in radioactivity; and as Professor Rutherford pointed out at the time, his hypothesis involved that of the possibility of perpetual motion. More recently Professor Meldola has suggested that radium, as we know it, is an endothermic compound of some unknown element with helium, and is not in itself an element at all. He points out that nitrogen, which to a certain degree resembles helium in its inertness, is a frequent constituent of endothermic compounds; and *a fortiori* suggests that a helium compound should on its decomposition liberate still greater energy. The objections to this hypothesis are several. In the first place it is difficult to believe that so endothermic a body as the proposed compound can be dissociated without an explosion. Secondly, the rate of the radium change seems nearly independent of the temperature, which is the case with no known chemical reaction; and, finally, the energy liberated is out of all proportion greater than that accompanying any known chemical change. Mr. C. D. Whetham states that the energy liberated by the dissociation of a gramme of radium is between 20,000 and 1,000,000 times as great as that set free in the formation of a gramme of water. Of course, the hypothesis that atoms consist merely of a constellation of negative and positive electrons is not yet fully proven, and it is certainly curious that no positive electron has yet been detected in the free state.—*Engineering (London)*.

Automobile Club Trials.

The Automobile Club of Great Britain and Ireland has been conducting some practical trials of various makes of machines. The machines were tested first for brakes, dust and noise, and were then entered in a 1,000-mile endurance run. No electrically propelled car was entered.

Production of Lead in 1902.

Under the influence of a lower range of prices for lead, assisted, in the Rocky Mountain districts, by low returns for the accompanying silver, says Mr. Charles Kirchhoff, in his report to the United States Geological Survey on the production of lead in 1902, now in press, the lead-mining industry did not prosper in 1902 as much as other branches of metal mining. The principal cause was that in the previous years a very large stock of lead had accumulated. This was successfully worked off during 1902, which was a year of enormous consumption of all the metals. The stock of lead, which was 53,733 short tons at the beginning of the year, had been carried down to 11,595 short tons at its close. Under the circumstances the fact that the production was about as large in 1902 as it was in 1901 is encouraging; but there has been some shifting of the territorial source of production. Relatively, the Mississippi region has gained in importance, showing an increase in output at the expense of the Rocky Mountain districts, which declined in production.

The domestic production in 1902 was 270,000 short tons, as against 270,700 short tons in 1901, and 270,824 short tons in 1900. The production of refined lead in the United States in 1902, irrespective of the source from which it was drawn, amounted to 377,061 short tons, as against 381,688 short tons in 1901.

The apparent home consumption of lead in 1902 was 335,485 short tons, as against 274,020 short tons in 1901, and 269,302 short tons in 1900. The domestic consumption was greater than ever before in the history of the country.

The total value of lead imported and entered for consumption in this country in 1902 was $648,063, as against $364,459 in 1901, and $702,213 in 1900. The total value of the lead exports in 1902 was $696,010, as against $624,534 in 1901, and $459,571 in 1900.

In January, 1902, the American Smelting and Refining Company advanced the price of lead from four cents, which had been named in December, 1901, to 4.10 cents for moderate lots. At that price the metal was held during the remainder of the year.

Electric Signaling on Railways.

The Northeastern Railway, of England, has just installed the Crewe system of electric signaling in its freight yards at York.

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THE STEAM, GAS AND FUELS BUILDING AT THE ST. LOUIS EXPOSITION.

TYPIFYING THE USE OF ALL MODERN FORMS OF FUEL AND FUEL ECONOMIZERS.

It is interesting to note the most recent ground plan issued by the Universal Exposition of 1904, and to compare it with the plans previously issued during the past two years. The claim has always been made that these ground plans have shown only such items as at the time of issue could be termed fixed facts, in other words, that they could be considered as plans showing the actual development. Comparison with previous issues seems to substantiate this claim and inspire confidence in the management which refrains from making statements until it is sure of making them good.

Over a year ago Mr. Moore, chief of the machinery department, claimed that the steam boiler, boiler appliance, gas producer and fuel-handling proposition would be adequately and creditably housed in a spacious building and that this building would be found in the centre of the grounds and at the intersection of the main thoroughfares connecting the northern and southern and the eastern and western sections of the exposition. To the outsider there seemed very little basis for this claim, but the physical evolution of the exposition appears to substantiate Mr. Moore's prediction. What at first was a boiler house about 100 by 75 is now the Steam, Gas and Fuels Building, a steel construction, fireproof structure, 326 by 300 feet. This building is over sixty per cent completed and the installation of boilers in it is already progressing. The structure is particularly light and airy and all the arrangements are to contribute to the programme for making this building attractive not only to the engineering fraternity but to the general public. It certainly is located at a point where, by the prominence of its location and the character of its surroundings, it can easily attract a full audience for its exhibitors.

The exhibits to be installed are intended to illustrate the most modern methods and economies in steam and gas generation and the handling and treatment of fuels. The illustration commences with the coal in fifty-ton, hopper bottom, self-cleaning, steel cars controlled and operated by the exposition. These cars bring the coal from the mine to the Steam, Gas and Fuels Building, there it is dumped and automatically conveyed to and from bunker and crusher, or either, and thence to the mechanical stokers, gas producers, and briquetting machines. Over 2,200 lineal feet of conveyor lines are required in this automatic coal-handling system. Bituminous coal, anthracite coal, briquettes and crude oil will all be availed of with the purpose of providing lines for comparison and to illustrate as fully as practicable the broad subject of the use of fuels for power purposes.

In both hand-firing and mechanical stokers particular attention is being paid to the avoidance of the smoke nuisance. The stoker builders are afforded an opportunity to substantiate their claims in this direction, for on installations of 1,500 horse-power or over a separate stack is to be furnished by the exposition for each installation and thus a line for practical demonstration and comparison is established. In hand-firing, briquettes will be largely availed of and the claim of the possibility of smokeless combustion from their use can be substantiated or refuted.

Boilers have been drawn from European as well as from American shops and particular attention is being paid to marine water-tube boilers. The standard marine types of boilers are less familiar than the standard stationary types to the average engineer, and it is believed that where economy of space is an essential they may demonstrate advantages. In any event opportunity for direct comparison between the various water-tube marine-type boilers operating side by side and under the same conditions will be interesting and instructive.

Different groups of boilers are to be operated at different pressures and practice from 125 pounds to 250 pounds illustrated.

Owing to the central location of the Steam, Gas and Fuels Building and in deference to the architectural harmony, it is impractical to establish natural draft boiler stacks, and, consequently, mechanical draft will be availed of. This affords the blower builders an opportunity to exploit their systems.

The water supply in St. Louis is not without features which are objectionable in boiler practice, and this condition is very generally being availed of by the builders of water-purifying apparatus to exploit the practical value of their systems.

The installation of a number of independent steam generating systems carries with it the possibility to illustrate a variety of accessory items, such as feed-water pumps, feed-water heaters, injectors, traps, valves, gauges and various steam specialties.

In gas producers the range is from a capacity to supply an engine of fifty horse-power to a capacity for a 3,000-horse-power unit or collection. The most notable producer units are as follows: one of 2,400-horse-power direct-suction system, from Julius Pintsch, of Berlin; one of 3,000-horse-power, Duff-Whitfield system, from W. F. Mason & Company, of Manchester, England, and one of 2,000-horse-power, from R. D. Wood & Company, Philadelphia. Both of the latter will avail of tanks or holders. A Thiessen gas scrubber built by the John Cockerill Society, of Seraing, Belgium, will be shown in operation. The installation of the latest gas producer serving the latest types of gas engines driving alternators and operating side by side on the same load with steam boilers at the one end and steam reciprocating and turbine engines on the other end will go far toward a determination of the claim by the gas engine advocates that the gas producer, gas engine proposition has in efficiency and first cost and operating expense great and universal advantages over the steam boiler, steam engine proposition.

The programme announced, and already so far carried into effect that we may reasonably look for its complete fulfilment, certainly demands consideration and no small amount of admiration. If Mr. Moore succeeds in doing what he has planned he will deserve great thanks from the engineering world, and in any event every assistance and encouragement should now be extended to him.

Purchasing a Play by Wireless Telegraphy.

On Thursday, October 1, a wireless telegram from Mr. Frank Curzon, the English theatrical manager who was at that time on board the St. Louis returning to England, was received by Mr. Charles B. Dillingham, the enterprising playwright and theatrical manager, while at the Garrick Theatre, making an offer for the English rights to "Her Own Way" in which Miss Maxine Elliott has been playing. Mr. Curzon saw the play on Tuesday night and just before sailing he telegraphed to Mr. Clyde Fitch, its talented author, asking for the English rights. Mr. Fitch answered with a wireless despatch, which reached the St. Louis off Nantucket, informing Mr. Curzon that Mr. Dillingham had already purchased the English rights. Mr. Curzon immediately sent a wireless despatch to Mr. Dillingham as mentioned above.

This incident shows how quickly an enterprising business man is to take advantage of the latest applications of electricity. Mr. Dillingham is now considering the offer which, had not wireless telegraphy service been available, would not have reached him until six days later.

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Vol. 43—No. 15

Mountain Electric Road in Switzerland and the Sublin Hydraulic Plant.

By C. L. Durand.

WITHIN the last few years a great number of mountain railways have been installed along different points of the railroad lines in Switzerland, in order to afford an easy communication between the railway stations and the numerous villages or health resorts which are situated at the top of the mountains. This is of great benefit to these localities, as they can be reached in a small fraction of the time which is taken by the old horse conveyances winding around the mountain. An interesting example of a heavy grade electric line is afforded by the Bex-Gryon-Villars system, which commenced to operate a few years ago. This line has been equipped by the Compagnie de l'Industrie Electrique, of Geneva, on the Thury direct-current system. The current for the road is furnished by a large hydraulic plant in the vicinity.

The electric road is built in three distinct parts, as is required by the profile of the region. The line starts from the railroad station near the town of Bex and has a total length of eight miles. The first section from Bex to Bevieux passes through a level stretch and the trolley system is used with the ordinary track. From this point the road climbs up the mountain on a rack-and-pinion system to Gryon; from this point to the terminus at Villars the road is nearly level and the ordinary system is used. This railroad supplies a region which is much frequented by tourists; the town of Bex, in the Rhone valley, as a spring and autumn health resort, and Villars, on the summit of mountain as a summer station; the village of Gryon is likely to develop considerably as a health resort since the establishment of the road.

In order to operate the line under these conditions an electric locomotive and a motor car are employed. The motor car runs alone over the two level sections of the road at the top and bottom. On the rack-and-pinion section, in the middle, the electric locomotive is used to take the car up the grade. The trolley system is employed in all these cases.

Starting from the station of Bex, on the Jura-Simplon railroad, the motor car runs as far as Bevieux on a comparatively level grade. The rack-and-pinion system then commences to climb the side of the mountain, starting in front of the company's shops at Bevieux. This part of the line, which is 3.1 miles long, presents the most interesting feature on account of the steep grades and the road construction which includes a number of tunnels, cuts and embankment walls. The longest tunnel measures 650 feet and is built on a twenty per cent grade and a curve of 270 feet radius. After a number of other constructions the line passes over the road from Bex to Gryon on an iron bridge truss. After a long curve the line passes to the north and finally reaches the village of Gryon which is situated on the top of the mountain at an altitude of 3,700 feet. The rack-and-pinion road thus mounts a total height of 2,110 feet.

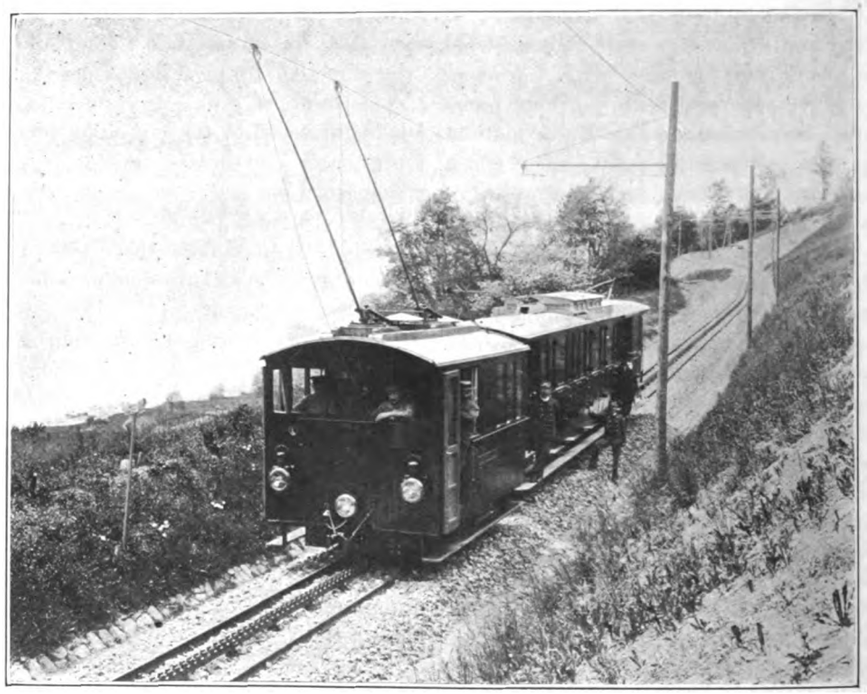

FIG. 1.—VIEW OF ROAD ON BEX-GRYON-VILLARS SYSTEM.

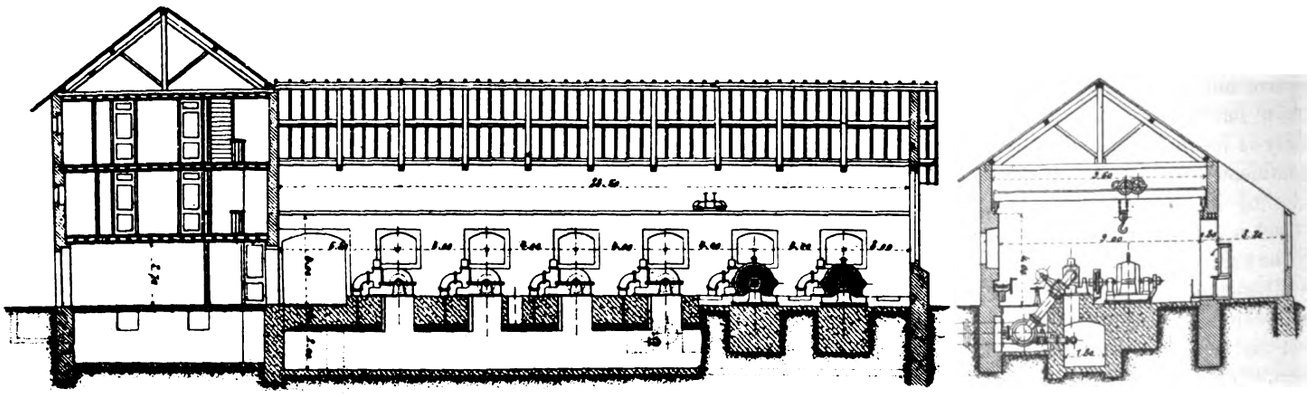

FIG. 2.—HYDRAULIC PLANT AT SUBLIN.

The engraving Fig. 1 shows a view of the road on the heavy grade. The locomotive is placed in the rear and pushes the passenger car up the grade. The electric locomotives have been equipped by

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the Compagnie de l'Industrie Electrique, on the Thury system, which is now in successful use on a number of such mountain roads in Switzerland and other countries. The mechanical part has been built by the Fabrique de Locomotives de Winterthur, a well-known Swiss firm. The present road was the first to use this new system of locomotive. It is equipped with two Thury motors of 100 horse-power each. The current for the motors is taken from an overhead line, which gives 650 volts, direct current, by means of a double trolley. The first section of the road, from Bex to Bevieux, is also equipped with a set of ordinary trolley cars of a smaller size in order to supply the local needs.

The hydraulic plant, Figs. 2 and 3, which supplies current for the traction line and the surrounding districts, is situated on the Avançon, a rapid mountain torrent which is already used for supplying power to other plants. The Sublin plant uses a head of water of 520 feet. The mean output of the stream is 800 litres per second, so that the turbines can use about 1,600 horse-power. From the dam starts an underground conduit 4,500 feet long which is constructed in cement beton, with an oval section, and has a maximum height of four feet.

The canal leads down to a small reservoir which serves as the starting point for the penstock and assures a constant water supply under a variable flow of the conduit. The reservoir is twenty-six feet in diameter and has twelve feet depth; it is built of armored cement. To the right will be noticed the penstock, which runs down a steep grade to the station. It has a total length of 1,350 feet with an interior diameter of thirty-six inches. The overflow conduit also starts from the reservoir and has a length of 1,020 feet, running in an armored cement conduit. The penstock leads to the six main turbines of the station, which have been constructed by Escher Wyss & Company. These turbines give 400 horse-power each and work at 600 revolutions per minute. They are provided with automatic speed governors, which are operated by a small hydraulic motor. The engraving, Fig. 4, shows the interior view of the station. The Sublin plant is equipped with six dynamos in all, and is laid out so as to provide for the lighting and motor circuits of the town of Bex and the neighboring region, as well as for the local tramway line of Bex-Bevieux and the

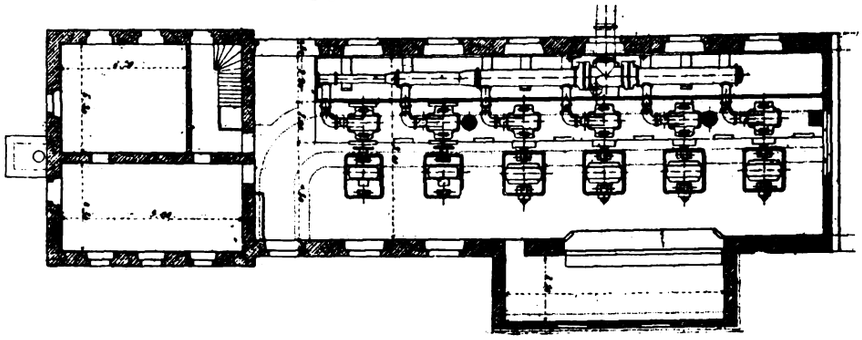

FIG. 3.—SUBLIN HYDRAULIC PLANT.

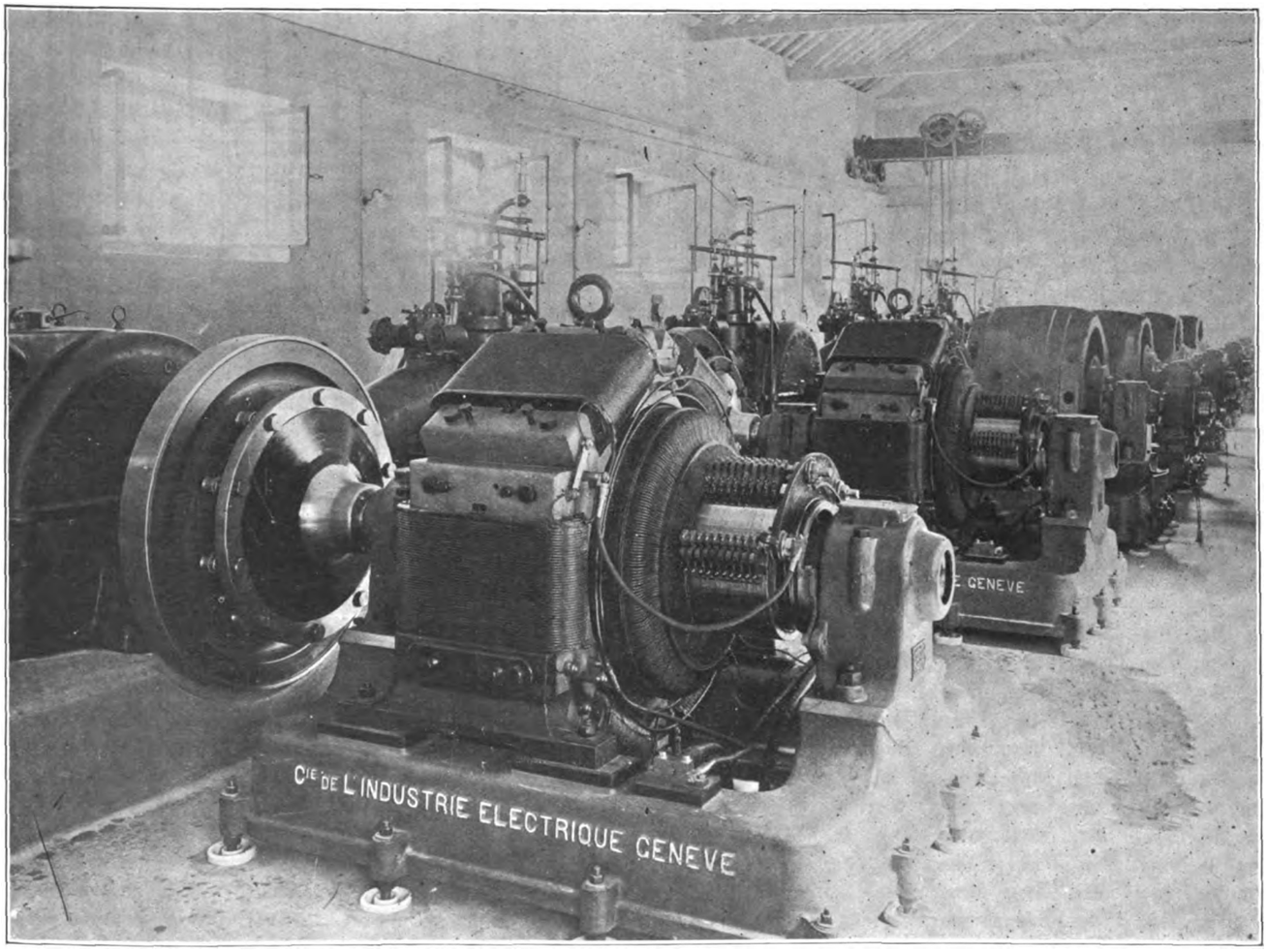

FIG. 4.—INTERIOR OF SUBLIN PLANT.

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mountain railway of Bex-Gryon-Villars. For the tramway lines the station has two main generating sets on the Thury direct-current system, one of which is used as a reserve. The remaining four groups are provided with three-phase alternators. The use of the three-phase alternating-current system is now becoming more general in Switzerland and it is replacing the monophase and biphase systems which were formerly used, on account of the advantages it gives both for motor starting and economy in the line. On the other hand, the monophase and biphase current have been preferred for different reasons, especially as they gave a greater facility for regulating the voltage, which is a considerable advantage in stations which combine both lighting and traction systems. But since the rise in the price of copper this latter consideration had to be sacrificed for the sake of economy in the line. Owing to these reasons the triphase current is coming into use in many of the new plants, of which the present station is an example.

The four alternators which are installed at Sublin are designed for 5,200 volts. These machines have been furnished by the Westinghouse company and furnish triphase current at 5,000 volts and fifty cycles, at thirty-three amperes per phase. The exciters are mounted on the end of the shaft. The machine complete weighs 12.2 tons.

The two direct-current generators for the traction lines will be noticed in the foreground. These machines have been built by the Compagnie de l'Industrie Electrique, on the Thury system. They are six-pole machines, which deliver normally 300 amperes at 650 volts. The field windings are over-compounded so as to compensate for the variations of voltage in the traction system. The machines are designed, however, so that the variation in the voltage from no load to full load does not exceed eight per cent at a constant speed and field charge. According to the tests these machines show an efficiency of ninety-three per cent. The total weight of the armature is about three tons, and that of the whole machine in running order nine tons. The commutator is built up of 309 copper strips, and on account of the great number of strips which are used a very uniform voltage line is obtained. The copper of the commutator alone represents a weight of 800 pounds.

The generators are connected to the turbines by an elastic coupling. The flywheel next to the turbine carries a set of pins or projections and a smaller disc lying next the generator has a like set of projections. The two sets of pins are then connected across in pairs by short rubber bands to form the elastic coupling. The floor of the station is covered with a layer of asphalt one and one-half inches thick, which forms a good insulating covering. As will be observed, the machines are bolted down upon a set of porcelain insulators which have been firmly fixed in the flooring. This system of insulation has given good satisfaction. The direct current for the traction lines is taken to the trolley wires by a series of overhead feeders which are connected in parallel. The other pole of the generators is grounded by connecting with the rails of the track at a point near the main station.

The alternators supply the main distribution lines directly without the use of step-up transformers. The system comprises both lighting and motor circuits. All the lighting circuits have been mounted upon one of the phases. The system of distribution will be observed in one of the diagrams. The high-tension lines for the motors use a three-wire line and the lighting circuits a two-wire line. At different points on the main circuit are placed the substations for supplying the low-tension circuits for the lighting or motors. In these stations are placed a set of monophase or three-phase transformers which are connected in parallel in each case. In one instance the high-tension current is used direct at 5,000 volts at the electrolytic plant of Monthey. In this case the alternating current is taken by large synchronous rotary converters of 300 horse-power each, which produce continuous current for the electrochemical work.

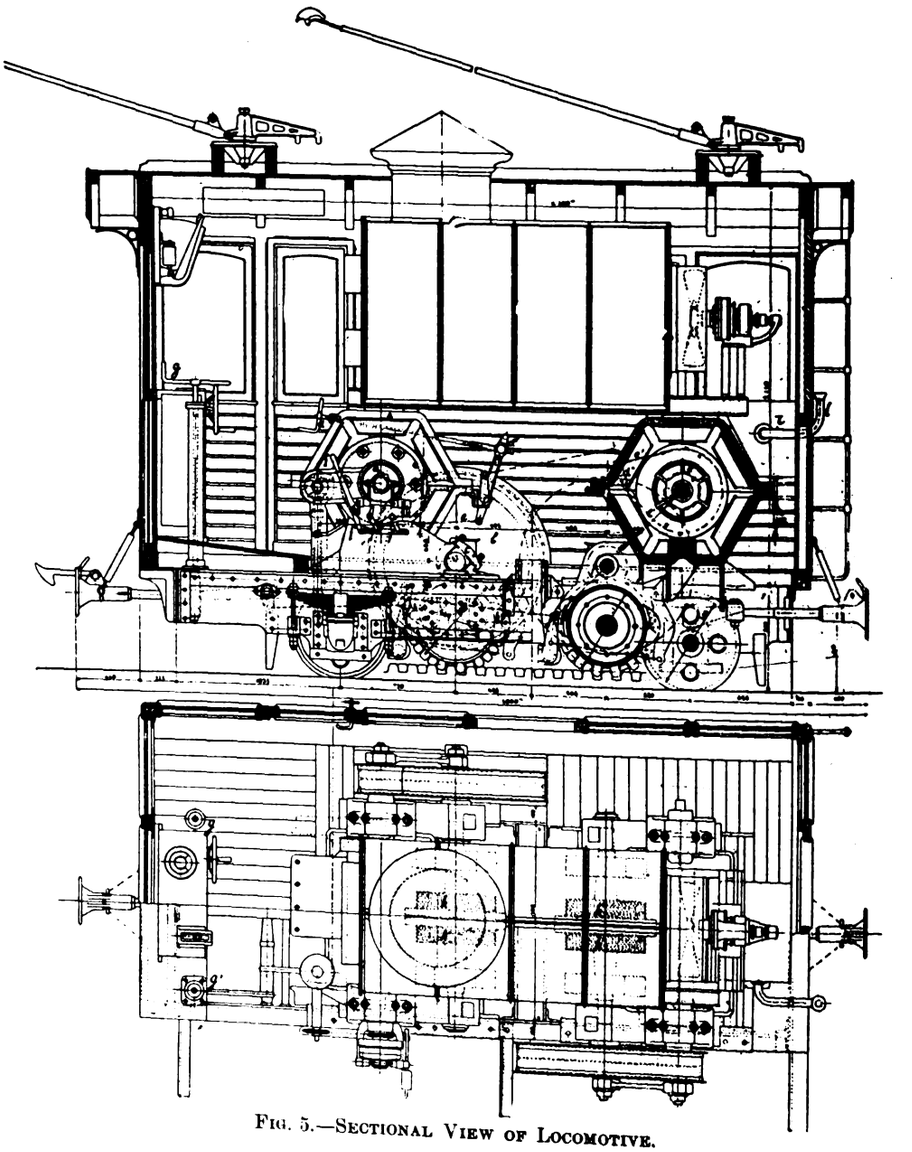

FIG. 5.—SECTIONAL VIEW OF LOCOMOTIVE.

The sectional view, Fig. 5, of the locomotive used on the traction line shows the general arrangement of the system and the method which has been adopted for mounting the two 100-horse-power motors, with the sets of gearing used for operating the rack-and-pinion mechanism.

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The total length of the locomotive over the connecting pieces measures sixteen feet. The distance between the main axles is seven feet three inches, and the distance between the shafts of the gear wheels of the rack-and-pinion three feet one inch. The locomotive has a total width of eight feet three inches, and a height of seven feet six inches from the rail level to the roof, exclusive of the trolley fixtures. The truck of the locomotive is composed of two strong side-beams of channel iron braced across by smaller bars. This forms a solid base on which is placed the frame or body of the locomotive, which has been furnished by the Société de Neuhausen. The body of the locomotive, which is thirteen feet long, has three windows and a sliding door on each side, also an iron ladder attached in the rear for mounting on to the roof to make repairs to the trolley.

The motor operates the pinion which engages with the toothed rail between the tracks by means of double-reduction gearing. Each set of motor and gears is exactly alike. The toothed rail is double, forming two racks placed side by side with about one-inch space between them. The teeth of the racks are staggered so as to give a better hold. The disposition of the gearing will be observed in the case of the left-hand motor. The first pinion *a*, mounted on the motor shaft, which has only ten inches in diameter, engages with a large gear wheel *b* of forty-three inches diameter. From the gear *b* a shaft passes across the locomotive carrying on the opposite side a small pinion *c*. The latter pinion engages with a gear of twenty-inches diameter which is placed directly below it and mounted upon the axle of the main pinion which engages with the rack. The latter pinion has a diameter of twenty-five inches. The second motor has a like system of gearing which is disposed symmetrically in the opposite direction. The total ratio of speed reduction given by the gear sets is one to eight, and as the motor makes an average speed of 525 revolutions per minute the locomotive has a speed of five miles an hour, as the diameter of the main rack pinion is twenty-five inches. The maximum speed admitted for the locomotives is 7.5 miles an hour.

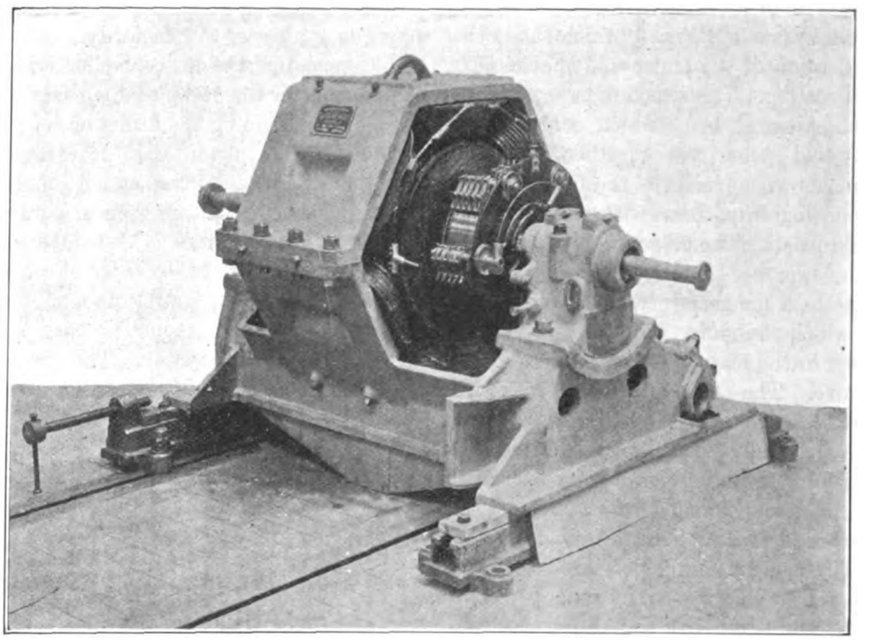

FIG. 6.—MOTOR IN USE ON LOCOMOTIVE.

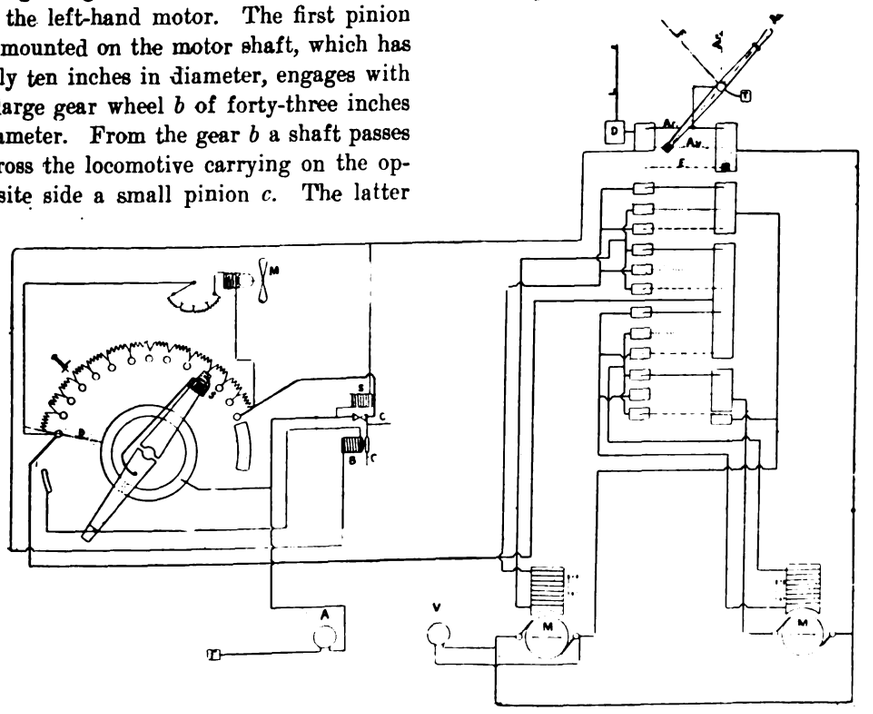

FIG. 7.—CONTROLLER CONNECTIONS.

As the locomotive is designed to mount a steep grade, the system of braking had to be carefully carried out. Three sets of brakes working on different principles have been provided in this case, namely, band brakes working over drums, brake shoes and an automatic brake. The band brakes are placed upon steel pulleys which are mounted directly upon the motor shafts. Above the motor A will be observed the handle *d* which operates a lever *d'*; to the end of this lever is attached one end of a strong steel band *e e e* three inches in diameter which passes around the large pulley on the motor shaft noticed in dotted lines. The band is fixed at the other end and by turning the handle *d* a strong pressure is brought to bear on the drum. The brakes on both motors are operated by the same handle. An automatic device operated by a centrifugal mechanism *ff* acts upon the steel bands when the speed exceeds a certain point and causes a braking action.

A powerful set of hand brakes is also provided. These will be observed in the section view where *h h, h' h'* represent two brake cylinders which are mounted on each side of the main pinions. These cylinders are of cast iron and carry a set of annular grooves on the surface in which fit a set of corresponding projections on the brake shoes to provide a strong gripping surface. The brake shoes of bronze, which are noticed at KK' in the sectional view, are thrown on by a series of levers from the crank *g* which is placed next to the controller in the front of the locomotive. In the rear will be observed the water tank *r* which has a set of piping to supply water to the different brakes for keeping them cool. It is filled from the outside of the locomotive at *l*. The disposition of the two trolleys will also be noticed in the sectional view. The total

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weight of the locomotives of this pattern is about fourteen tons, and the weight of the passenger car when fully loaded varies from sixteen to eighteen tons.

The motor which has been designed for this type of locomotive will be observed in the engraving, Fig. 6, which shows the disposition of the motor and the foundation casting. These motors have a hexagonal cast-steel body which contains the six field poles cast together with the frame. The armature is of the Thury drum-wound pattern with the winding laid in slots. The field bore is 23.2 inches. The lower bed-plate is cast in one piece and has a flange projection at either end by which the motor can be solidly bolted down to the main side beams of the locomotive. The shaft of the motor, which runs in ball bearings, carries on the outer side the pinion which engages with a set of double-reduction gearing for operating the rack-and-pinion system, as will be further described.

The controller which is used with the present locomotive consists of a rectangular sheet-iron box containing the controller mechanism and has a vertical hand-wheel on the front side and a lever at the top which works over a sector. The controller is composed of two distinct parts, which will be observed in the diagram of connections, Fig. 7. One part consists of a regulating circle for the motor speed composed of twenty-five segments for the resistances, and the second is a series of contacts which is shifted back and forth by the hand lever, as noticed to the right. The regulation of the motor speed by means of the resistance coils is carried out by a central pivoted arm which revolves over the segments. This arm also passes over an inner metal ring which has a ground connection. At the outer end the controller arm is provided with a strong magnetic blowout which suppresses the sparking at the contacts.

As to the arc which is produced when the current is finally cut off, this has been made as small as possible by the following device. The arc formed by the main current is produced in a special apparatus or spark-breaker, which is placed outside the controller case in the roof of the locomotive and is operated by a small electromagnet. This device is shown to the right of the controller circle in the diagram. At the time of breaking the circuit the current is passed into a circuit containing two carbon contacts C, one of which is movable. When the controller arm comes over its last contact plate the current is broken in a small electromagnet B, which holds the carbon contacts together, and the points are separated. The spark which is produced at the contacts is then blown out by the action of the electromagnet S, into which a strong current is passed at this moment. This device is found to work very satisfactorily.

The second part of the controller, which is observed on the right of the diagram, is used for obtaining the direct or reverse running of the motor and for carrying out the electric braking action of the motors by short-circuiting their armatures through a low resistance. This controlling switch is composed of a lever which works over a toothed sector, acting upon a stout rod which shifts the contacts back and forth in a vertical direction. The current which comes from the two trolleys passes

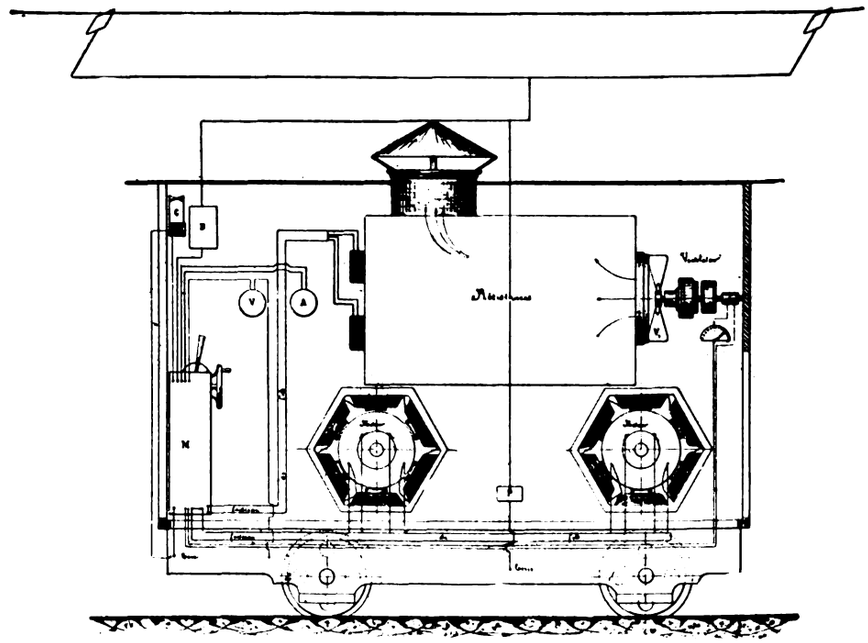

FIG. 8.—ELECTRIC CONNECTION OF LOCOMOTIVE.

first through an automatic circuit-breaker D, placed overhead. The circuit-breaker can also be worked by hand in case of need. The current passes through the controller switch and thence to the two motors, which are connected in parallel. From the motors it passes to the resistance coils by means of the circular switch and from thence to the ground circle and to earth.

The diagram, Fig. 8, shows the electrical connections of the locomotive, with the controller M on the left. At D is the automatic circuit-breaker, and at C the magnetic blowout. The resistances are mounted above the motors in a large sheet-iron box. These resistances are formed of strips of corrugated iron whose section is calculated so as to support the total current due to the electric braking action of the motors. On this account they are required to have a much larger size than a set of ordinary starting resistances for the motors. To avoid heating up of the resistances under the heavy currents an effective air-blowing system is provided. In the rear of the resistance case is an electric motor which drives a large air fan. This motor is connected to the circuit of the resistance coils so that it can operate when the locomotive is on the down-grade and the trolleys are taken down, as it is during this time that the resistance heats up the most and the fan is especially needed. In this case the motors of the locomotive run as generators and are connected upon the resistances.

To carry out this manœuvre, as well as to secure the electric braking action, the current from the overhead line is cut off by a switch and a connection is made with the ground by means of the controller lever. The direction of the current in the machines is the same as for the forward running. The motors now act as generators and work directly upon the resistances, and the latter are varied to suit the requirements.

A series of interesting tests was carried out at the time of putting them into practice which showed that they were capable of performing all that the constructors claimed for them. The locomotives were required to push a passenger car of the standard type up a twenty per cent grade. The car was loaded with salt bags up to the maximum weight allowable, or 18.7 tons. Four trips were thus made up the grade at a speed of 4.5 miles an hour. The motors of the locomotive each took a current of 112.5 amperes at 650 volts, thus giving together about 210 horsepower. On the down-grade trips with

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the electric brake alone in action the result was all that could be expected, and the speed of the descent could be regulated with ease and also within the widest limits, for the electric braking action comes into full play at a speed as low as a quarter of a mile an hour and works from that point up to the maximum of seven miles an hour, which is not exceeded in practice.

The automatic brake also worked very well on the different trials; it is thrown on automatically when a speed of seven miles an hour is reached and brings the train to a full stop without any shocks and inside of a short distance. In the test of the hand brakes it was found that with a very slight effort the descent of the thirty-ton train on a twenty per cent grade could be stopped within ten or twelve feet. One point to be remarked is the advantage which the electric braking action with direct current has over the polyphase locomotives, as in the former case the locomotive is entirely independent of the line and the machines at the generating station. This gives a great security to the system, especially in the present case where heavy grades are used on the line. Usually the car descends with its trolley poles lowered. Another advantage of the direct current for this application lies in the fact that the speed can be varied within wide limits down to an almost complete stop of the train, while with the polyphase system the electric braking action can only take place when the speed exceeds the normal speed of the ascent corresponding to the synchronism of the polyphase motors with the alternators.

Electric Railway Possibilities in South Africa.

The following interesting discussion of the possibilities of electrical operation of railways in South Africa is taken from the report of Mr. Hoy, the chief traffic manager of the Central South African Railways:

"The success with which heavy locomotive engines are now being employed in these colonies, as well as in England, points to the maximum having been nearly, if not actually, reached. A 120-ton locomotive upon an eighty-pound rail, on a three-foot six-inch gauge, is what would generally be considered a favorable result. If the locomotive limit has been attained, there are evidences of developments in substituting a newer motive power upon lines where the nature of the traffic to be conveyed renders it possible to utilize electrical or other systems of energy. The employment of the heavy locomotive has its unquestioned economic merits, but it is an important consideration whether freight vehicles may not with advantage be equipped with their own motive power, either for individual or collective haulage. The grade will always largely influence the value of the locomotive, but upon sections admirably adapted for the use of electricity, the adhesive power may with advantage be abandoned for the energy attached to the vehicle itself, and thus overcome the resistance common to the present system of haulage. Whether the power to be employed be electricity or a combination of other forces, there can no longer be any doubts, that upon short and busy lines steam can be superseded. If any section of railway in South Africa lends itself for advancement in this direction, the Springs-Randfontein length offers an admirable opportunity for the expansion of such scientific energy. The working of so many mines sidings might assure the success of a change in working. There is a further guarantee of sufficient traffic within the section. I assume that electricity will supersede steam for passenger work along what is known as the Rand tram section within a measurable space of time. There are excellent opportunities for installing electricity, and of taking early steps, not only to cultivate the suburban traffic, but to retain it."

ELECTRICAL NOTES FROM INDIA.

(Special Correspondence.)

During last August all of the motors and compressors operating at the Kolar gold fields, India, were taken over by the operating company from the Mysore Government. This machinery was put in by the Mysore Government under a very liberal guarantee, the agreement being that it should be operated continuously for one year, and if in satisfactory condition it would then be accepted. This machinery is operated by power generated at the power station on the Cauvery river, this being transmitted to the mines at 30,000 volts. There were thirty-one motors in all, including induction and synchronous, and eleven double air compressors. The motors have been running under the care of native attendants who know practically nothing about them and who have a tendency to go to sleep while on watch, allowing oil cups and lubricators to run dry.

Work has been started on the installation of 4,000 horse-power additional to the Cauvery power station, and the building and forebay are being enlarged to provide for this. This will double the output of the station, and to lessen the line loss caused by this increase the voltage of the system will be raised to 35,000.

It is possible that the city of Bangalore will be lighted by power supplied from the Cauvery station, as the transmission line passes within eighteen miles of it, though the town is rather scattered and the lighting load will not be very large. The government pumping station, which is located six miles from the Kolar gold fields, is also to be operated electrically.

It is reported that the city of Madras is considering the installation of an electric railway service in the near future, and that Bombay is contemplating an electric lighting plant. A. C.

Mysore, India, September 19.

ELECTRIC MOTORS FOR CENTRIFUGAL PUMPS AND FANS.[1]

BY AUG. J. BOWIE, JR.

The rapidly increasing use of electric motors for driving centrifugal pumps and fans renders important the study of these loads under the varying conditions encountered in practice. The possible loads which may thus be thrown on a motor, due to variations in speed, or in the head against which it must operate, are serious enough to warrant careful consideration.

The problem of determining the proper capacity of a motor is not always easy to solve. The solution is too often the result of guesswork, and is liable to be seriously in error. In the case of direct-acting pumps working against a known head, the proper motor capacity can be easily calculated. The most economical size of motor for the purchaser, however, may not be solely determined by the possible loads, and their duration, which the motor may be called upon to carry. Particularly is this true where a flat-rate system is in vogue and where power is purchased at a price depending upon the rating of the motor and not upon the power actually used. This system of charging for power leads to great abuse in the underrating of motors; on the other hand, it may work a great hardship on a purchaser of power who innocently uses a motor far larger than is necessary and pays for power that is not consumed. Several instances of the latter have come under the writer's observation, and the system in his opinion should be condemned. Where measurements of power are taken as a basis for determining the flat rate, such measurements should be taken under the average running conditions. A variation in these conditions may lead to a very erroneous system of charges in the case of centrifugal pumps and fans, as will be seen later.

For centrifugal pumps and fans the power required for operation at a rated speed and head is by no means all that need be known. One should also know the maximum load which can ever come on a motor when driving the pump or fan at the rated speed and under any possible head. This maximum may be far in excess of the rating.

The problem in case of centrifugal pumps and fans will be treated under the following three heads: (1) Constant speed and varying heads; (2)

[1] A paper read at the 179th meeting of the American Institute of Electrical Engineers, New York, September 25, 1903.

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changing speed with head varying directly as the square of the speed; and (3) constant head and varying speed.

I—CONSTANT SPEED.

The following treatment applies equally well to centrifugal pumps and to centrifugal fans, as the same laws govern the flow of either fluid, but pumps alone will be considered. Represent by H the head generated by the pump. This is equal to the difference between the discharge and suction pressures, plus the difference between the discharge and suction velocity heads. Represent by Q the cubic feet of water discharged per minute. The general equation expressing the relation between Q and H is $H = A - B Q^2 + C Q$, where A, B, and C are constants.

This is the equation of a parabola, and it will approximately represent the actual curves obtained in practice. Back-slippage through the running wings of the pump has not been taken into account in the above equation, and will account in part for discrepancies between theoretical and actual results.

The pressure exerted by the pump is a maximum when $D\ q\ H = 0$. Hence, when $2\ BQ = C$, $Q = \frac{C}{2B}$, and $H = A \div \frac{C^2}{4B}$, is the maximum value.

Let W_0 = output of pumps in watts. $W_0 = KHQ$, K being a constant. $W_0 = KQ(A - BQ^2 + CQ)$. This is a maximum when $D\ q\ W = 0$, or

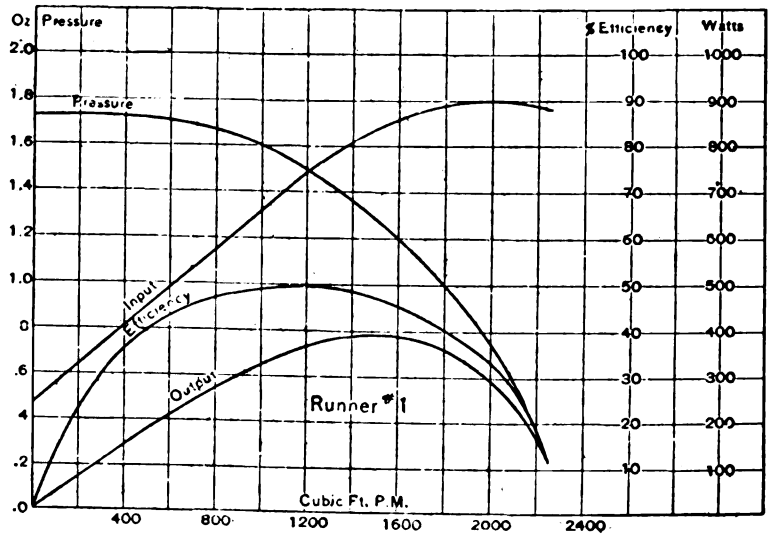
$A - 3\ BQ^2 + 2\ CQ = 0$. $Q = \frac{C}{3B} \pm \sqrt{\frac{A}{3B} + \frac{C^2}{9B^2}}$, corresponding to $H = \frac{2}{3} A + \frac{1}{3} CQ$.

In some pumps the constant C is so small that it may be disregarded. In this event the maximum head is obtained at zero discharge and is equal to A. The maximum output of the pump is obtained at a head of $\frac{2}{3}$ A. The relative values of C and B determine the nature of the output curve of the pump and the maximum obtainable pressure. If B be fixed, the greater the value of C the greater will be the capacity of the pump. If C be fixed, the less the value of B the greater will be the pump capacity. However, the relative values of C and B will have a very important bearing on the ratio between the maximum power required to run the pump, and the power required to run it at the point of highest efficiency, or at the point of maximum output.

The quantity $\frac{C}{B}$ is influenced largely by the angle which the vanes of the pump make with the radial at the external periphery, as well as by the width of the face of the runner. However, it is beyond the scope of this paper to enter into a discussion of the design of pumps, other than in a general way, so as to show the effect of the design upon the maximum power required to drive the pump. Usually this power will increase as the effective head of the pump decreases. This would naturally be expected as long as the energy output of the pump is on the increase, but after the latter starts to decrease it might be considered natural to look for a decrease of the driving power. However, when B is fixed, the smaller the value of C the less will be the tendency of the pump to require additional power to drive it at heads lower than its rated capacity, and the higher the value of C the greater will this additional power become. When C is fixed, the reverse holds true for B.

A centrifugal pump, when operated at too low a head, shows a very low efficiency. In general, however, with a well-designed pump, the range of efficient operation for a constant speed is fairly broad. The principal point which the writer wishes to bring out in this connection is the danger of overloading a motor through too low a head. A manufacturer will usually guarantee a certain efficiency and input for a pump at its rated load, but will say nothing concerning the power required to drive it at heads lower than that called for. The question may arise, why not give a pump the proper speed for a given head? This is frequently impracticable, since pumps must often be installed to work under widely varying heads, where it is not an easy matter to change the speeds. Oftentimes the heads at which the water must be elevated may vary practically from zero to the maximum head against which the pump will deliver. In some cases these overloads may be of long duration, and a sufficiently large motor should be installed. On the other hand, the maximum load will often be only of short duration, as for example in the case of pumping from a well, particularly where there is a pit in connection with it, which is partially filled up with water. Generally it will not take the pump long to very decidedly lower the water, and the duration of overload will be brief.

The behavior of centrifugal pumps may be represented very completely by four curves. These curves are based upon an absolutely fixed speed. Corrections for variations from this speed may be made without difficulty. These curves have,



CURVES SHOWING OPERATION OF CENTRIFUGAL PUMP.

in each case, for abscissæ, the volumes of the fluids delivered in a fixed time interval, while for ordinates they have respectively, head, watts input to pump, watts output from pump, and pump efficiency.

The last two curves determine the proper rating of the pump. In general, the maximum efficiency occurs before arriving at the point of maximum output. The proper rating is somewhat indefinite, as will appear from the appended curves obtained in practice. The natural tendency of a manufacturer is to rate his pumps as high as possible. Still, he does not care to go far beyond the point of maximum efficiency at the full load rating.

The accompanying curves show the results of tests on two fans with the same casing, but with different runners. In the first set $\frac{C}{B}$ is smaller than in the second set. According to the curves,

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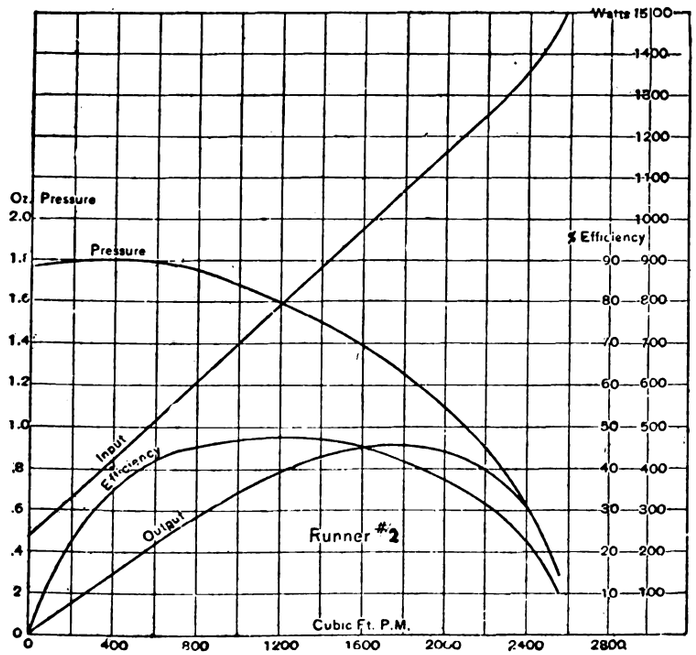
the first fan is of smaller capacity, but of higher efficiency than the second. Particularly noticeable is the curve of watts input, which in the first case shows a decided concavity towards the X axis, shortly after passing the maximum output of the pump. While in the second case the corresponding curve, on the contrary, becomes slightly convexed toward the X axis, and requires far more power under low heads. Thus the ratio of maximum outputs is 1.15, and the ratio of maximum inputs, within the range of the tests, is 1.68. These fans represent by no means extreme conditions. In the case of the second fan, if it should be called upon to operate under the lowest head tested, and if it were rated at the point of maximum efficiency and a corresponding motor were installed, then this motor would be liable to an overload of eighty-nine per cent.



CURVES SHOWING OPERATION OF CENTRIFUGAL PUMP.

II—CHANGING SPEED WITH HEAD VARYING AS THE SQUARE OF THE SPEED.

If a centrifugal pump delivers Q cubic feet of water per minute, against a pressure of H feet while running at R revolutions per minute, and then if the speed be altered to $R_1 = KR$, it will deliver $Q_1 = KQ$ cubic feet per minute against a pressure $H_1 = K^2H$ feet. If W = watts output of pump in the first case, and I = watts to pump, then $W_1 = K^3W$, and $I_1 = K^3I$. These equations follow from the proportionality between the head generated and the square of the speed, and because, when the volumetric output varies directly as the speed, the relative angles of motion of the water are not altered. Furthermore, all frictional losses vary as the cube of the speed, and all volumetric leakage losses vary as the speed. Hence it follows that increasing the speed of the runner, where the effective head varies as the square of the speed will result in increasing the capacity of the pump directly as the speed, and increasing the power input and output directly as the cube of the speed. The conditions presupposed in this case, namely, that the head varies as the square of the speed, is the condition which exists in the case of ventilating fans, where the head is used up in friction in the pipe, and in the velocity head of discharge from the pipe. This velocity head, and also the friction head vary as the square of the discharge from the pipe.

What concerns the motor capacity particularly is the fact that the power varies directly as the cube of the speed. Hence the I^2R loss in the armature varies as the sixth power of the speed.

III—CONSTANT SPEED.

This is the condition which exists when pumping against a fixed lift, when the velocity heads lost at entrance and discharge, and when the fractional losses in the pipe may be disregarded in comparison with the lift.

In this case, and likewise in case 2, the characteristic curves of a pump under variation of speed can be obtained from those at another speed by multiplying the quantities discharged by the ratio K of the speeds, the pressures by K^2, and the watts input and output by K^3. The efficiencies remain the same.

It is evident that the apparatus of case 3 will operate at a point situated further along on the curves than that of case 2; the result being a greater delivery of water, and, usually, a greater input to the pump. In general this input will vary faster than the cube, and not as fast as the fourth power of the speed. As an approximation say as the three and one-half power of the speed. This makes the I^2R loss in the armature vary as the seventh power of the speed. Thus ten per cent increase in speed represents forty per cent increase in power and ninety-six per cent increase in the I^2R loss in the armature. From this it may be seen what an extremely large effect speed variation has on motors driving centrifugal apparatus. There is perhaps no other form of apparatus so sensitive to change of speed in its power consumption. The effect which a steady pump load has in holding the voltage constant by preventing the racing of generators is thus explained.

If centrifugal apparatus be provided with induction or synchronous motors then the speed is practically fixed by that of the prime mover, so that the maximum load for the motor with a given pump or fan is determined.

Speed control of direct-current motors by variation of field resistance has a limited range in practice and has many points which tend to make it objectionable for the best conditions of commutation. Even at best there will be considerable field distortion at the high speeds. The effect of a load which would increase as the cube of the speed, and even faster, would seem to limit still further the allowable speed variation to be obtained in this manner. In view of these facts it is well to provide a motor of ample size for such work and at the same time to see that the field rheostat can not cut in so much resistance as to overload the motor. As has been shown, the volumetric output of a centrifugal pump varies directly as the speed of revolution. In spite of this fact, many manufacturers rate their pumps at a fixed volumetric output, and publish a list of suitable speeds for different heads under which it may be desired to operate the pump. In some cases the highest speed given in these lists is three, or more times as great as the lowest speed. Such misinformation leads to a great deal of trouble and can not be too strongly condemned.

In regard to the statement previously made, that the efficiencies of pumps and fans were independent of the speed, proper changes being made for head and discharge, no consideration was taken to the effect of unbalance of the runner or of bearing or stuffing-box friction. These, of course, would modify the results obtained. Lack of proper running balance is very apt to cause serious loss of power.

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The British Association for the Advancement of Science.

Meeting at Southport, England, September 9, 1903.

From Our Special Correspondent.

THE 1903 meeting of the British Association was held at Southport and commenced on Wednesday, September 9, concluding on Wednesday, September 16. This was the second visit paid by the association to this seaside health resort, the first occasion being some twenty years ago. The present meeting was the seventy-third annual session, and the president this year was Sir Norman Lockyer, K. C. B., LL. D., F. R. S.

As a first duty, Sir Norman referred to the great loss which the nation has sustained in the death of Lord Salisbury, and, in dilating upon the fact that this politician had also occupied the proud position of president of the association (and the present Premier, Mr. A. J. Balfour, having accepted the same position for next year), he came at once to the theme of his lecture; *viz.*, the influence of brain power on history. The nineteenth century would ever be known as the one in which the influences of science were first fully realized in civilized communities, scientific progress being so gigantic that it seemed rash to predict that any of its successors could be more important in the life of any nation. At the same time, however, there was a great necessity in Great Britain for a body dealing with the organization of science. The present awakening in relation to the nation's real needs was largely due to the warnings of men of science. During many years it had been a part of his duty to consider such matters, and he had been driven to the conclusion that our great crying need was to bring about an organization of men of science and all interested in science similar to those which proved so effective in other branches of human activity. For the last few years he had dreamed of a chamber, guild or league with a wide and large membership which could give us what, in his opinion, was so urgently needed. The foundation of such a body was the British Association itself, and they could rest assured that sooner or later such a guild would be formed. He believed the association would be a vast gainer by such an expansion, *viz.*, a British science league, on the lines, for instance, of the German navy league. Our position as a nation, our success as merchants, was in peril chiefly because of our lack of completely efficient universities and our neglect of research. From neglect of research came imperfect education, and a small output of new application and new knowledge to reinvigorate our industries.

Chief among the causes which had brought us to the terrible condition of inferiority, as compared with other nations, in which we at present found ourselves was our carelessness in the matter of education and our false notions of the limitations of state functions in relation to the condition of modern civilization. As an analogy he compared the navy with education. In the early days the navy was largely a matter of private and local concern, but all this had passed away. Again, time was when not a penny was spent by the state on elementary education. But when we passed from primary to university education, instead of state endowment we found state neglect. We appeared to be in a region where it was nobody's business to see that anything was done. What were the facts relating to private endowment in this country? In spite of the munificence displayed by a small number of individuals in some localities, the truth must be spoken. In depending in Great Britain upon this form of endowment we were trusting to a broken reed. Taking the twelve English university colleges private effort, during sixty years, had found less than $20,000,000. Against this, in the United States, during the last few years, the universities and colleges had received more than $200,000,000 from this source alone, and private effort had supplied nearly $35,000,000 in the years 1898 to 1900. Likewise in Germany, state aid was considerable. The buildings of the new University of Strassburg had already cost nearly $5,000,000, which was about as much as had yet been found for buildings in Manchester, Liverpool, Birmingham, Bristol, Newcastle and Sheffield. But in Great Britain, the state really conceded the principle, for its present contribution to our universities and colleges amounted to $830,000 a year.

After dealing with the importance of research work, as the most powerful engine of education we possessed, the address concluded with a reference to the need of a British scientific national council.

The sectional meetings commenced on the following day, Thursday, September 10. The following are the presidents of the sections devoted to engineering and allied subjects: Section A, mathematical and physical science, Professor C. Vernon Boys, F. R. S. Section B, chemistry, Professor W. N. Hartley. Section G, engineering, Charles Hawkesley. Section L, educational science, Sir W. de W. Abney, F. R. S.

Section A—The president's address paid an eloquent tribute to the memories of the many men of science who have passed away during the past twelve months in Great Britain, Germany and the United States. The subject matter of his discourse had reference to the much discussed question of the discovery of radium, in which he briefly reviewed the work accomplished by the various physicists who have taken this matter up.

The papers read in this section on the first day were of a peculiarly similar character as the following list will show: "On Electro-Etheral Theory of the Velocity of Light in Gases, Liquids and Solids," by Lord Kelvin; "On the Nature of the Emanations from Radioactive Substances," by Professor E. Rutherford (this was followed by a discussion in which many important persons took part); "On the Radioactive Emanations Present in the Earth's Crust and Atmosphere," by Messrs. Elster and Geitel; "Cosmical Radioactivity," by Professor A. Schuster; "The Production of Helium by Radium," by Sir W. Ramsay, F. R. S., and W. F. Soddy, and "Intersification of Chemical Action by the Emanations from Gold and Platinum," by G. T. Beilby. Obviously, it is impossible in this brief summary to give in detail all these important contributions, more than one of which, however, recounted the existing knowledge on the subject. It was noticeable, however, that the biggest discussions took place upon papers of this character rather than upon those on purely engineering subjects. The paper by Mr. James Swinburne upon "The Treatment of the Thermodynamics of Irreversible Processes" was discussed briefly.

Section G. Engineering—Mr. Charles Hawkesley's presidential address to this section dealt with many practical matters. First of all intercommunication. At the commencement of the nineteenth century we were told there was not a mile of tramway in the United Kingdom. Now there

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are about 22,000 miles. From that commencement the improvement of the condition of the public roads followed as a natural necessity for speed in locomotion. A burning question at the present time was the speed of motor cars along public thoroughfares. However, electric cars were a luxury, like the petrol motor, which, nevertheless, had a wider field of application and a greater degree of prosperity than electrically propelled vehicles. The use of "standardized accumulators" to be supplied to the owners of electrical vehicles at depots on production of a subscription ticket had been suggested, and the engineering standards committee had appointed a subcommittee to consider the question. Turning to electric tramways and light railways, the president did not think it could be regarded as fair to the railway companies—which had to pay large sums of money for the land upon which their lines had been constructed—to have to compete with tramways which were laid along public roads without payment being made for their use. The roads were disfigured by aerial conductors and the supporting posts by which the electric current was conveyed to the cars, except on those comparatively rare instances in which the conduit system was employed; neither could it be denied that tramways greatly interfered with the use of the roads for ordinary traffic. Further, the effect of electrolytic action on iron pipes laid beneath the roads was still undergoing investigation. In saying a few words upon wireless telegraphy, the opinion was expressed that there appeared to be a practical field for the development of wireless telegraphy more especially where ordinary telegraphy could not be applied, as, for instance, between shore and ships and ships at sea, or between one ship and another.

"Improvement in Locomotive Design" was the title of a paper read by Mr. T. Clarkson, dealing with some improvements he himself had effected in steam-driven cars. He attributed the fact that so many flimsy cars of the internal combustion type had been put upon the market to the great popularity of these cars, and it was very satisfactory that so few accidents had occurred. In the discussion great praise was bestowed upon the author for his improvements in steam cars.

Lieutenant-Colonel Crompton next read a paper entitled "The Problem of Modern Street Traffic." Very early in the paper attention was drawn to the somewhat startling fact that in most great cities to-day progress could never be made at a higher average speed than five miles an hour. In fact, slower than forty years ago. This state of affairs having been brought about by the heterogeneous description of vehicles which at present crowded our streets all going at varying speeds; the establishment of a special department of police to supervise street traffic was suggested. Among the functions of the proposed body were the advising of local authorities in drawing up by-laws and also with regard to new crossings, subways, tramways, etc. A great consideration was the regulation of vehicles overtaking others. It was also advocated that no speed limit should be enforced in towns, and this was especially desirable with motor cars which were under far greater control than horse-driven vehicles. Electric automobiles he considered the vehicle of the future.

Mr. W. B. Woodhouse read a paper on "Protective Devices for High-Tension Electrical Devices." This paper advocated, among other things, the use of needle points in air as most reliable for relieving excessive pressure rise, which was questioned, however, in the discussion. The old switch was also eulogized as a useful device, mention was also made of an Italian interrupter consisting of three water jets.

A paper by Mr. J. B. C. Kershaw on the use of aluminum as an electrical conductor referred to some further work by the author, in which he found bare aluminum wires, when exposed under conditions similar to those which might be anticipated if overhead wires for electrical transmission purposes were used, actually gained in weight. Wires suffered more from pitting and corrosion than thick rods. A comparison of galvanized iron wires, exposed under precisely similar conditions, lost in weight. His conclusion was that commercial aluminum lost from 0.9 per cent to three per cent in strength, and gained largely in resistance. Mr. B. Hopkinson remarked that an attempt to use aluminum wire at Leeds as a trolley wire on the tramways there had not been altogether successful.

Professor E. Wilson had two papers, one "The Electrical Conductivity of Certain Aluminum Alloys as Effected in Exposure to London Atmosphere," and "A Method for Finding the Efficiency of Series Motors." The former referred to some aluminum wires, or rather some wires of aluminum alloy, which were placed upon the roof of Kings College, London, in order to investigate the effect of exposure to London atmosphere. The specimens were in the form of wire 0.126 inch (3.2 millimetres) diameter and were placed on the roof on June 11, 1901, and were the subject of communications to the British Association and the Institution of Electrical Engineers in 1902. Since then they have been exposed for another year. The results are given in the accompanying table:

No. of Specimen.	Analysis.						Specific Resistance in 10⁻⁶ Ohm at 15 Degrees Centigrade before Exposure in 1901.	Percentage Variation of Electrical Resistance at 15 Degrees Centigrade.			'Breaking Load in Pounds per Square Inch of Cross Section.
	Si.	Fe.	Cu.	Ni.	Mu.	Zn.		During 1901-2, Taken on Value in 1901.	During 1902-3, Taken on Value in 1902.	During 1901-3, Taken on Value in 1901.	
16	0.31	0.37	0.11	..	..	..	2.92	1.04	0.65	1.69	26,600
4	0.38	0.25	0.16	..	..	..	2.88	1.86	1.10	2.98	25,700
13	0.38	0.25	1.58	..	..	..	3.34	3.49	1.79	5.33	39,000
14	0.40	0.31	1.86	..	..	..	3.25	5.24	1.52	6.84	40,600
15	0.40	0.40	2.61	..	..	..	3.34	6.69	2.77	10.15	43,500
1	0.38	0.22	0.17	..	..	0.62	2.86	3.54	1.05	4.62	28,100
2	0.43	0.28	0.30	..	..	1.20	2.94	2.67	3.09	5.84	30,500
5	0.43	0.39	0.09	..	..	2.04	3.07	2.33	1.14	3.50	26,000
7	0.37	0.25	0.05	0.75	..	..	3.05	1.22	0.73	1.96	29,700
8	0.35	0.29	0.09	1.19	..	..	3.24	2.10	0.11	2.22	33,700
20	0.37	1.10	0.06	2.25	..	..	3.18	1.55	0.23	1.78	38,600
24	0.35	1.16	0.09	..	..	..	2.97	0.765	0.76	1.53	31,300
3	0.37	0.28	0.59	..	..	0.59	3.06	2.52	0.82	3.36	30,500
6	0.39	0.31	0.63	..	..	1.20	3.12	2.02	0.12	2.14	30,900
17	0.35	0.53	0.10	0.83	..	0.90	3.03	0.63	0.50	1.13	31,700
12	0.31	0.59	0.19	1.09	..	0.73	3.33	1.26	1.02	2.24	31,700
18	0.43	0.40	0.21	1.13	..	1.94	3.24	2.29	1.07	3.38	34,500
19	0.35	0.29	0.11	2.01	..	1.77	3.26	2.60	0.81	3.43	36,200
11	0.39	0.56	0.24	2.31	..	0.38	3.48	1.95	0.425	2.38	34,500
22	0.37	0.43	1.08	1.29	..	..	3.41	—1.42	3.96	2.48	45,900
21	0.39	2.57	0.10	1.39	..	..	3.24	—0.97	3.28	2.27	42,200
10	0.32	0.54	0.02	..	0.05	..	3.09	0.783	0.31	1.09	29,200
9	0.31	0.35	0.03	..	0.35	..	3.30	1.94	—0.55	1.39	30,500
23	0.44	0.56	0.09	..	1.78	..	3.49	2.34	..	2.34	35,300
Al.[1]	0.14	0.31	..	..	..	..	2.76	not exposed	2.70	..	28,200

[1] Commercial aluminum.

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Mr. B. Hopkinson's paper on "The Parallel Working of Alternators" considered a dynamo. He considered a dynamo connected to a source of supply of constant amplitude and periodicity, and driven by a constant power or working against a constant resistance. He supposed the dynamo and the generators had the same number of poles; then the dynamo would run with the same angular velocity as the supply generators, but with a certain difference of phase dependent on its excitation and on its load or driving power. If that state of steady motion were disturbed the dynamo would make oscillations, sometimes running ahead and sometimes lagging behind the position of steady motion. When ahead of the position it would take less, and when behind it would take more, than its proper supply of energy from the mains. The practical problem was to keep these oscillations, with their accompanying fluctuations in the flow of energy to or from the main, or bus-bars, within moderate limits. The author's mathematical explanations would take up too much space here.

A paper by Mr. J. W. Thomas on the "Ventilation of Tube Railways" described the scheme of ventilation for the Central London Railway, which utilizes both the natural heat in the tunnel as well as the motion of the train.

"Single-Phase Repulsion Motors," by Mr. W. Cramp, considered at great length the winding of commutators of these motors and described some experiments made with a view to improving the utility of these motors.

The presidential address to Section L, educational science section, was by Sir William de W. Abney, F. R. S. It dealt with education in science, and gave the history of state-aided scientific training to the artisan population. His main object in doing this, he said, was because he was confident that ninety-nine educationists out of one hundred had but little idea what the state had been doing for the past fifty years. He knew of some people connected with secondary schools who were, until recently, actually ignorant that financial assistance was offered them by the state.

Captain E. W. Creak, F. R. S., in his address to the geographical section, taking a somewhat different course to that usually followed by earlier presidents of that section, brought to the notice of his audience the subject of terrestrial magnetism in its relation to geography, in order to show that much could be done by the traveler on land and the seaman at sea in helping to fathom the mysteries connected with the behavior of the freely suspended magnetic needle, as it was carried about over the great needle, the earth, by observations in different regions. It was known, he said, that the normal distribution of the earth's magnetism for any epoch was in many localities seriously affected accordingly as the nature of the country surveyed be mountainous, or generally a plain, in the form of islands (or mountains standing out of the sea), and from land under the sea. There was also reason to suspect that the magnetism of that portion of the earth covered by the ocean differed in intensity from that portion of the dry land. A connection between the disturbances of the earth's crust in earthquakes and disturbances of the magnetic needle also seemed to exist, although the evidence on this point was not conclusive. The discourse then went on to treat of magnetic surveys, the magnetic poles of the earth, local magnetic disturbances and terrestrial magnetism and geology. The hope was entertained that geographers would become more interested in a subject so important to pure science, and in its practical applications, and that it would become an additional subject to the instruction which travelers could now obtain under the auspices of the Royal Geographical Society in geology, botany, zoology, meteorology and surveying. There was a wide field open to magnetic observers, and where results often depended so much upon locality, it was necessary that more and more exploration should be made with the magnetic needle. To look over the great oceans and think how little was being done for terrestrial magnetism was a matter for great regret. Yet even here we could be hopeful, for the United States Coast and Geodetic Survey authorities were making arrangements to fit out its vessels with the necessary instruments for determining the magnetic elements at sea.

Another paper read before the engineering section G was one by Mr. F. B. Behr, the expert in high-speed mono-rail railways. He said he had not been able to effect an alteration in his plans which would be a distinct improvement and add a great deal to the comfort and safety of passengers. The great opposition to his invention up to the present had been that the guide wheels which went in the curve had necessarily to go with the bogey and therefore could not get a fair contact with the rails on that side. Needless to say, he did not agree with this any more than he did with the argument that the centrifugal force developed when traveling at 110 miles an hour was too enormous for comfortable traveling. But seeing danger in all this opposition he had set to work to dispose of it. The result was that the pressure produced on the inside of the curve, which required a certain amount of electrical force to overcome it, had been very largely diminished and the carriage could be inclined to any angle with absolute safety.

The report of the committee on electrical standards concluded as follows:

(1) The original British Association unit and the standard ohm based on it could be recovered from the wire coils of the association; (2) the Board of Trade unit was now less than the laboratory unit by 0.006 per cent; (3) the laboratory unit was less than the international ohm by 0.009 per cent; (4) the Board of Trade unit was less than the international ohm by 0.015 per cent; (5) the mercury tubes made at the National Physical Laboratory to represent the international ohm were less than those made at Reichsanstadt by 0.0015 per cent.

Before the engineering section on Tuesday, September 15, a paper by Mr. W. F. Goodrich dealt with the question of refuse disposal which is being largely entertained in connection with electric lighting in the country. He did not commend the American system of "cooking" and chemically treating the garbage, as this still left the bulk of the waste to be disposed of. The real improvement during the past twenty-five years had been the introduction of consumption by fire at high temperature, a system which rendered nuisance impossible besides showing the value of the destructor as a power producer in combination with electricity works. Twenty-five years ago only twelve destructor cells were in use, to-day there were 1,650 in 180 towns. On the continent and the colonies large British destructors were being constructed, and he thought that Great Britain would be preeminent in this branch of engineering for many years to come.

A large number of papers were of such a character that no useful abstract could be prepared for such a report as this, and could only be valuable when printed in full. As usual the full importance and benefit of papers read will take time to manifest themselves, as in many instances copies of the full papers were not available, and I believe, no official verbatim report is published by the association. At present, however, the two great outstanding subjects are technical education and radium, the amount of time devoted to these two matters being far greater than any of the others. A. W.

London, September 26.

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THE PARALLEL WORKING OF ALTERNATORS.[1]

BY B. HOPKINSON.

The question of the parallel working of alternating-current dynamos, under which term may be included the working of synchronous motors and of rotary converters, has been much discussed during the twenty years which have elapsed since it was first shown that it could be done. No very definite result, however, has been arrived at from the theoretical point of view, though engineers have evolved various empirical rules of design, and have produced the well-known "amortisseurs," in consequence of which the difficulties of parallel running have ceased to be serious, and the theoretical problem has lost much of its importance. Of late, however, a new interest has been given to the discussion of this question by the introduction of large gas engines, with which it is more difficult than with steam to satisfy the requirements of the dynamo designers as to the uniformity of angular velocity necessary for satisfactory running. In this paper I do not propose to add much new matter to the discussion, but rather to attempt to coordinate the mathematical treatment of the subject with the practical rules which have been framed, and which are now regarded as good standard practice, and to point out the reason for certain phenomena which have been observed. It would appear that hitherto the mathematical treatment of the subject has been carried out without sufficient reference to practical conditions, and on the other hand it is possible that the empirical rules of practical engineers, though their success is a sufficient guarantee of their correctness under the conditions to which they have been applied, may not be fully applicable without modification to the new conditions which have followed the introduction of the new types of prime mover.

Dynamically, the question of the parallel working of alternators, or the running of a synchronous motor or converter, is a problem of oscillation about a state of steady motion. Consider an alternating dynamo connected to a source of supply of constant amplitude and periodicity, and driven by a constant power or working against a constant resistance. For simplicity of expression we may suppose that the dynamo, and the generators giving the supply, have all the same number of poles. Then the dynamo will run with the same angular velocity as the supply generators, but with a certain difference of phase which we may call a ϵ dependent on its excitation and on its load or driving power. This is the state of steady motion. If that state be disturbed —say by temporarily varying the load on the dynamo if working as a motor—the dynamo will make oscillations about it, sometimes running ahead of and sometimes lagging behind the position of steady motion. When ahead of that position it will take less, and when behind it will take more, than its proper supply of energy from the mains.

The practical problem is to keep these oscillations, with their accompanying fluctuations in the flow of energy to or from the mains or bus-bars, within moderate limits.

The oscillation may be either free or forced. To clear the ideas we may consider the case of a dynamo working as a synchronous motor, but the results are immediately applicable to the case of a generator. Suppose that the load on the motor is slightly increased. The motor will take up a position in which the phase difference between it and the generators is rather greater than before, becoming, say, $\epsilon - \xi$ where ξ is reckoned positive in the direction of motion of the motor. The torque developed by the motor which was T, is now $T - \xi \frac{dT}{d\epsilon}$ or, say, $T - c\,\xi$. The constant c is readily calculable from the electrical constants of the machine. If now the additional bit of load $-c\,\xi$ be removed there will be a balance of torque of that amount available for accelerating the motor, which, accordingly, will proceed to catch up, so to speak, the state of steady motion. After a time it will arrive at the position of steady motion corresponding to torque T (for which, of course, $\xi = 0$), but will then be moving with more than the steady motion velocity. In consequence of the difference of velocity, the motor will not exert quite the steady motion torque T, but there will be a balance of torque tending to accelerate it or retard it. This, if the difference in velocity is small, will be proportional to that difference and equal, say, to $b \frac{d\xi}{dt}$. Adding the effect of this and of the term $c\,\xi$, we find the equation of motion of the motor

$$M \frac{d^2\xi}{dt^2} + b \frac{d\xi}{dt} + c\,\xi = 0,$$

where M represents on a suitable scale its moment of inertia. Under a rigorous mathematical treatment, differential coefficients of higher order will appear, but the terms here given are the most important.

The solution of this differential equation is

$$\xi = \xi_0\, e^{-\frac{b\,t}{2\,M}} \sin(\delta\, t + \eta),$$

where $\frac{2\pi}{\delta}$ is the period of the oscillation and δ is equal to $\sqrt{\frac{c}{M}}$ nearly, if (as is usually the case) b^2 is small compared with $4\,c\,M$.

The oscillations represented by this expression are the free oscillations executed by the dynamo when disturbed by a temporary change of conditions—*e. g.*, if its load be suddenly thrown off, or if, being a generator, it be switched into parallel with its fellows. Dr. Hopkinson showed many years ago that the quantity c is positive—in other words, that if the state of steady motion be disturbed the forces so called into being tend to restore it, or the motion is stable. Since then Kapp and others have worked out the value of c. It is easy to show that, sufficiently nearly for all practical purposes,

$$c = \sqrt{\frac{A^2}{2L}},$$

where $\frac{A\,p}{\sqrt{2}}$ is the open circuit electromotive force of the dynamo ($\sqrt{\text{mean}^2}$) ($2\pi/p$ being the periodic time of the alternations) and L the self-induction of the armature, including therein the armature reaction, and the self-induction of any conductors in series with the armature. Another expression for c, at once deducible from the above, is $c = \sqrt{\frac{E\,i_0}{p}}$, E being the open circuit electromotive force and i_0 the current in the machine when short-circuited and driven at the proper speed.

It is obvious that the importance or otherwise of these free oscillations depends on whether they are damped out or not. It has usually been assumed that b is a positive quantity—*i. e.*, that the oscillations are resisted by a sort of viscous force, and if that is so the oscillations will, of course, rapidly disappear. I have, however, recently shown that under certain circumstances b may be negative, in which case the oscillations will continually increase in amplitude and the running of the dynamo will be unstable, even though b be very small.

Suppose that the dynamo is working as a generator and is driven by a force with a certain periodic variation—*e. g.*, by a reciprocating engine. It is supposed to be coupled in parallel with such a num-

[1] Paper read before the British Association, Southport meeting, September 9 to 15.

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ber of other machines that the bus-bar potential is practically constant. The equation of motion then is

$$M\frac{d^2\xi}{dt^2} + b\frac{d\xi}{dt} + c\xi = P\sin\delta' t,$$

where $2\pi/\delta'$ is the period of the variation in the force. The solution of this equation is (leaving out the free oscillations)

$$\xi = \frac{P}{\sqrt{b^2\delta'^2 + (c - M\delta'^2)^2}}\sin(\delta' t - \eta),$$

where

$$\tan\eta = \frac{b\delta'}{c - M\delta'^2}.$$

I shall presently show that in practical cases $b\delta'$ is small compared to c, so that the equation for ξ is, unless c is nearly equal to $M\delta'^2$,

$$\xi = \frac{P}{c - M\delta'^2}\sin\delta' t,$$

$$= \frac{P}{c\left(1 - \frac{\delta'^2}{\delta^2}\right)}\sin\delta' t,$$

where $2\pi/\delta$ represents, as before, the period of the free oscillations. These are the forced oscillations produced by uneven turning moment in the prime mover. Superposed on them there will be the free oscillations already considered.

The possibility of parallel working, or of the working of a synchronous motor, therefore depends on two conditions. First, the quantity b must be positive, so that any free oscillations are damped out within a short time of being set up. Second, the forced oscillations must be of such moderate amplitude as not to interfere with practical working. I will deal first with the last-named condition, as it admits of much simpler treatment than the other.

For an ideal machine, without any flywheel effect at all, δ is infinite, and we have $\xi = \frac{P}{c}\sin\delta' t$. In this case, the phase displacement is always such as to correspond exactly with the torque exerted by the prime mover. Such a machine would run fairly well in parallel with others, simply delivering to the bus-bars at all times exactly the energy given to it by its engine. But now if a flywheel be added, δ becomes finite, and so long as it remains greater than δ', that is, so long as the natural period of the alternator is less than that of the variation in turning moment—the amplitude of the oscillations becomes greater with increase of flywheel until, when $\delta = \delta'$, there is perfect resonance, and the oscillations are only restrained by the viscous damping. Further increase in the flywheel effect results in a continuous diminution of the oscillations. If δ is so far diminished by increasing the flywheel that δ' is several times as large as δ, the formula for ξ becomes

$$\xi = -\frac{P}{\frac{c\delta'^2}{\delta^2}}\sin\delta' t$$

$$= -\frac{P}{M\delta'^2}\sin\delta' t.$$

Now, the practical rule always adopted by designers for working in parallel is that the angular displacement of the machine in a revolution when running unloaded as compared with a uniformly revolving wheel shall not exceed a certain fraction (varying from one one-hundred and forty to one-seventy) of the angular pitch of the poles. If the machine is unloaded the equation of motion is

$$M\frac{d^2\xi}{dt^2} P\sin\delta' t,$$

or

$$\xi = -\frac{P}{M\delta'^2}\sin\delta' t.$$

ξ is the phase-angle of displacement measured in such units that the angle between a pair of adjacent poles (or pitch-angle) is π. The practical rule, therefore, directly limits the angular amount of the forced oscillations, provided that δ' is large compared with δ, or that the natural period of oscillation of the alternator is large compared with the period of variation in turning moment.

Limitation of the angle by which the machine deviates from perfectly uniform rotation is not, however, precisely what is needed. What should be limited is rather the amount of the fluctuation in the rate at which energy is delivered by the machine to the bus-bars. This, since the speed is practically constant, is proportional to the variation of torque—that is, to $c\xi$. Now, c is equal to $\sqrt{\frac{A^2}{2L}}$, and depends upon the electrical properties of the machine. Hence a machine with small self-induction will operate worse in parallel under a given amount of angular displacement than will another of large self-induction, always supposing the above-mentioned condition of long natural period to be fulfilled. Here, therefore, is a sufficient explanation of the wide variation in angular deviation permitted by different designers; what suits one machine will not suit another, and a machine with small self-induction and armature reaction, or what is called a machine with good inherent regulation, must be subject to more stringent rules as regards angular deviation than one with large self-induction.

Another cause which makes a fixed rule as to angular deviation inapplicable to all cases, is the fact that in some designs the natural period of oscillation may not be long, compared with the period of the engine impulses. Should these two periods become even approximately equal—if, for example, δ were anywhere within twenty per cent of δ', then the rule quite ceases to be applicable, and the amount of angular deviation in actual working as a generator bears no fixed relation to, but is much greater than, the same deviation when unloaded. As a matter of fact, in machines as now designed, in which the self-induction and armature reaction are usually sufficient to allow the machine to be short-circuited when partially excited without damage, the natural period of oscillation, even without a flywheel, is usually greater than the period of engine impulse. The latter period, even in a slow-speed engine, will not, as a rule, exceed one-third of a second, while the natural period will be found to be of the order of half a second or more, and very much greater with a heavy flywheel. Probably, therefore, a designer will generally be justified in assuming that the two periods are sufficiently different to ensure that he will get about the same angular deviation when delivering energy to the bus-bars as when the machine is running disconnected. He will, however, have to take account of the change in the rate of flow of energy to which that deviation corresponds on his particular machine, and it is in neglecting that factor that the practical rule seems to be illogical.

We have, so far, considered that particular component of variation in turning moment which is responsible for the major part of the phase displacement when the machine is running disconnected, and which is, accordingly, alone regarded in the practical rule for flywheel effect. That, however, is not in fact the only component of the variations; there will be other components of both longer and shorter period. Take for example the case of a single-cylinder double-acting Körting gas engine running at ninety revolutions. The principal variation in turning moment, and the only one producing any appreciable effect on the phase displacement when running light, will be due to the explosions, and will have a period of one-third of a second. As stated above, the natural period of oscillation of the alternator will probably be much greater than this. But there will also be a variation in turning moment due to the weight of the crank,

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with a period the same as that of the revolution of the engine, or two-thirds of a second. Now it is not impossible, with a light flywheel, for the period of oscillation of the alternator to have that value, and if that were so violent hunting would be set up, even though the variation in turning moment due to this cause were too small to produce an appreciable effect on the phase displacement when running light. Only, in this case of a small disturbing force, the approximation of periods must be fairly close to produce serious effects. The ordinary rules as to flywheel effect generally result in the natural period of oscillation being substantially greater than the period of revolution of the engine, but in a somewhat roundabout and accidental way. It seems highly desirable on many grounds to pay more attention than has hitherto been usual to the natural period of oscillation of the alternator when specifying flywheels. The period of oscillation of the governor of the engine should not be lost sight of; this is generally fairly long, and may not impossibly give rise to resonant oscillations.

So far, we have considered the forced oscillations caused by the uneven turning moment of the prime mover in a generator working in parallel with a number of others. A very similar, and equally important problem is that of a synchronous motor or rotary driven from mains in which the potential varies periodically owing to unevenness of rotation in the supply generators. Here, if the motor or rotary had no flywheel effect at all, it would follow the generators precisely in their oscillations, and it is easy to see that if ξ_0 be the maximum phase displacement in the generators and ξ_0' that in the rotary, then

$$\xi_0' = \xi_0 \Big/ \left(1 - \frac{\delta'^2}{\delta^2}\right),$$

where $2\pi/\delta'$ is the period of the variation in the generator, and $2\pi/\delta$ the natural period of oscillation of the rotary. In the case of a rotary, however, it is unusual to have any flywheel, and consequently δ, though usually less than δ', may be sufficiently near it to cause the oscillations of the rotary to exceed in amplitude those of the generator. Furthermore, the danger of actual resonance with the revolution of the engine is in this case very much greater. I came across a case recently of a motor-generator which could not be worked owing to resonance. Its natural period happened to be very nearly equal to that of the revolution of the generator—about two-thirds of a second—and it dropped out of step in a very short time, though the variation of turning moment of the period in question must have been quite small. By altering the field current so as to increase the natural period about twenty-five per cent the forced oscillations disappeared almost completely, showing that the difficulty was entirely due to resonance. This suggests the reflection that it might possibly be better in some cases to put flywheels on the comparatively high-speed rotaries, and allow a small flywheel and a bigger angular deviation in the slow-speed generators.

The question of free oscillations is a very much more complicated and difficult one than that of forced oscillations. The period is, of course, easily determined, but, as already indicated, the importance or otherwise of these oscillations depends almost entirely on the way in which they are damped, or on the sign of the quantity b. If b be positive, the oscillations are damped out and are unimportant. On the other hand, if b be negative, even though very small, the oscillations will continually increase according to an exponential law, and the running of the machine will be impossible as a practical thing. The stability or otherwise, therefore, depends in this case on the sign of a small quantity and may be affected by a very small change in the conditions. I have recently investigated this question, and I have shown that under certain circumstances[1] b may be negative. I will not reproduce the mathematics here, but will merely give the conclusions.

Consider an ideal synchronous motor in which the exciting current is maintained absolutely constant, while the field magnets and the armature core and conductors are so perfectly laminated that no appreciable eddy currents flow therein. I find that the motion of such a motor is unstable or b is negative, provided that $L\,p > \rho$. Here ρ is the resistance and $L\,p$ is the reactance of the armature and any conductors in series with it. The actual value of b I find to be

$$-\frac{1}{2}\,\rho\,A^2\,\frac{L^2\,p^2 - \rho^2}{(L^2\,p^2 + \rho^2)^2}.$$

The condition $L\,p > \rho$ is generally fulfilled, so that an ideal motor such as that described is in general unstable, and all motors have this element of instability. In actual machines, however, there are a number of causes which give rise to real viscous forces, and generally overcome this tendency to instability. Such are the local currents induced in the substance of the armature conductors, and (generally but not always) the "amortisseur" effect of currents induced by the oscillations in the pole-pieces, the field coils, and in any special "amortisseur" coils put there for the purpose. It will be found, on working out the value of b that in machines of modern design and any considerable size, it is insignificant under ordinary conditions of working. In small machines, however, and in large ones on long transmission lines it may be important. I have myself experimented with a small motor, the running of which was actually unstable from this cause.

Of the causes mentioned above as making for stability by producing a viscous damping effect, the most important is that described as giving rise to "amortisseur" action. Consider an ideal motor of the type described in the last paragraph coupled to mains giving constant alternating potential moving steadily and doing external work. For simplicity we may suppose the open-circuit potential of the motor to be equal to that of the mains. The effect of the armature current on the field will be to decrease the induction in the field magnets somewhat and also to distort it, so that the point of maximum induction and zero back electromotive force is displaced backward against the direction of rotation. Suppose, now, that the motor executes oscillations about the position of steady motion. Then the field will experience variations of like period both as regards its magnitude and its distortion. To put the matter in symbols, suppose that $A \cos\theta$ is the induction linked with armature and field coils in the steady motion (θ being an angle defining the position of the armature). Then in the oscillation which is given by $\xi = \xi_0 \sin \delta\, t$ the induction will be $(A + a_0' \sin \delta\, t) \cos\theta + b_0' \sin \delta\, t \sin\theta$, the quantities a_0' and b_0' being positive, since when ξ is positive there is a greater total induction and a less displacement of point of maximum induction than when ξ is zero.

Now suppose that the pole-pieces are surrounded by short-circuited copper conductors, and that the pole-faces are covered with copper plates, or have copper conductors threaded through them to form a grid. Then the changes of magnetizing force due to the armature current will cause induced currents to flow in these conductors, and the general effect of the currents will be to somewhat reduce the amplitude of the changes of induction in the pole-pieces, and to cause them to lag rather behind the changes in armature reaction which give rise to them.

[1] Paper read before the Royal Society, June 18, 1903. See the *Electrician* (London), August 7, 1903.

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The consequence is that the induction linked with armature and field coils is now

$$\{A + a_0 \sin ('t - \eta)\} \cos \theta + b_0 \sin (\delta t - \zeta) \sin \theta,$$

where a_0 b_0 are (for the motor) positive quantities less than a_0' and b_0' respectively, and η ζ are positive angles which depend upon the resistance of the "amortisseur" conductors and on the armature reaction. Thus, at the time when the armature is passing the position of steady motion ($\xi = 0$), but moving with more than the steady motion velocity, the induction, instead of having its normal value A cos θ, has the value (A — a_0 sin η) cos θ — b_0 sin ζ sin θ. In other words, the currents then circulating in the "amortisseur" coils are such as to reduce the magnetization somewhat and to displace the point of maximum induction or zero open-circuit electromotive force rather behind the position which it would occupy in ordinary steady motion. We have now to consider the effect of these changes in the induction on the torque at this moment, since it is the then deviation of the torque from its steady value that determines the value of b.

First, as regards the demagnetization. due to diminution of current in the field coils or to currents in short-circuited windings surrounding the pole-pieces. It is easy to show that the effect of reducing the field current in a synchronous motor may be either to increase or diminish the torque—it depends on the load on the motor. Let β_0 be that component of the current which is in phase with the back electromotive force, and Ap the back electromotive force of the motor, so that the rate of working of the motor is $\frac{1}{2}$ A p β_0. Then a reduction in the field current will result in a reduced torque provided that

$$\beta_0 > \frac{A\, p\, \rho}{L^2 p^2 + \rho^2},$$

where, as before, ρ is the resistance, and L p the reactance of the armature and any conductors in series with it. Similar considerations apply when the dynamo is working as a generator, only in this case the effect of the induced currents when $\xi = 0$ is to increase the magnetization while the sign of β_0 is changed. The general result is that if β_0 be outside the limits $\pm \frac{A\, p\, \rho}{L^2 p^2 + \rho^2}$ the induced currents tend to damp out the oscillations. On the other hand, if β_0 be within these limits, the induced currents tend to increase the oscillations, and under such circumstances damping coils surrounding the pole-pieces are additional causes of instability. In the case of a machine connected direct to bus-bars in parallel with others, these limits for β_0 are very narrow; but in motors or converters on long transmission lines they may be so far apart as to give rise to instability at light loads. There is little doubt that trouble has been experienced from this cause. It was one reason for the instability of the small motor to which I have referred, and the constants of that motor might easily be repeated on a much larger machine if there were considerable self-induction and resistance in circuit with it.

We may now consider shortly the damping effect of solid pole-pieces, copper plates over the pole-faces, or copper bars threaded through the pole-face to form a grid. As already pointed out, the effect of the currents in such conducting bodies at the moment when the motor is in the position of steady motion, but moving with more than the steady motion velocity, is to so distort the field as to move the position of maximum induction somewhat behind that which it occupies in steady motion. This is in effect the same as reducing the phase difference between motor and generators, and it therefore in all cases results in a reduction of the torque of the motor as compared with the normal steady motion torque, or on the balance in retardation of the motor. Hence damping coils of this kind invariably exert a true damping or viscous effect. Moreover, I have worked out the amount of the effect, and find that it is much greater than that due to the variation of current round the pole-pieces. It is these conductors across the face of the pole-pieces that are the really useful "amortisseurs," and by their use it would seem that b can always be made positive and the motion stable.

I do not propose here to go into the actual value of the damping effect produced by these "amortisseur" coils. It has been worked out and the results will shortly be published. One thing, however, may be noted here, and that is, that as the resistance of the coils is diminished, the effect increases to a maximum and then diminishes. It is obvious that if the pole-pieces were surrounded by perfectly conducting coils and faced with perfectly conducting plates there could be no changes of induction produced by an oscillation about steady motion, and, therefore, no damping effect. The point is that the coils diminish the amplitude of the changes of induction produced by armature reaction approximately in proportion to their conductivity, and at the same time give rise to a difference of phase between those changes and their cause. The amount of damping effect is proportional to the amplitude of the changes and to the phase difference. It is therefore possible to increase the conductivity of the coils too far—that is, to such an extent that the diminished amplitude more than compensates the increased phase-difference. Whether this happens in practice I am not prepared to say, as it depends on many elements, such as the period of oscillation, amount of armature reaction, etc., but I am clear that it is not impossible with constants such as one meets with in ordinary designs.

One other point is of interest in connection with "amortisseur" coils. They have been regarded here as a means of making b positive, or of removing that tendency to instability as regards free oscillations which is inherent in all machines. Of their great value for that purpose there can be no doubt whatever. It has often been suggested that they also play an important part in reducing the forced oscillations which were considered in the first section of this paper. My own belief, however, is that their action in that respect is insignificant. Looking back for a moment to the expression for the forced oscillations, damping being taken into account, we found that it was

$$\xi = \frac{P}{\sqrt{b^2 \delta^2 + (c - M \delta'^2)^2}} \sin (\delta' t - \eta),$$

while the free oscillations were

$$\xi = \xi_0 e^{-\frac{b t}{2 M}} \sin (\delta t + \epsilon).$$

Now, by the courtesy of the Westinghouse company I have been able to observe the free oscillations on a rotary converter fitted with heavy dampers round the poles and across their faces. The design of these coils was the outcome of much experience, and they may probably be taken as giving the most powerful attainable damping effect. I found that if the machine were paralleled when a little out of phase one could hear it make six or eight complete oscillations. There can be no doubt that the ratio of two successive oscillations was much greater than $1/e$. Assuming it to be equal to $1/e$, we readily find that

$$\frac{b}{2M} \cdot \frac{2\pi}{\delta} = 1.$$

Hence in the expression for the forced oscillation

$$b \delta' = \frac{\delta . \delta' M}{\pi}.$$

Now I have already pointed out that the effect of the ordinary flywheel rules is to make δ considerably less than δ'. Hence b^2 δ'^2 is but a very small fraction of M^2 δ'^4, and unless c is nearly equal to M δ'^2—that is unless there be resonance—the forced oscillations are almost unaffected by the damping. If there be resonance we have $\delta' = \delta$ and

$$b \delta' = \frac{M \delta^2}{\pi} = \frac{c}{\pi}.$$

Hence the amplitude of the forced oscillations is

$$\xi = \frac{P}{b \delta} = \frac{P \pi}{c}.$$

In other words, in case of resonance the forced oscillations would be about three times as big with this amount of damping as they would if there were no flywheel effect at all and no damping. It would seem, therefore, that damping coils are not of much use for dealing with cases of resonance; a slight variation of the period is a much better solution. To sum the whole matter up, the proper way to deal with forced oscillations is to use the right flywheel, while damping coils must be used for giving stable free oscillations.

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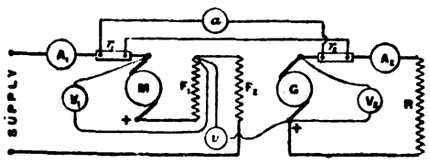
A METHOD FOR FINDING THE EFFICIENCY OF SERIES MOTORS.[1]

BY ERNEST WILSON.

The following method has the advantage of great accuracy, and I have found it work well in practice. The figure gives a diagram of connections, in which M and G are two like machines mechanically coupled together, either through or without gearing, according as it is desired to obtain the efficiency of either machine inclusive or exclusive of gearing. In the test M runs as a motor and delivers its energy to G running as a generator. The field coils, F_1 F_2, are placed in series with one another and with the motor armature in order that each machine may be conveniently magnetized to the same degree in any test. The input of the motor is measured on the voltmeter V_1 and ammeter A_1. The generator is loaded on a resistance R, and its output measured on voltmeter V_2 and the ammeter A_2. Let R_1 and R_2 be the ohmic resistances of the motor and generator armatures, respectively, then $V_1A_1 - V_2A_2 = X$ are the total watts dissipated in the system, ex-



METHOD FOR FINDING THE EFFICIENCY OF SERIES MOTORS.

clusive of the generator field coil F_2. Of these $A_1^2(F_1 + R_1) + A_2^2R_2 = Y$ are the ohmic resistance losses in watts, and $X - Y$ are the watts due to brush, bearing and wind friction, eddy currents and magnetic hysteresis. The machines are equal, and rotate at the same speed. $\frac{X-Y}{2}$ are the watts which can be debited to each machine when calculating efficiency, it being assumed that the brush contact resistance has the same value as when measured with the machines at rest, and that armature reaction does not produce inequality in the watts dissipated by eddy currents and magnetic hysteresis in the two machines. The expressions for the efficiencies are, for the motor, $\frac{X-Y}{2} + V_2A_2 + A_2^2R_2/V_1A_1$, and, for the generator, $V_2A_2\Big/\frac{X-Y}{2} + A_2^2R_2 + A_1^2F_2 + V_2A_2$. The above, so far, is a well-known method, and has been described by Mr. Field. The extension here described consists in the addition of two low-resistance shunts r_1 r_2, a milli-voltmeter a, and a voltmeter v. By these instruments the differences $A_1 - A_2$ and $V_1 - V_2$ have been measured as direct quantities. It is easy to show that greater accuracy can be obtain by measuring A_1 and a and using the value $A_1 - a$ instead of A_2, and measuring V_1 and v and using the value $V_1 - v$ instead of V_2. For instance, let $V_1 = 500$, $A_1 = 50$, $V_2 = 450$, $A_2 = 42$, $R_1 = R_2 = F_1 = F_2 = 0.5$ ohm, and let there be a liability for error of one per cent in reading instruments. Then the possible error in the value of $X - Y$, when V_1V_2 A_1A_2 are the measured quantities, is 31.9 per cent, whereas it is 1.9 per cent when V_1 v A_1 a are the measured quantities.

[1] Paper read at the British Association, Southport, 1903.

Annual Meeting of the Indiana Electrical Association.

At a recent annual meeting of the Indiana Electrical Association, the name of the association was changed to the Indiana Public Utilities Association. The by-laws were so changed as to make engineers connected with electrical apparatus in any branch, and agents covering Indiana territory for factories located outside of the state, eligible for membership. An initiation fee of three dollars is charged for membership, and the dues are two dollars per annum.

The new officers elected, together with the committees appointed, are as follows:

President, J. H. Harding, Laporte Electric Company; vice-president, H. D. Haring, Western Electric Company, Indianapolis; secretary-treasurer, A. M. Barron, consulting engineer, Indianapolis.

Executive committee—S. E. Gard, superintendent Citizens' Electric Company, Richmond; H. A. Smith, General Electric Company, Indianapolis; H. E. Wells, Buckeye Electric Company, Indianapolis; Carl Seaman, superintendent Citizens' Electric Company, Winchester; E. M. Sherburn, superintendent light and water plants, Knightstown.

Finance committee—H. C. Kimbrough, American District Steam Company, Muncie; H. D. Schrantz, Westinghouse Electric Company, Indianapolis; I. J. Bell, superintendent electric light company, Bedford; C. D. Boyd, General Electric Company, Indianapolis; John G. Bryson, electric light plant, Brazil.

By-laws committee—A. M. Barron, Indianapolis; T. C. McReynolds, Kokomo; J. H. Harding, Laporte.

The office of the secretary of the association is in suite 5, 120 North Pennsylvania street, Indianapolis.

Breakdowns of Electrical Machinery.

The annual report of Mr. Michael Longridge, chief engineer of the Engine, Boiler and Employers' Liability Insurance Company, of London, England, gives some interesting particulars of the nature of the breakdowns occurring to electrical machinery. This company has adopted a system of periodical independent supervision and inspection, and in this way, besides keeping a record of the most usual breakdowns, makes note of many unusual accidents which would not otherwise be reported.

In this report mention is made of a dynamo which was wrecked by a wood screw one inch long that got between one of the magnet poles and the armature. In another case a small screw-driver was plucked out of the hands of an employé as he was passing a machine, was drawn against the armature, and short-circuited it. A two-pole series motor driving a centrifugal pump ran away one afternoon, most likely owing to the pump losing its water. The armature conductors were forced out of the slots in the core by centrifugal force, and the armature jammed so tightly between the pole-pieces that it could only be got out by driving out the spindle with a sledge hammer and prying out the core-plates a few at a time. The armature of a small shunt-wound dynamo, used for charging a storage battery, was short-circuited by failure of the insulation. The dynamo stood close to a door leading to the battery room, and the fumes from the battery destroyed a cotton covering of the conductors. A motor was short-circuited due to the disintegration of the insulating cardboard disc which was used to cover the end of the core. This had been three-sixteenths inch thick, but crumbled away and allowed the core-plates to get loose and cut through the insulation of the conductors. The shaft of a two-horse-power enclosed-type motor, three and one-half years old, running at 1,800 revolutions, broke. On examination it was found that a deep V-groove had been worn in the shaft by the brass oiling ring.

In addition to these exceptional cases, breakdowns were reported from more frequently noted causes and from defective or incorrect wiring.

World's Fair and the Technical Press.

The interest which the electrical department of the Louisiana Purchase Exposition has awakened among the electricians of Europe, is well attested by the attention paid to it during the last three months, by the leading technical publications from Norway to the Mediterranean. All the magazines and other periodicals devoted to electric industries have presented pictures of the Electricity Palace and the Machinery Palace and have commented approvingly on the details of the great preparations made for an unprecedented display of electric exhibits at St. Louis.

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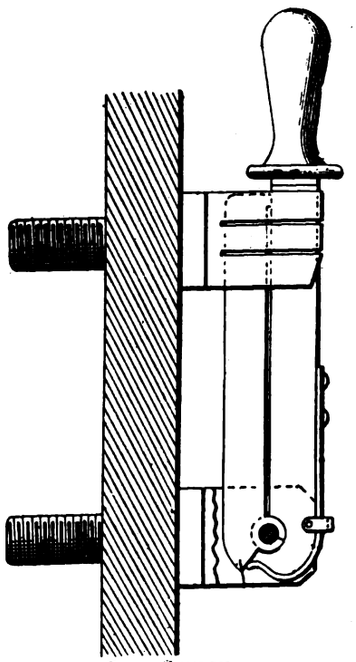
Electrical Patents.

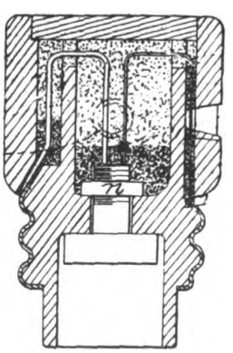
The General Electric Company is the assignee of a new snap switch invented by Robert H. Read, of Schenectady, N. Y. Heretofore switches of this type have been made with two movable members or plates pivoted on a common axis and connected by a spring in such a manner that when one member is moved it puts a tension on the spring, so that presently either by the increased spring tension or



Snap Switch.

by abutting stops on the two members, the second member is forced out of the clip, whereupon the recoil of the spring breaks the circuit so quickly that no arc of any consequence can form. In this kind of switch the tension of the spring increases regularly from the time the first member is started out of the clip until the second member begins to move. It is not really necessary to put the spring under tension, at least, to any effective degree, until after the first member has cleared the clip. The patented construction, therefore, comprises a switch having a plurality of blades connected by a spring, the spring being such that one blade can have a certain amount of free or but slightly restrained angular movement before the spring is put under any appreciable tension. The hinge and contact clips are of ordinary construction and the switch preferably comprises two plates mounted on the same pin in the hinge-clip, and both closing into the jaws of the contact clip. On one of the blades is secured a leaf spring, whose free end extends adjacent to a lug or shoulder on the other blade. In one form of the invention the spring does not touch the lug when both blades are closed and in another form shown in the patent the spring does touch the lug, but is not normally under effective tension. In the first case, the outer blade can be swung out of the contact clip before the spring strikes the lug, after which by the continued movement of the blade the spring gradually stores tension until it is strong enough to snap the inner blade out of the clip. In the second form the tension of the spring increases but slightly, when the outer blade is swung out of the clip, but at this point the spring seats against a stop such as a stirrup carried by the outer blade and its effective length is therefore so much shortened that its tension rapidly increases and soon snaps the inner blade out of the clip.

A patent recently issued and assigned to the Siemens & Halske Electric Company, of Chicago, Ill., is the thermal fuse for electric circuits and is invented by Rudolph Hundhausen, residing in Germany. The inventor explains that it has been customary in employing electric fuses, especially in connection with high-potential circuits, to enclose the terminal portions of the fuse wires in cement, gypsum, or some other self-hardening insulating material, leaving the remainder of the wire exposed. Upon a rupture of a fuse, due to an overload or short-circuit, explosions frequently occur which scatter fine metallic particles and result in flames, which tend to maintain a short-circuit between the terminals of the



Thermal Cutout or Fuse for Electric Circuit.

looped fuse, and which may short-circuit adjacent conductors. In order to decrease the force of the explosion and the consequent danger, the patented construction embraces a fuse plug having concentric terminals, and so constructed that upon a rupture of the fuse the talc or talcum powder, surrounding the ruptured portion of the fuse wire, will readily absorb the gases and metallic vapors resulting from the melting of the fuses. The plug comprises a hollow cylinder having an exterior metallic terminal threaded thereon and a centre metallic terminal located in a recess formed in the inner end thereof, the main fuse wire and the supplemental or indicator fuse wire being extended through the plug. One end of the main fuse is soldered to the exterior terminal, while its other end is soldered to a threaded extension of the central terminal. This threaded extension of the central terminal is passed through the bottom of the shell and is secured in place by suitable means? Both fuses are preferably looped with suitable division walls interposed, and the terminal parts of said fuses are preferably embedded in gypsum or any suitable cement, while their middle portions are embedded in talcum powder or other suitable material capable of absorbing the metallic vapor when the fuses are blown. The partition walls serve to reenforce the powder and to prevent the vapor from passing from one end of each fuse to the other. The wall of the casing is reduced in strength and thickness at one or more places, so that the shell will not be ruptured except at such places when an explosion follows the blowing of the fuses. The supplemental fuse is so constructed that it can not possibly burn before or at the same time the main fuse is blown. This result is accomplished by so constructing the supplemental fuse that an abnormal flow of current in the protected circuit that would cause a rupture of the main fuse when divided between the same and the supplemental fuse would not cause a rupture of the supplemental fuse if the path closed by the main fuse were left intact, or, in other words, the same proportion of this abnormal current initially flowing through the supplemental fuse would not in itself be sufficient to burn the same, so that the supplemental fuse can not possibly burn until the main fuse is blown. The supplemental fuse is designed to serve as an indicating means, whereby the working condition of the main fuse may be determined, and in order to permit the supplemental fuse to be observed, the same is preferably located opposite an opening in the wall of the fuse casing, a small portion of the gypsum or cement being removed from the space between the supplemental fuse and the opening.

A patent just issued to Ludwig Gutmann, of Peoria, and Robert C. Lanphier, of Springfield, Ill., and assigned by them to Sangamo Electric Company, a corporation of Illinois, discloses several important features in electric meters of that type, wherein an armature in the form of a disc or plate of copper is contained in a sealed chamber, and rotates in a gap

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in a magnetic circuit, the current being conveyed to the disc or plate by means of a conducting liquid, as, for instance, mercury, in which the disc is immersed. The patented features relate particularly to means for transferring motion from the armature to external devices, such, for instance, as an indicating or recording device when the instrument is used as a meter or gauge of electrical energy. This feature of the invention includes novel means for converting the rotary movement of the armature into an oscillatory

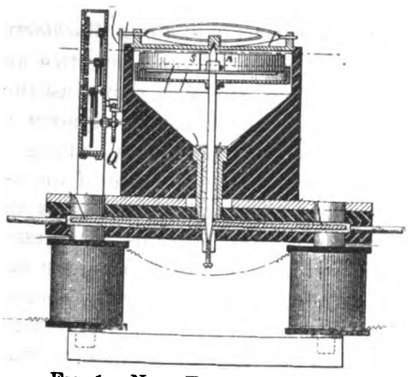

FIG. 1.—NEW FORM OF METER.

movement of the externally operated device, this end being attained by producing a magnetic field rotating synchronously with the enclosed armature and means for causing said magnetic field at opposite sides of its path of rotation to operate upon the oscillatory external armature. Another of the emphasized features relates to means for shielding the magnet of the external device from the magnetic lines of force in the field magnet of the motor portion of the meter. Within a shallow circular chamber of a circular

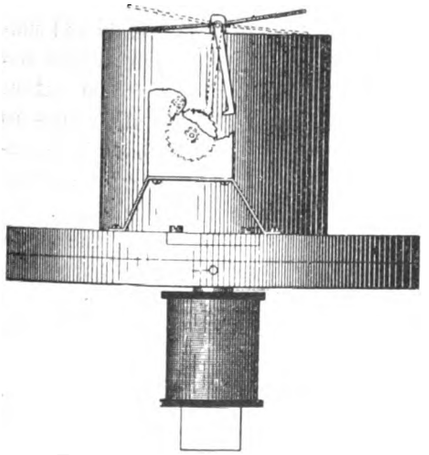

FIG. 2.—NEW FORM OF METER.

casing lined with insulation rotates a copper disc constituting the armature of the motor portion of the device. This armature is mounted on a shaft having a lower bearing in the bottom of the casing and an upper bearing in the cover or head set into the upper end of a hollow block, which encloses the rotating parts of the instrument. This block is of insulation and has a restricted shaft-opening, into which rises the mercury from the armature chamber. It is alleged that this arrangement serves to remove the weight of the rotating element from the lower bearing and to allow free rotation without friction. The field magnet of the motor has its poles embedded in the lower wall of the casing in a manner to make a fluid-tight joint and to be in close proximity to the armature at diametrically opposite points of the edge thereof. Electrical terminals make connection with the body of mercury in which the armature rotates, and the current passes from one to the other, the circuit including the mercury and disc in series. An iron plate is embedded in the top of the casing and has projections which extend down into close proximity to the upper face of the disc immediately opposite the poles of the field magnet, so that the disc or armature will rotate in narrow gaps, through which the magnetic flux of the single magnetic circuit passes from one pole of the field magnet to and through the iron plate and back to the opposite pole of the magnet. This plate also serves to cut off the magnetic lines of the field magnet from certain other parts, particularly a second magnet, designed to assist in the operation of the external device. At the upper end of the shaft carrying the armature is secured an actuating magnet in the form of a ring, whose continuity is interrupted by a narrow gap defining spaced poles, the magnetic flux between which serves to create the magnet field by the rotation of which the external armature is actuated. This ring or magnet rotates immediately beneath the cover of the casing and above said cover is mounted one or more oscillatory armatures, which, together with the operating magnet, are shielded from the magnetic field of the motor by an iron or other magnetic shield fastened to the shaft. A complete rotation of the magnetic field at the top of the shaft will cause a complete oscillatory movement of the oscillatory armature. From this armature motion is communicated to a register-train by means of a lever fastened thereto and carrying at its lower end a pawl operating upon the prime wheel of the register mechanism in an obvious manner.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

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Edwin Wilson Babcock, Brooklyn, N. Y.
Charles Edward Barry, Schenectady, N. Y.
Henry Field Blackwell, New York city.
Zolly Masby Bowden, Schenectady, N. Y.
Daniel Henry Brierley, Laurel Springs, N. J.
Irving Emerson Brooks, Chicago, Ill.
Frank Zenas Brown, Richmond, Va.
Garry Estep Brown, Niagara Falls, N. Y.
Richard C. M. Calvert, Champion Reefs, Mysore State, India.
William Henry Carlin, Johannesburg, S. A.
M. Cheever, Niagara Falls Centre, Ontario.
Richard Charles Cliff, Dalston Junction, London, N. Eng.
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Frank Neal Drane, Corsicana, Tex.
Bernard Maurice Dufresne, Pittsburg, Pa.
Charles Keyser Edmunds, Canton, China.
J. Waldron Farley, Pittsburg, Pa.
Ervin Moul Fitz, Columbus, Ohio.
Thomas Joseph Fleming, London, England.
John Tressler Flickinger, Schenectady, N. Y.
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James Ewing Johnston, Denver, Col.
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Sylvester Bedell Way, St. Louis, Mo.
Charles Dietrich Wesselhoeft, Chicago, Ill.
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Ferdinand G. Wiechmann, New York city.
Robert Edward Wylie, Fort Terry, N. Y.
Louis Milton Zapp, Indianapolis, Ind.

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Reviews of Current Engineering and Scientific Literature.

The Boehm Train Lighting System.

In this section of the series of articles on train lighting by Herr R. Goutze, the Boehm system is taken up. In this system a generator is driven from the car axle, so that it is possible to equip each car, though this is not contemplated; rather, it is thought better to install a larger generator on one car which will be sufficient to supply the lights and charge the batteries for a number of cars. The generator is driven from the axle by means of intermediate friction rolls. On the axle is placed a driving wheel, and below it is mounted a generator with a suitable pulley on the shaft. Between the two, and mounted on rocking arms, are two friction rolls, which are pressed in from each side by a spring. The tension of this spring can be altered at will and is regulated by a controlling magnet. The winding of the magnet is connected across the generator terminals. Its pull then varies with the voltage of the system, and as it works in opposition to the spring, the pressure of the two rolls on the driving and driven wheels varies in such a way as to maintain almost constant the speed of the generator and the voltage. The car equipped with the generator has an automatic switch which cuts in and cuts out the generator when the voltage has reached predetermined values. This switch also short-circuits the lamp resistance when the generator is disconnected. The other cars are equipped with a battery and an automatic switch which short-circuits the lamp resistance while the batteries are being charged. The batteries consist of sixteen cells with a capacity of thirty ampere-hours at a three-hour discharge. The generator has an output of two kilowatts and a terminal voltage of forty. It runs at 600 revolutions per minute. The system is used to some extent in Germany.—*Translated and abstracted from the Centrallblatt für Accumulatoren Elementen und Accumobilen Kunde (Gross-Lichterfelde-West), September* 15.

Transmission of Energy to the Sugar Refinery at Cambrai, France.

This is a serial by M. E. J. Brunswick. The author first discusses the general conditions at this plant, which has been using a direct-current system since 1892, but recently it became necessary to add to the electrical plant. The operation of some of the motors in this refinery, which drive the centrifugal drying machines, is peculiar, and it was necessary to study carefully the relative advantages of direct and alternating currents for this work. These machines start and stop very frequently during the day. They are heavy and revolve at a high speed, and the least possible time must be consumed in bringing them up to speed. They must also be stopped quickly, and if accomplished by mechanical brakes, this entails a considerable loss of energy. At first the use of series and compound motors for driving these machines was suggested, as these two motors have a good starting torque; but while the torque at the moment of starting is good, it falls off rapidly as the machine nears its normal speed, which in this case is 1,000 revolutions. This characteristic is undesirable, because the energy required to raise the speed from 900 to 1,000 is far greater than that required to raise the speed from 100 to 200, the kinetic energy being proportional to the square of the speed. These conditions led to the selection of polyphase inductions motors of a peculiar construction, and operated in a particular way. An experimental unit was designed and set up by M. Boucherot at his factory, and from the data secured, motors were designed which require from sixty to seventy-five seconds for starting, run at full speed about fifteen seconds, and require fifteen seconds for braking. The diameter of the centrifugal is 1.25 metres and the kinetic energy at full speed is 110,000 kilogramme-metres. The machines are started 250 times a day. About ten seconds is required for charging the centrifugal and fifteen seconds for emptying it. These motors have a double winding on the rotor; one but slightly embedded in the surface of the core, the other deeply embedded. The outer has a high resistance, and the inner a high inductance. The effect of these two windings is to give the motor a flat torque characteristic. In addition, the motor is started on three frequencies—twenty-one, thirty-five and fifty cycles per second, respectively. In this way the starting current is kept within limits, the loss of energy in starting is reduced from what it would be with a higher frequency, and braking is effected by throwing the motor, when running at full speed, first on the circuit having a frequency of thirty-five and then to the lower one. The machine is thus brought to rest quickly, and energy which would otherwise be lost in mechanical braking is returned to the circuit. The other appliances of the installation are also described in detail.—*Translated and abstracted from l'Electricien (Paris), August* 8 *and* 22, *and September* 5 *and* 19.

Motive Power for Coal-Cutting Machinery.

In a full report of the committee appointed by the North of England Institute of Mining and Mechanical Engineers to examine into mechanical coal-cutting is given an interesting discussion of the use of compressed air and electricity as the motive powers. As regards compressed air, there have been improvements in machinery, by means of which the output has been increased and the supply regulated This power is comparatively simple when placed in the hands of any experienced workman. It is readily adaptable to all power purposes and comparatively free from injury to the machines worked by it in wet or damp pits. On the other hand, the greater efficiency of electricity and the simplicity and low cost at which it can be conveyed from the surface to the face, have led to its increased introduction for power purposes. For coal-cutting its use is extending rapidly. The conditions under which electric cutters operate are peculiarly severe. There is heavy vibration and the load changes greatly and suddenly. The presence of iron pyrites and ironstone-nodules in the stratum cut at times blocks the machinery and causes an increased rush of current which, if it continues for more than a few minutes, may cause overheating and a breakdown. To avoid this the close attention and ready judgment of the man in charge are needed. Bar and chain machines are not likely to become jammed. They consume less power and therefore are not so liable to break down in this way. It is wiser not to let an electric coal-cutter run continuously for a long time, as the temperature rise may cause trouble. Three-phase induction motors have been applied successfully to both the disc and bar types. The difficulty of their low starting torque has been overcome by a mechanical contrivance which allows the motor to make a few revolutions before engaging the disc or bar. In one English mine these motors have been used for more than a year. The three-phase motors have one disadvantage over the direct-current motors, in that they are higher and can

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not be used as conveniently in low seams. Electric cutters, owing to the rotary motion in place of the reciprocating, are not subject to such heavy mechanical strains as compressed-air machines. The face connections or trailing cables are handier than compressed-air hose. As regards the capital expenditure, there does not appear to be a large difference between the first cost of a compressed-air and an electrical plant. For deep mines the electrical system is more economical, as it costs less to run cables than pipes.—*Abstracted from the North of England Mining and Mechanical Engineers (Newcastle-upon-Tyne), September.*

The Musical Arc.

This is a communication from Mr. W. Duddell, and draws attention to what the author believes actually determines the pitch of the note in the musical arc. In his original paper an equation was given for the periodic time of the circuit which neglected the resistance, as this was specifically assumed to be negligible. Some misconception has arisen on the subject, as in actual experiment the resistance is not usually sufficiently low to be neglected. Under this condition the complete formula for the periodic time is:

$$T = \frac{2\pi}{\sqrt{\frac{1}{LF} - \frac{R^2}{4L^2}}}$$

The resistance here includes that of the arc itself, and this depends, among other things, on the arc length and the current. Consequently, the pitch of the note will depend on the arc length and the current, unless the term, $R^2/4L^2$, is made negligibly small compared with 1 LF. When small capacities are used the resistance of the oscillatory circuit may be high. Although the pitch of the note depends upon the resistance, the author does not think that this fact may be made use of in measuring the resistance of the arc. He has found by experiment that it is possible, by using sufficiently high-frequency alternating currents, not to alter the conditions of the arc. Then each increase in current is accompanied by an increase in potential difference, but it is impossible for the arc itself to maintain oscillations of this high frequency owing to the fact that then there is no supply of energy to the oscillating circuit. This leads to the important question of obtaining very high-frequency currents by this method. The author has tried this with many conductors, such as gases, vapors, electrolytes and for various kinds of carbon, and has found that ordinary solid carbon can be used to convert direct current into alternating current, giving a frequency of 1,000, but not of 100,000. From these experiments he believes that some of the statements which have been published as to the high frequencies obtained with the carbon arc are erroneous.—*Abstracted from the Electrician (London), September 18.*

Electromechanical Compounding of Generators.

In compounding a generator, regulation may be effected directly or indirectly. In the first method regulation is brought about by a change in that factor which it is desired to have remain constant. Indirect compounding is where regulation is effected through some other factor. A new system of compounding of the second class has been developed by M. J. L. Routin, which is applicable to both direct-current and alternating-current generators. The system is applied to a generator unit by changing the field current of the generator and the steam admission to the engine. To accomplish this a compound solenoid, one winding of which is in series with the generator field and the other with the external load, forms the regulating device. This solenoid acts upon a weighted movable core, the motion of this core changing the resistance in the field circuit and operating a valve in the steam pipe. The windings of the solenoid act in opposition, and under normal conditions the current through the coil in series with the field of the generator exerts a greater influence upon the movable core than the series windings. Supposing the system to be in equilibrium, a change of load causes a greater current to flow through the series winding of the solenoid, thereby decreasing its effective pull upon the core. This allows the latter to descend, reducing the resistance of the field circuit and admitting more steam to the engine. This action goes on until equilibrim is again reached. When the external circuit is open, the solenoid is drawn up completely and steam shut off from the engine. On short-circuiting the abnormal current passing through the series turns of the solenoid overpowers the shunt winding, with the result that the core is again drawn up and the generator shut down. To apply this system to alternators the compound solenoid is replaced by an induction motor, the rotor of which oscillates, but does not revolve. Changes in load on the generator shift the rotor of the regulator through an angle and bring the voltage of the generator to the desired value.—*Translated and abstracted from l'Industrie Electrique (Paris), September 10.*

The Generating Sets for the New Electricity Works of the Manchester Corporation, England.

The city of Manchester is at present equipping several large municipal light and power stations. For one of these stations—that on Stuart street—two vertical, triple-expansion, four-cylinder crank engines are now being installed. These are designed for 190 pounds pressure per square inch at the stop-cock. The steam is to be superheated to a temperature of 500 degrees Fahrenheit, and jet condensers giving a vacuum of twenty-seven inches are being installed. The normal output of each engine is 6,000 indicated-horse-power at seventy-five revolutions, and an emergency output of 6,500 indicated-horse-power for two hours. In running non-condensing the output will be 5,000 indicated-horse-power. The engines were constructed by the Walls End Slipway and Engineering Company. They are mounted on a cast-iron bedplate of box pattern. The corresponding alternator is mounted on independent bedplates with a main bearing on each side. This engine is fitted with two governors driven from the crank shaft through positive gear. One governor controls the speed within two per cent from the mean between no load and full load, with a momentary run up of five per cent when the load is thrown off. Provision is made for adjusting the speed within a range of five per cent up or down by hand. The second governor is provided to prevent excessive speed being attained in case of accident. The flywheel is mounted on the low-pressure end of the crank shaft and is designed to give angular variation in one revolution, not exceeding one in 300. The engine is provided with forced lubrication throughout at a pressure of fifty pounds per square inch, the oil pumps being direct driven from the shaft. Electrically driven oil pumps are provided between the oil separator and the main engine oil tank. Electrically driven barring gear is provided for turning the engine. The guaranteed efficiency is at least ninety-one per cent, and the steam consumption is not to exceed eleven pounds per indicated horse-power-hour, condensing, or eighteen pounds, non-condensing. The generators to be driven by these engines were built in the works of the Allgemeine Electricitäts Gesellschaft, of Berlin, and were described in the ELECTRICAL REVIEW of September 12. —*Abstracted from the Electrical Review (London), September 18.*

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INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

A New Type of Field Regulator.

The Cutler-Hammer Manufacturing Company, of Milwaukee, Wis., has recently placed upon the market a new type of field regulator, an illustration of which is shown herewith. This apparatus is the result of several years of careful study, experiment and test, and it is claimed that in its construction is eliminated various objectionable features which exist to a greater or less extent in some types of field regulators now on the market.

The apparatus consists of a base of insulating material, to which is attached the resistance wire contacts and lever, the whole being carried by a japanned iron casing, which not only gives the instrument a handsome finish, but prevents the possibility of direct contact with the heat-radiating portion of the rheostat. No enamel or similar material is used in the construction, and the resistance material itself can not possibly disintegrate through misuse. It is claimed that grounding is impossible on account of the insulating base, and the compound by which the various current carrying parts are attached thereto is of such nature as to become practically part of the base when the apparatus itself is complete. This substance possesses the qualities of insulation, heat conduction and radiation to a marked degree, and is so little affected by heat that the resistance wire has frequently been run white hot by passing excessive currents through it without in any way causing the compound to deteriorate or separate itself from the base. This ensures the maximum factor of safety for the apparatus, as it makes certain that current will be carried without permanent damage up to the actual burning-out point of the wire itself. The working parts of the apparatus are all amply proportioned for their designed load.

NEW TYPE FIELD OPERATOR.

With these field rheostats for rear of switchboard mounting is furnished a five and one-half-inch hand-wheel, which is made throughout of copper, handsomely polished and lacquered. This new type of hand-wheel is of an entirely novel design. The insulation is of the simplest character, consisting of but a single large piece, and consequently the loosening up of small parts has been entirely done away with.

Test Run of Combination Gasolene-Electric Truck.

In a test run made by one of the Fischer Motor Vehicle Company's five-ton combination gasolene-electric trucks to Morristown, N. J., the following results were obtained:

The truck left the factory at Hoboken at 8.45 A. M. on September 18, running to Jersey City, arriving there at 9.15, where four tons and two hundredweight of sash weights were loaded, the vehicle started on its way to Morristown at 11.05, and arrived there at 6.25 that evening, after having made several stops in the course of the trip, including one hour for dinner. The total time lost on the various stops was one hour and thirty minutes, making the actual running time five hours and fifty minutes. The distance covered was thirty-one and one-half miles, and eighteen gallons of gasolene were consumed.

Taking the total ton-miles traveled for the trip they amount to 129, and with gasolene at twelve and one-quarter cents per gallon—of which eighteen gallons were used—it would figure out one and three-quarter cents per ton-mile for hauling the useful load.

The truck being a five-ton one—if loaded with its maximum—would have used but very little more oil and would have reduced the cost of operating per ton-mile by fully twenty per cent.

In the course of the trip a number of long hills was encountered, one of them being about a mile long, and in some places these hills were very steep, the grades reaching as high as twelve per cent.

The truck left Morristown on September 19 at 8.25 A. M. and arrived at Hoboken at 1.20 P. M. Several stops, amounting in all to twenty minutes, are to be deducted from this time, which would show the actual running time to be four hours and thirty-five minutes for the return trip. Twelve and one-half gallons of gasolene were consumed.

The Fischer Motor Vehicle Company, Hoboken, N. J., is still busy finishing its orders for the large "buses" for London, and also has secured several orders for five-ton trucks in the United States.

A New Type Reflector Lamp.

The accompanying illustration shows a new type of reflector lamp made by the Franklin Electric Manufacturing Company, of Hartford, Ct. This is the latest addition to the "Femco" line, and the manufacturer claims that it has many good qualities which will recommend the lamp to a particular class of users. Many features of this lamp are unique. The reflecting service is designed with a view of obtaining the maximum effect as a reflector lamp, at the same time making the reflector an integral part of the lamp bulb.

NEW TYPE OF REFLECTOR LAMP.

A candle-power diagram made up from tests on this lamp shows a maximum illuminating effect of slightly over forty candle-power with the same amount of current consumption as required by a regular lamp producing sixteen candle-power. The best materials are used in the manufacture of these reflectors, and the company guarantees the lamp as to voltage, candle-power, efficiency and life. These lamps are furnished with either a crystal or frosted front.

The New York office of the Franklin Electric Manufacturing Company is 815 Havemeyer Building, and the southwestern representative is the Sachs Electric Company, St. Louis, Mo.

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The Westinghouse "Turret" System of Electropneumatic Control.

The Westinghouse Air Brake Company and the Westinghouse Electric and Manufacturing Company, under the personal direction of Mr. George Westinghouse, have worked out an electropneumatic system of control differing radically from the drum electropneumatic system which is now well known in the electric railway field. This system has been designated as the "turret" system from the fact that the connections are made and broken by a series of unit switches or

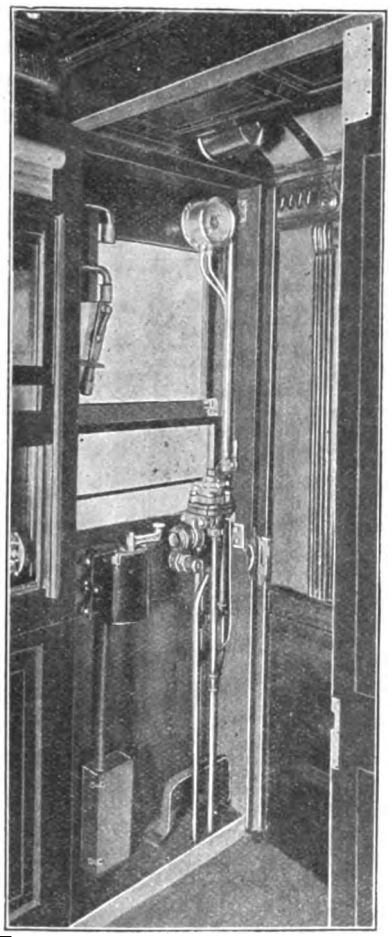

FIG. 1.—MOTORMAN'S CAB, SHOWING AUXILIARY APPARATUS.

breakers grouped in a circular case or turret underneath the car. The movement of the individual switches is through the use of air power controlled by magnets from a battery circuit through a master controller.

The actuating mechanism is not connected directly to the main source of electrical supply, and the connections for the low-voltage control circuits are the only ones which have to be established between the cars of the train. Seven wires are required in the train line battery cable. An important advantage with the use of this separate electrical circuit is that the controlling apparatus can be worked while the main current is cut off, making the control independent of an interruption to current due to the blowing of a fuse, to bad third-rail contact, or other cause. The motors can be reversed and used for braking at any time necessary, even when the rails are dead.

The accompanying illustrations give a good idea of the assembly and detail of the apparatus. Fig. 1 is an illustration of the interior of the motorman's cab. This shows the master controller and operating valve mounted on the inside end panel of the car. In this way the door of the motorman's compartment can be shut against the end panel when the apparatus is not in use, completely enclosing the controlling apparatus. The dimensions of the master controller are seven and one-half inches in height, six inches in width, and four and one-half inches deep, occupying a small amount of room. When the controller is in use the door is swung parallel to the side of the car, providing an enclosed compartment for the motorman. The master controller is mounted so that the controlling handle is thirty-four inches from the floor.

Fig. 2 shows the interior of the master controller. The rotating cylinder of the master controller is made of wood with copper plates and copper spring fingers. This design is very satisfactory, as only fourteen volts are used in the battery or controlling circuit. The reverse cylinder is interlocked with the controller cylinder by a simple device which prevents the movement of the reverse cylinder unless the controller cylinder is at the off position, or the controller cylinder when the reverse cylinder is at either the forward or backward step. The master controller handle is provided with a spring return, making it a "dead man's handle." If the motorman lifts his hand at any time from the controller handle the brakes are automatically applied, unless the reverse handle has first been turned to centre. Another device cuts off the power automatically if the brakes are applied while the power is on. The first result is secured by a connection between the spring return handle and the air brake system, and the second by a connection between the air brake system and a small air cylinder whose piston opens the battery circuit.

A junction box, to which the terminals of the seven battery wires used in operating the turret controller and other car apparatus are led, is placed just below the master controller. This is clearly shown in Fig. 1. This box measures thirteen and one-half inches high by five inches wide by three inches deep.

The batteries for operating the electropneumatic switches of the controlling apparatus consist of two sets of seven cells each, of the Electric Storage Battery Company's type D-5. These are carried under the car in a box twenty-five inches by sixteen and one-half inches by sixteen and one-half inches. The weight complete, with the box, is 300 pounds. Two sets are used to ensure absolute continuity of service, and each is in series with the set of lamps for charging by the line current. Either set is of sufficient capacity to supply all the current required for a day's service and receive sufficient charge during the night while the lights are on. There is no apparatus above the car floor, except the master controller and battery switches, and no power wires are carried above the floor except to one main switch

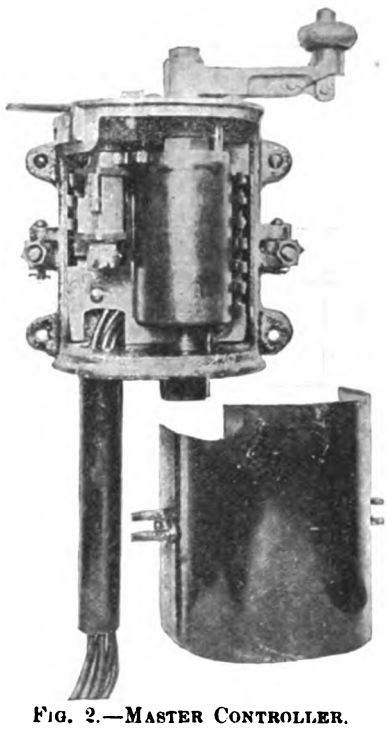

FIG. 2.—MASTER CONTROLLER.

which is located in one of the motorman's compartments.

Fig. 3 is a diagram of the connections. The reverse switch, Fig. 4, is located as near the motor truck as possible, to reduce the length of wire. This is of the usual type, with copper contacts, but is operated by two air cylinders controlled by electropneumatic valves worked from the reverse cylinder of the master controller. Adjoining the reverse switch is the limit switch (Fig. 5) for governing the acceleration. These two switches are usually mounted on opposite sides of the car from the resistance, while the turret controller is located in the centre of the car.

Fig. 6 shows the turret controller open. This is made up of thirteen unit switches arranged radially around an air reservoir and enclosed in a cylindrical casing. The individual switches are operated by pneumatic pistons controlled by electro-

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pneumatic valves and operating against a spring pressure of seventy pounds. By utilizing air pressure operating against a spring to control the individual switches, all possibility of welding or sticking of the contact surfaces is eliminated. As an additional precaution, the switch

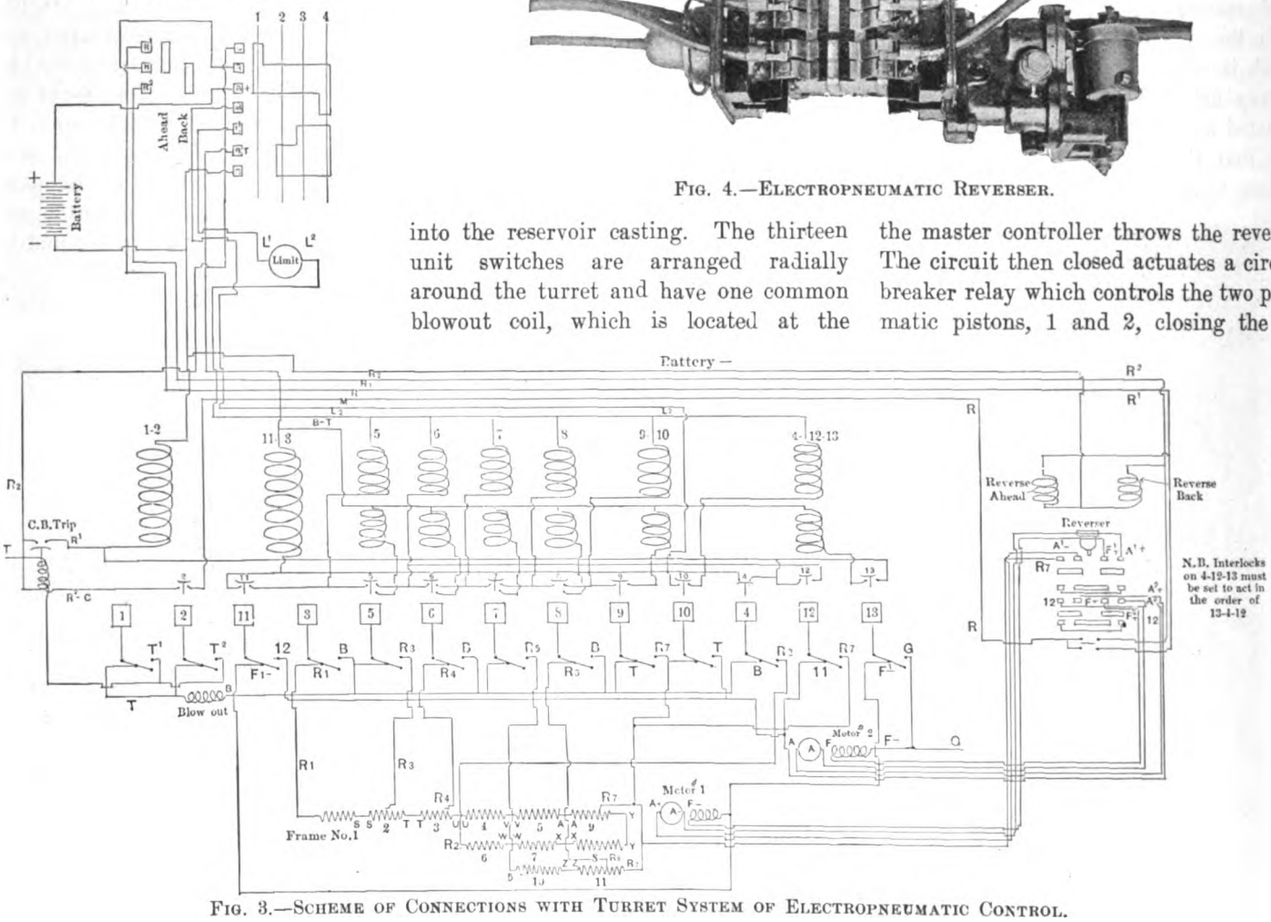

FIG. 3.—SCHEME OF CONNECTIONS WITH TURRET SYSTEM OF ELECTROPNEUMATIC CONTROL.

finger levers are flexible, so that as they are drawn up by pneumatic pressure, and again as they are released by spring pressure, there is a slight rubbing of the con-

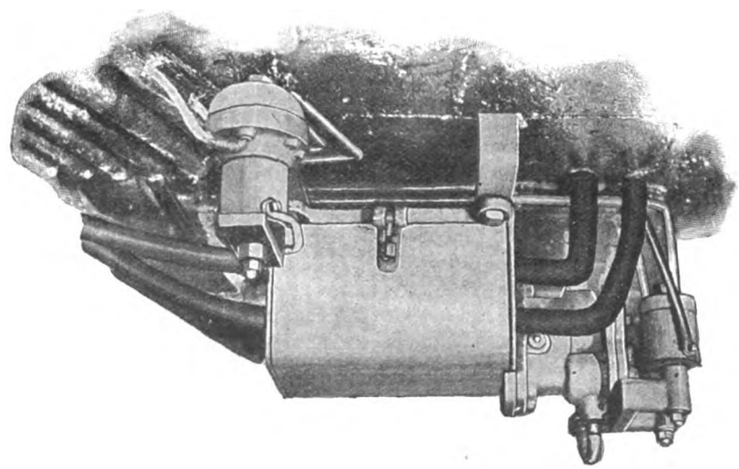

FIG. 5.—LIMIT SWITCH AND REVERSER.

tact surfaces at the moment of engagement or disengagement.

An air reservoir is placed in the centre of the turret, from which the air to the different pneumatic cylinders for the individual switches is supplied. No piping between the cylinders and the reservoir is required, as the cylinders are drilled into the reservoir casting. The thirteen unit switches are arranged radially around the turret and have one common blowout coil, which is located at the centre. The arms of the spider supporting the individual switches form the pole-pieces for the blowout, and as the magnetic field is horizontal, the direction of current in the contactors is arranged so that the arc is always blown out radially. Several of the switches work together, and only eight pneumatic cylinders and controlling valves are required for the thirteen switches.

The operation of the controller is essentially as follows: The first step on

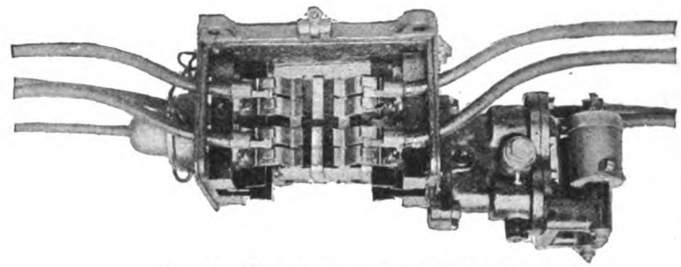

FIG. 4.—ELECTROPNEUMATIC REVERSER.

the master controller throws the reverser. The circuit then closed actuates a circuit-breaker relay which controls the two pneumatic pistons, 1 and 2, closing the circuit-breaker. The second step on the master controller places all the motors in series by actuating the pneumatic cylinders, 11 and 3, which close the series connection and also the connection through the rheostat R-1. The third step cuts out the resistances by closing the circuit through the limit switch and also through the coil No. 5. The action of the switch No. 5 in closing is to establish a circuit through No. 6. When No. 6 closes, a circuit is established through No. 7, and so on up to No. 10, or the full series, thus gradually cutting out the resistances. As each piston drops in closing its switch it also closes a "holding connection" shown directly above each piston, which cuts out the limit switch coil. This prevents the switches, after they have once closed, from opening when the limit switch acts. The limit switch simply prevents the new switch from picking up.

The fourth position throws the motors in parallel. This is accomplished by means of the solenoids, 4, 12 and 13,

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which actuate the switches of the same numbers. When these switches start to close they open a circuit on switches 3 and 11, and as soon as they are fully closed they establish a circuit through the holding coil. The current then starts to pick up the resistance coils controlled by switches 6, 7, 8 and 9; No. 6 being the first resistance used in the multiple position. The circuit-breaker trip indicated at the extreme left of the diagram is actuated by the main circuit and is intended to interlock the circuit-breaker, so that in case it opens while the power switch is closed, the breaker can not be reset until the power switch is again opened.

All wires run in "electrobestos" conduit, ensuring a thoroughly fireproof construction. The air for operating the

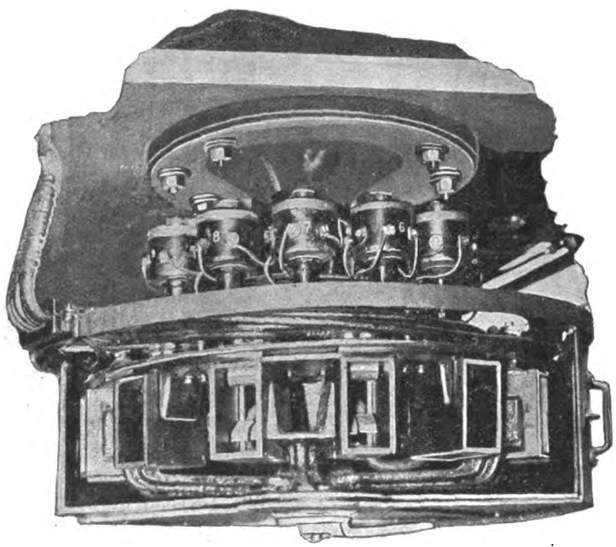


FIG. 6.—TURRET CONTROLLER.

pneumatic switches is taken from the main train line and is first conducted to an auxiliary reservoir through a feed valve to ensure uniform pressure; thence into the reservoir in the centre of the turret. The auxiliary reservoir is provided with a check valve, so that it will retain sufficient air to operate the system in case the main supply should fail. Any number of motor cars can be operated from one master controller by conducting the battery connections from the master controller to any number of turret controllers mounted on any number of motor cars. There are no high-voltage couplings at any point, as the number of battery wires, as mentioned before, is only seven, and the train cable carries only fourteen volts.

The weight of the complete apparatus used per car, as installed on the Manhattan Elevated Railway, New York city, is as follows: Master controller, 695 pounds; reverse switch, 118 pounds; resistances, 490 pounds; circuit-breaker relay, 39 pounds; three junction boxes, 36 pounds; supplementary reservoir, 45 pounds; two master controllers, 39 pounds; storage batteries (fourteen cells), 202 pounds; four seven-point receptacles, 32 pounds; one reducing valve, 15 pounds, making a total of 1,711 pounds.

This system is manufactured by the Westinghouse Air Brake Company, Pittsburg, Pa. The control is now being installed on several cars of the Manhattan division of the Interborough Rapid Transit Railway Company, New York city, and a contract has been closed with the Brooklyn Rapid Transit Company for 264 control equipments of the turret type.

A Large Shipment of Wattmeters.

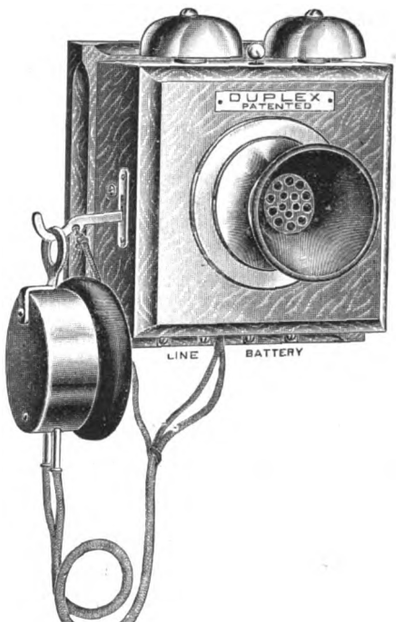
The Stanley Instrument Company, Great Barrington, Mass., has recently made a shipment of glass-enclosed switchboard meters to the New Milford Power Company, New Milford, Ct., for its power stations at Waterbury, Cheshire and New Britain, Ct. The shipment consisted of thirty-six meters, having an aggregate capacity of 16,000 kilowatts. The meters were made up on three sets of marble switchboards to be placed one in each of the substations, respectively, at Waterbury, Cheshire and New Britain, and are to be used for the purpose of registering the current delivered to the electric railway and electric light and power companies in these cities and towns.

This shipment is noteworthy and is probably one of the first of so large an aggregate capacity wherein recording wattmeters are utilized by a transmission company to measure its delivery of current to its customers at the substations at points of delivery. This is in itself an excellent illustration of the progress which is being made in transmission work and the utilization of hydraulically developed electric power for all the various purposes of urban railway service, lighting, and general manufacturing and motor power service.

A New "Duplex" Telephone.

The Connecticut Telephone and Electric Company, Incorporated, of Meridan, Ct., has placed on the market a new type of telephone which has been designated as the "Duplex." About a year ago this company placed its No. 40-30 telephone on the market, which has given satisfaction, and because of this it has been decided to put out the same design built on precisely the same lines, the only difference being in the outward appearance, having double gong bells instead of a monitor pattern bell as used on the original instrument. This arrangement allows the instrument to be put up in a smaller box, making a neater appearance.

The instruments are designed for use on lines of any length over which an ordinary electric bell can be operated. The apparatus is constructed on an entirely new principle, doing away with permanent magnets in the receiver and induc-



NEW INTERCOMMUNICATING TELEPHONE.

tion coils in the body of the instrument. They are made up with long-distance transmitters, high-grade "Duplex" battery bell, tempered-steel hook springs, with phosphor-bronze contact springs tipped with pure silver.

The receiver is made of a steel cup, over which is forced a heavily nickeled brass cap, in which is mounted a magnetic coil which is wound with silk-insulated wire. The receiver cord is also of silk, and so attached that, no matter if the receiver is left off the hook, the batteries will not be run down.

These instruments are designed for use with but two on a line, and are used principally from house to stable, from one house to another, or to connect different rooms in a house. They are also used extensively in connection with annunciators for both house and hotel work, in which case they are made up for central battery.

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Quick-Break Switches.

The accompanying illustrations show some of the types of switches manufactured by Linton & Southwick, of 60 Hermon street, Worcester, Mass. Fig. 1 shows the "Monarch" quick-break switch, which is especially designed for stations, isolated plants and railway switchboards. This type of switch is smooth-acting, built in a substantial manner, and makes a neat appearance. The springs to operate the auxiliary knives are entirely concealed and do away with side coil springs and other visible features. These switches are made both single-throw and double-throw, single-pole and double-pole, ranging from 50 to 2,000 amperes at 600 volts. The upper fuses carry the current, the lower ones being out of circuit, the fuses on the handle end not touching the clips. When either of the upper fuses blow, the switch is raised so that the lower fuses come into the circuit and make contact. The burned-out fuse can then easily be replaced and the switch thrown back into its original position. These are made in single, double and triple-throw, for 25 to 500 amperes.

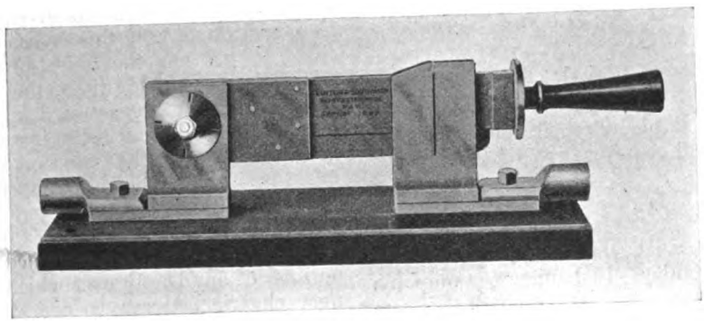


FIG. 1.—QUICK-BREAK SNAP SWITCH.

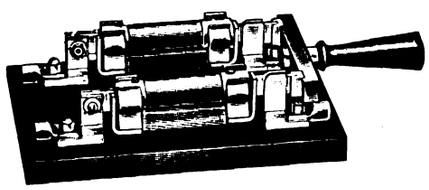


FIG. 2.—FUSE SWITCH

three-pole switches are made both in single-throw and double-throw, from 50 to 2,000 amperes at 600 volts.

Fig. 2 shows the "Ideal" fuse switch manufactured by this company. The special feature of this switch is economy of space. As may be seen from the illustration, the fuse takes the place of a knife, reducing the length of the switch. This switch is made in single, double or triple-pole, single and double-throw, from 25 to 500 amperes.

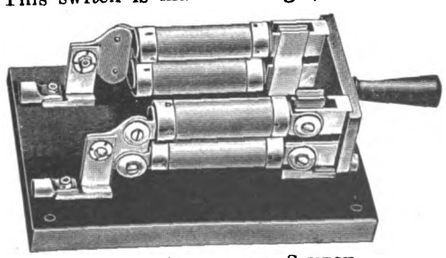
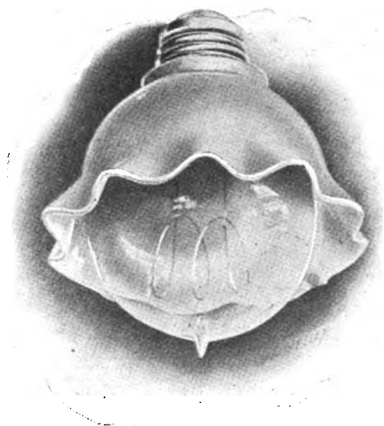


FIG. 3.—EMERGENCY SWITCH.

Fig. 3 shows the "Ideal" emergency switch. The object of this switch is to replace a burned-out fuse instantly. The

Incandescent Lamp Catalogue.

The Standard Electrical Manufacturing Company, Niles, Ohio, has just issued, from the Lakeside Press, a catalogue that contains complete data in regard to its line of incandescent lamps. This catalogue has been in the hands of artists for several months, and the lamp cuts have been worked up in the most artistic manner. The catalogue also contains tables and other information valuable to lamp users.



FLUTED SHADE, "WHITE STAR" LAMP.

Among the specialties illustrated is the "White Star" lamp, one of which is shown in the accompanying illustration. The company makes a special feature of the quality of illumination from this lamp. The lamp is made with a plain white porcelain shade, or with red or green white-lined shades, and also with the fluted white shade shown in the illustration. The fluted "White Star" lamp is one of the most artistic lamps on the market, and the company states that it is finding a ready sale, both for decorative work and general use.

An Adjustable Desk Telephone Device.

The Chicago Writing Machine Company, 94-96 Wendell street, Chicago, Ill., has placed on the market a device which is known as the "Adjustaphone," and for which the company makes a number of claims of novelty and value. The "Adjustaphone" is a practical device for adapting the desk telephone to any form of desk, and combines a telephone holder or desk bracket for a complete telephone desk set.

FIG. 1.—ADJUSTABLE DESK TELEPHONE.

The accompanying illustrations will show the adaptations of the "Adjustaphone." This can be attached equally well to any vertical or horizontal flat surface. It is movable in any direction without any degree of effort, and as it is securely attached, there is no danger of breakage through a fall or other accident.

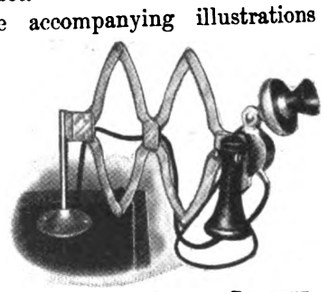


FIG. 2.—THE DOUBLE BRACKET.

The arrangement of the internal mechanism affords compactness, simplicity, durability and efficiency. By removing the cover from the cylindrical box containing the internal mechanism, the latter is exposed to full view. The working parts are all easily accessible without removing any of them from the instrument. The contact springs are insulated from the box by a circular

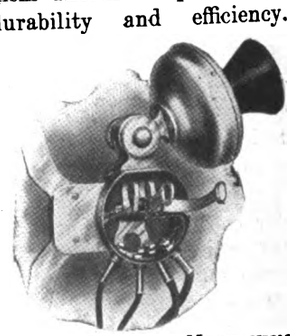


FIG. 3.—INTERIOR MECHANISM.

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strip of fibre which lines its lower portion. These springs are connected with the cord by terminals passing through metal bushings covered with vulcanized rubber sleeves to provide insulation from the box. The contact springs are held in permanent contact with the metal bushings by means of small nuts which hold them securely in place. The cord terminals, after being inserted through these bushings, are likewise held in place by lock-nuts. A long double curve spring controls the receiver hook, making and breaking contact with smaller curved springs. All of these springs are made of German silver, and platinum points are used for all contacts.

The "Adjustaphone" can be used on any circuit for any class of service, as sufficient contacts are provided for all purposes.

Fig. 1 shows the "Adjustaphone" as attached to the ordinary roll-top desk, with the toggle arms closed up. The arms, as shown in Fig. 1, will extend the "Adjustaphone" about eighteen inches. In Fig. 2 the double length is shown, the arms allowing an extension of twenty-eight inches. Fig. 3 shows the box with cover removed, exposing the working parts.

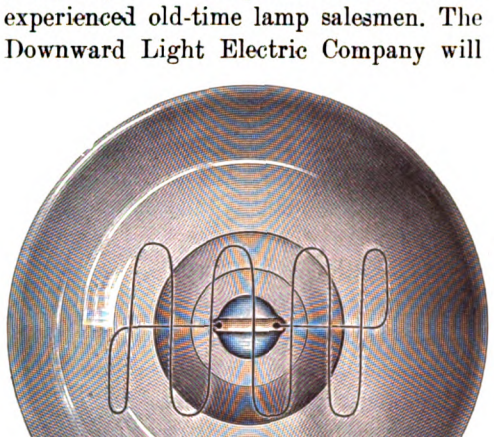
A New Type of Incandescent Lamp.

The Downward Light Electric Company, New York city, has developed a new type of incandescent lamp which possesses a number of features of more than ordinary merit. The accompanying illustrations show the appearance of the lamp and also give a good idea of the design of the filament, together with a comparative set of curves made by the Lamp Testing Bureau, of New York city, showing the distribution of light from the new type of lamp. As will be noticed in the illustration, the filament is so designed that a maximum intensity of illumination is given below the bulb. In doing this the manufacturer has sacrificed horizontal distribution, and where a vertical distribution is desired it is claimed this lamp will be very popular.

Another important feature of this lamp is the tipless bulb which will obviate a great amount of loss due to breakage at the tip. In machine shops and factories, where there is considerable movement at all times and a necessity of having a lamp moved to different points about a piece of work, the advantage of the tipless bulb is obvious.

The accompanying curves show a comparison in the light distribution of several types of lamps. Curve No. 1 is for a sixteen-candle-power double-carbon lamp; curve No. 2 is for a sixteen-candle-power oval anchored lamp; curve No. 3, a sixteen-candle-power double-round-coil lamp; curve No. 4, a sixteen-candle-power flattened double-coil lamp, and curve No. 5 is for a sixteen-candle-power "downward light lamp."

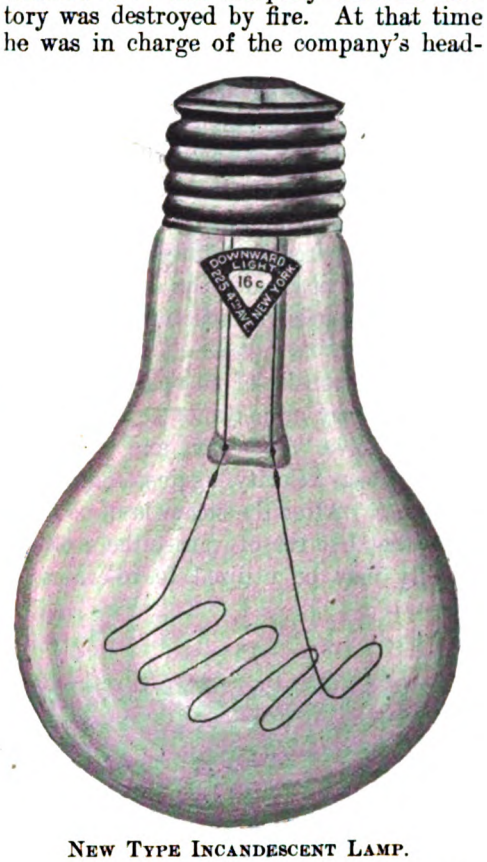
The Downward Light Electric Company is incorporated under the laws of the state of New York with a capital of $100,000, and is composed of a number of experienced old-time lamp salesmen. The Downward Light Electric Company will



TIPLESS BULB AND SPECIAL FILAMENT.

be distinctively a selling company. A factory has been erected and equipped at Cleveland, Ohio, for the manufacture of incandescent lamps by a separate company, and while this is an organization distinct and separate from the Downward Light Electric Company, long-time contracts have been made for almost the entire output of the lamp factory. The Downward Light Electric Company will have a complete lamp-testing laboratory at the factory and will maintain a full corps of inspectors in every department to regulate the output and quality of the finished lamps. The main office of the company will be in New York city, at 225 Fourth avenue. Branch offices will be established in all of the large cities of the United States.

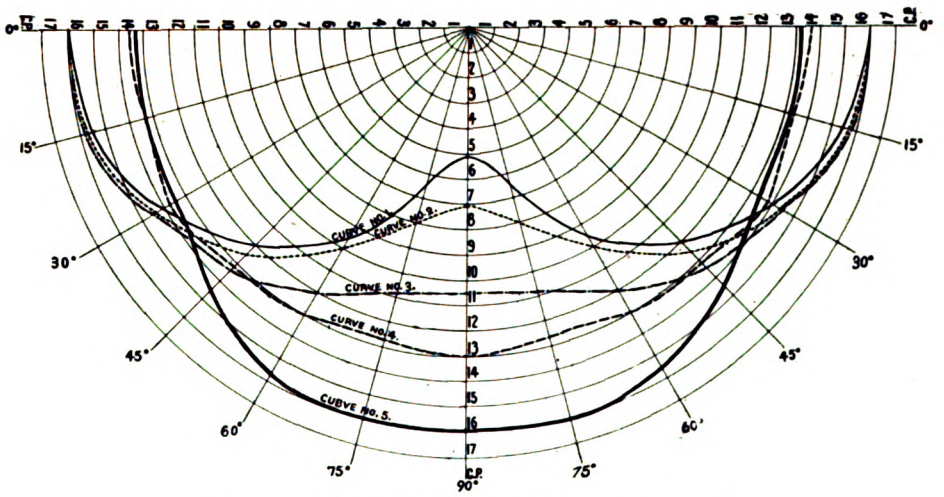
Mr. James C. Wormley, the president of the company, is one of the best-known incandescent lamp salesmen in the United States. Twelve years ago he was connected with the Universal Electric Lamp Company, of Cleveland, Ohio, being associated with this company until its factory was destroyed by fire. At that time he was in charge of the company's head-



NEW TYPE INCANDESCENT LAMP.

quarters at Chicago, Ill. After the destruction of this factory he made a contract with the Bryan-Marsh Company to make lamps under his own label and carried on business in Chicago under the firm name of J. C. Wormley & Company.

At the time the Shelby company was inaugurated, he transferred his contract to it to manufacture lamps for him. In 1896 he sold out his interest to the Shelby company and became a stockholder, shortly after being one of the directors of the company. In 1899 Mr. Wormley opened the New York office of the Shelby company and remained in the capacity of eastern and export manager until September 30, 1903, when he severed his connections with this company to become president and general manager of the Downward Light Electric Company.



COMPARISON CURVES FOR DOWNWARD ILLUMINATION.

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ADVANTAGES OF STEAM TURBINES FOR TEXTILE MILLS.[1]

BY AUSTIN DODGE.

Within the past six years a great impetus has been given to steam engineering by the rapid development of the turbine as a substitute for reciprocating engines.

The advantages are many. To a casual observer of a turbine installation, perhaps the most apparent are the small amount of attention necessary, the small number of moving parts, compactness and simplicity.

All types consist of an opening or nozzle which may or may not be expanding, which receives the steam and directs it at the proper velocity, against the revolving vanes. After the steam is discharged from the first set of vanes, the residual velocity may be utilized to re-evaporate some portion of the moisture inherent to the process of expansion, and enter a second nozzle. This condition ensures expansion in straight lines, preventing eddies in the steam, but necessitates a high vane velocity or a multiplicity of parts.

Another method is to receive the jet from the revolving vanes in a stationary set of vanes so arranged as to prevent material loss in velocity at the entrance, and redirect the jet at increased velocity by proper expansion into a second and third set of revolving vanes. This method permits a lower bucket velocity, but the tendency for leakage of steam through the clearance spaces is somewhat greater, and the steam jet more irregular the farther it travels in a curved path from one direct guiding nozzle, before reaching another. The buckets revolving nearest the nozzle therefore show the highest efficiency.

With an increased number of stages, the velocity at the end of the nozzle is reduced, as the expansion is less, and a smaller number of wheels per nozzle is necessary to abstract the velocity, reducing the losses mentioned.

The efficiency of action depends largely on the relative velocities of the steam jet and the moving vanes, and the energy required to rotate these vanes under the existing conditions of steam density and moisture.

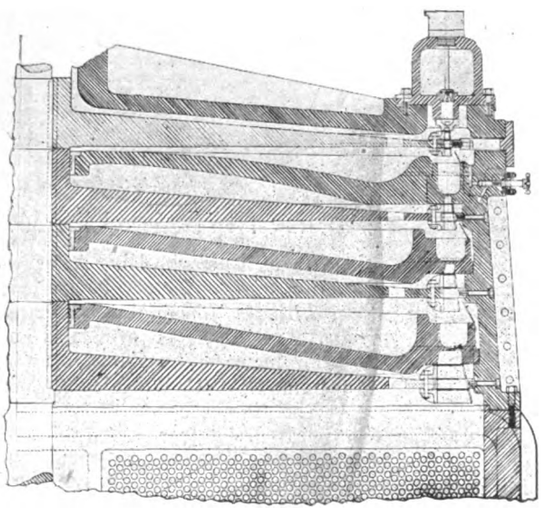
One of the earliest efficient turbines of practical form was brought out by De Laval, and consists of a single combination of nozzles and a wheel attached to the shaft, carrying the vanes on its periphery. The transformation of pressure into velocity in the nozzle is complex but highly efficient. A high velocity of the moving vanes is essential, but as the angles of entrance and discharge are the same, and as the wheel rotates in a medium which has everywhere the same pressure, there is no troublesome end thrust.

The Parsons machine was brought out shortly before the De Laval and has much lower velocities of steam and vanes, and the process of transforming pressure into work must be repeated many times, entailing a large number of successive revolving rows of vanes with stationary rows of vanes between each.

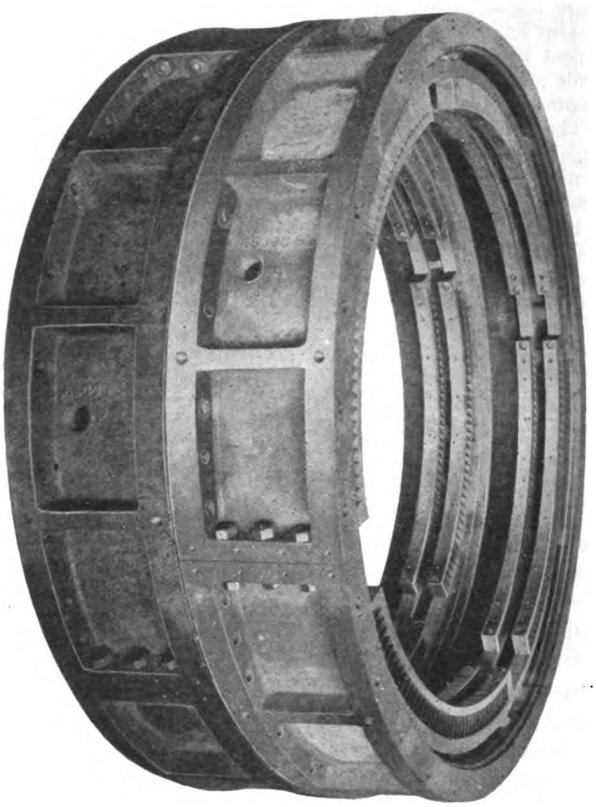
The Rateau type is similar to the De Laval, except that the combination of nozzles and single wheel is repeated several times, with less expansion during each process than in the earlier turbines. A space is given for the steam discharged from the revolving vanes to utilize its energy in the form of velocity by evaporating part of the moisture, and start the process of fractional abstraction anew in the following nozzle. A single wheel per nozzle, or group of nozzles, affords a minimum change in the direction of the steam jet at high velocity and shortens its opportunity to diverge, before a following nozzle again brings it into line.

The outer clearance is small and the buckets have no outer band like the De Laval, but as steam is admitted only in sections of the periphery, end thrust is eliminated as the pressure on each side of the disc tends to equalize through the empty vanes. The cylindrical clearance space between each intermediate nozzle and revolving element is near the shaft where the clearance can be made a minimum.

Still another type is that brought out in this country by Mr. Charles G. Curtis, which in addition to nozzles delivering steam at high velocity to a single wheel has also stationary vanes which redirect the steam discharged at considerable velocity from the first wheel, due to the relatively low bucket speed, into the second wheel. The velocity of the jet leaving the nozzle is about 2,000 feet per second, while the peripheral speed of the vanes in the Curtis is about 400 feet per second. By this process of fractional



ASSEMBLY OF 5,000-KILOWATT FOUR-STAGE TURBINE.



TWO INTERMEDIATES FOR SECOND STAGE OF A 500-KILOWATT TURBINE.

[1] Abstract of a paper presented at the semi-annual meeting of the New England Cotton Manufacturers' Association, Lenox, Mass., September 30 and October 1, 1903.

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abstraction the speed of revolving vanes need not be excessive to secure maximum economy, in other words to bring the direction of the jet discharged from the last set of vanes parallel to the shaft. With this high steam velocity only a minimum of revolving vanes are necessary, and they rotate in steam which has a lower density, due to the considerable drop in pressure from one stage to the next. There is a large clearance between outer wall of revolving vanes and the shell, reducing friction due to water of condensation. End thrust is eliminated, as there is abundant opportunity for the pressure to equalize on each side of the revolving discs, and the entrance and discharge angles of the vanes are the same.

In the larger sizes the shaft is vertical and floats on oil under sufficient pressure to balance the weight of the revolving element, which rises a few thousandths of an inch until the clearance is sufficient to permit the discharge of the oil delivered at the centre of the supporting block.

That there is no end thrust in this turbine is shown by the fact that the oil pressure necessary to float the revolving element does not change under any condition of load. This vertical arrangement affords great compactness and greater uniformity of expansion due to heat.

The clearances between stationary and moving parts have proven thoroughly commercial, as shown in several months operation of vertical 500-kilowatt units. In cases in which the oil pressure has failed in the vertical type of this unit during the use of a temporary belt-driven oil pump, there has been no damage to the revolving or stationary vanes. Any contact which may occur is due to the lifting of the revolving element owing to formation of ridges on the step bearing surface. The weight of the revolving element therefore tends to neutralize any tendency to injury. As the vanes are less in width than the metal from which they are cut, nothing more serious happens than a polishing of the solid part of the wheels. Even the step bearing blocks can be faced off and used again. When using the standard direct-driven oil pump a failure of oil supply to the step bearing is highly improbable.

The 500-kilowatt type has two sets of nozzles, each delivering steam to a set of three revolving discs, carrying the vanes, which are machined from the solid disc. Governing is effected by operating a series of valves which controls the admission of steam to the nozzles on the first stage. This ensures a constant velocity in the first stage nozzles, while the pressure in the first stage diminishes with the steam flow until at no load, it is nearly equal to the vacuum in the second stage, a desirable condition, as it reduces the density of the steam in which the first stage wheels rotate, and renders unnecessary adjustment of the valve controlling the second stage nozzles.

The following table embodies approximately the velocities of turbines of 300 kilowatts to 500 kilowatts:

Type.	Rows of Rotating Bucket Rings.	Steam Velocity. Feet per Second.	R. P. M.	Peripheral Speed.	Buckets.
Parsons,	35	400	3,600	200	Inserted.
Rateau,	25	800	2,400	400	Inserted.
Curtis,	3	2,000	1,800	400	Solid.
DeLaval,	1	4,000	20,000	1,200	Inserted.

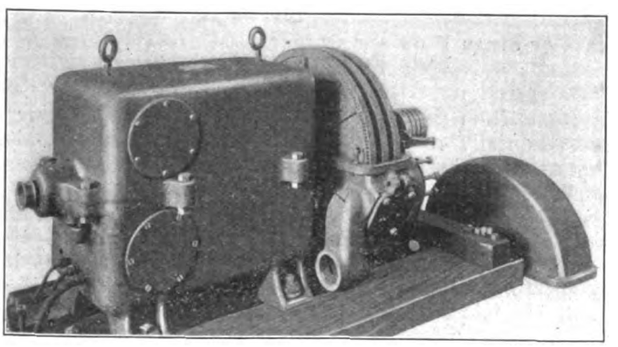
Each type has its characteristics and the advantages of one over another will depend largely on the cost of construction, reliability and improvement in efficiency.

The amount of capital invested in cotton manufacturing interests has been estimated at over two billion dollars. Let us consider the utility of the steam turbine in increasing the return from this investment. The desirability of the electric drive in textile mills has been clearly established and has already been brought to your attention by Mr. Sidney B. Payne. The advent of the turbine, obviating the necessity of changing reciprocating motion to rotative motion will rapidly increase this application of electricity to your factories.

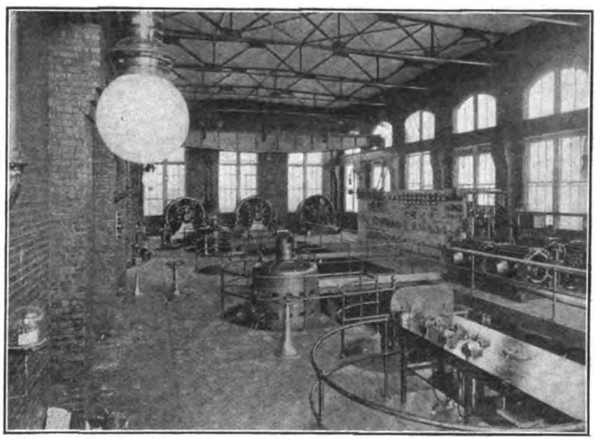
As to first cost of such an installation, a Curtis turbine requires only seven per cent of the floor space taken by a horizontal cross-compound engine of the same capacity, and the cost of foundations is in about the same proportions in favor of the turbine. The weight is from fifteen per cent to twenty-five per cent that of the engine.

There is no wear with a moderate amount of superheat resulting from the action of the steam jet on the vanes, even at a velocity of 2,500 feet per second, as shown by long continued tests.

One of the great advantages of a turbine is due to the entire absence of internal lubrication. Consequently the condensed steam can be returned to the boilers, saving the cost of oil and feed water, often ten per cent the cost of fuel.



FIFTEEN-KILOWATT TRAIN LIGHTING SET.



NEWPORT STATION, NEWPORT-FALL RIVER STREET RAILWAY COMPANY.

As no boiler scale is formed while using the same feed water continuously, tube cleaning is unnecessary and the boilers are maintained at the highest efficiency without withdrawal from service.

It is estimated that the saving in attendance charges will average twenty-five per cent on the entire station payroll. A turbine having but one moving part requires no adjustment, unlike a reciprocating engine with a large number of moving parts, which must be carefully inspected at frequent intervals by a skilled engineer. The economy therefore remains constant, which is not true of a reciprocating engine.

One of the principal requirements of textile mills is uniform speed. A turbine has a large amount of stored energy in its revolving parts and is therefore well adapted for work requiring close regulation. Attached are two curves showing the regulation of a twenty-horse-power

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turbine and also a 100-horse-power turbine, when full load is suddenly thrown on and as suddenly removed.

The variation in speed of the larger units is within two per cent when the load is varied from no load to full load. Flywheels are not required on any type, as the driving force is always transmitted without angular variation; a desirable condition when generators are operated in parallel.

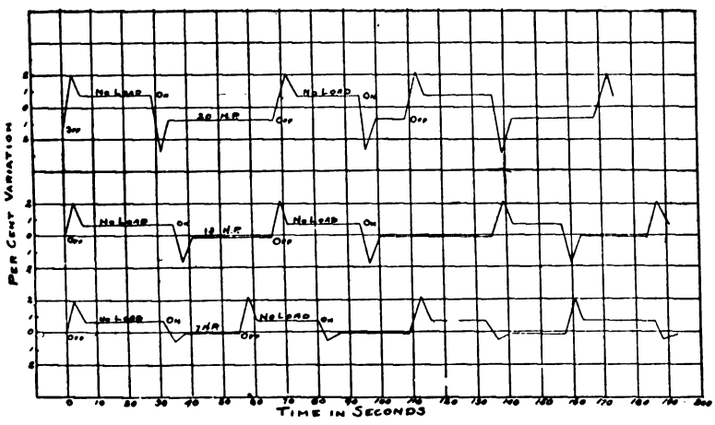
The absence of internal lubrication permits a high degree of superheat. In the Newport plant the superheat of the turbine has been raised to 250 degree Fahrenheit without increasing the temperature of any part of the revolving wheels or surrounding casing, except the admission valves. The conditions in an engine operating at this high temperature would not be as favorable.

Actual experience in commercial operation has shown that water carried over from the boilers in large quantities does no injury to any part of the turbine, a serious condition when engines are in use.

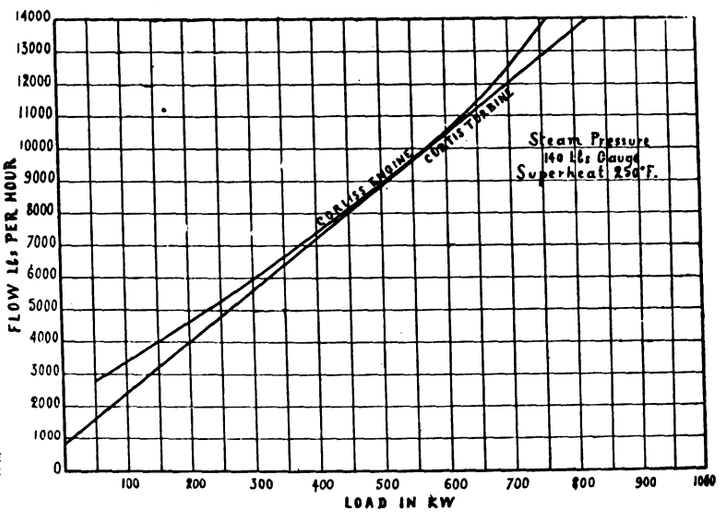
The first vertical turbine engine to be installed in this country was at Newport, R. I., and has given the following results which have not heretofore been published. Comparison with a Corliss cross-compound condensing engine of similar capacity under the same conditions of pressure and superheat is also made, assuming the engine to have the same full load economy. Few engines of this capacity, even when new, can show as high efficiency at full load. The curves clearly indicate the saving afforded in steam by installing a turbine when operating at light loads and overloads.

The motors required to operate the circulating and air pumps for the condenser are driven from the turbine generator and this power, about twenty kilowatts, is included in the output of the machine. Analysis of the velocities obtained indicates that this result from the first vertical unit will be materially reduced. Lighting, railway and arc load are all carried on the same unit without difficulty. Minor troubles have developed but no more than with every radically new device, and these have in turn been corrected as rapidly as possible under commercial operation.

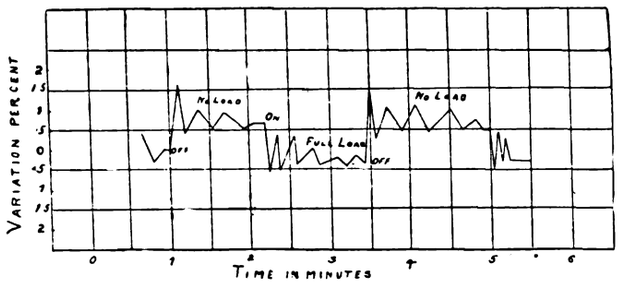
The station is arranged for four turbines, two of which have been put in service.



CURVES SHOWING REGULATION OF TWENTY-HORSE-POWER CURTIS TURBINE, 3,000 REVOLUTIONS PER MINUTE, WITH SUDDEN CHANGES OF LOAD.



CURVE OF STEAM FLOW AND OUTPUT, 500-KILOWATT UNITS ASSUMING SAME EFFICIENCY AT FULL LOAD.



CURVE SHOWING REGULATION OF FIFTY-KILOWATT CURTIS TURBINE, 1,800 REVOLUTIONS PER MINUTE, WITH SUDDEN CHANGES OF LOAD.

Similar plants have been installed at Scranton, Pa., Dover, N. H., and within the past year orders have increased to such an extent that 200,000 horse-power of Curtis turbines are under contract. A 600-kilowatt horizontal unit has been in continuous service at Schenectady for two years, operating for two periods of about four weeks each without a single shutdown. A 1,500-kilowatt Curtis unit is in successful operation at Port Huron, Mich., carrying a mixed load of motor power, railway and lighting. This turbine has the standard clearance of 0.03 to 0.05 inch between stationary and moving parts, and can be started cold and brought up to full speed in half an hour. It is easily brought into synchronism with other three-phase generators driven by cross-compound engines. One 800-horse-power Russell and one 500-horse-power Ball, both tandem-compound engines, also one 500-horse-power Westinghouse cross-compound engine, all condensing, have heretofore carried the load, about 750 kilowatts, requiring two 500-horse-power and one 250-horse-power Sterling boilers. With the turbine alone carrying the same load one of the 500-horse-power boilers is cut out.

A 5,000-kilowatt Curtis turbine has recently been installed at the Commonwealth station, Chicago, where provision has been made for fourteen similar units. This machine, the first of its size, has been operated continuously for several periods of eight hours each on a water rheostat load of 5,000 kilowatts and will shortly be put in commercial service. On account of water leaks around the condenser tubes, no reliable economy tests have yet been made.

In textile mills the first units to be installed are three 500-kilowatt Curtis turbines at the Lane Cotton Mills, New Orleans, and two similar units at the Fulton Bag and Cotton Mills, Atlanta, Ga.

I need not describe these plants further. A sufficient number are already in operation to demonstrate their superiority over recoprocating engines, and the extent of their installation is limited only by capacity for production. The flexibility of the electric drive for textile mills together with still greater adaptability of turbine-driven generators must result in increased capacity at diminished cost.

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CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

PROJECT FOR MUNICIPAL ELECTRIC LIGHTING AND POWER SYSTEM IN ARGENTINE REPUBLIC—The construction of a municipal electric lighting and power system is projected in Buenos Aires, Argentine Republic, which it is estimated will entail an expenditure of at least $5,000,000.

NEW INDEPENDENT TELEPHONE COMPANY—The Queen City Telephone Company, Cincinnati, Ohio, has been incorporated with a capital of $1,000,000, and it is announced that this capital will eventually be increased to either $4,000,000 or $6,000,000. The company claims to have connections as far east as Philadelphia, west to Kansas City, north to St. Paul, and south to Galveston, and will apply for a franchise.

WASHINGTON, D. C., ELECTRIC NOTES—The electric road building between Washington and Baltimore is making considerable progress, and it is stated that much over half of the grading is completed. The route of this road runs from the boundary line of the District of Columbia east to Bennings, following in a general way the route of the Pennsylvania Railroad to Baltimore. The electric railway company has acquired the steam road to Annapolis, Md., and it will not be necessary to build a new roadway for the proposed branch to that city. It is thought that the road will be in operation next summer. An electric road will also be built between Washington, Vienna and Fairfax, Va., and it is stated that a road of this kind to the great falls of the Potomac river, fourteen miles from Washington, will be begun this fall.

CARBORUNDUM WORKS AT NIAGARA FALLS, ONT., DESTROYED BY FIRE—One of the five furnaces in the furnace and transformer building of the carborundum works at Niagara Falls, Ontario, exploded on Saturday morning, October 3, setting the structure on fire. The power cables leading into the works were cut to enable the firemen to work without danger from the line. The fire was confined, through the efforts of the firemen, to the western building, and the adjoining building, in which were the grinding rooms, storerooms and business offices of the company, was saved. The building contained five furnaces, one large and three small transformers, a switchboard and other electrical equipment, machinery, material, etc. The works at Ontario is a branch of the Carborundum company's works in Niagara Falls, N. Y. Work is already under way clearing away the debris and making preparations for rebuilding and installing the necessary equipment for continuing the business.

NEW MEXICAN TRACTION COMPANY—It is announced that a company known as the Compania Mexicana de Traccion has been recently organized for the purpose of constructing and operating an extensive electric traction system in Mexico City. The company has acquired what are known as the Moylan, Garcia and Requima rights, which permit of the building and working of about 100 miles of road—fifty in the city, and about fifty in the suburbs. The company has also assumed control over the Empresa del Circuito de Banos, a horse road over two miles long, operating between Belvanera and Alberca, in the heart of the Mexican capital. This road will be electrically converted. It is stated that the company has ordered about 1,000 tons of eighty-five-pound girder rails, and is in the market for twenty forty-foot cars which will be equipped with four motors of fifty-six horse-power each. The power-house will have an initial capacity of 2,000 horse-power. The company is incorporated under the laws of Mexico. The directors are James H. Oliver, Julius Bieler, Reuben Miller, Sr., James H. Park and Frank B. Smith, of Pittsburg, Pa. Mr. M. C. McAdoo is president of the company. It is stated that the system will be in active operation inside of eighteen months.

RECENT STATISTICS ON ELECTRIC STREET RAILWAY SYSTEMS—Bulletin No. 3 of the United States census report on street and electric railways shows an unprecedented record in the application of electricity. In 1890 there were 126 companies operating their lines by electricity. They had 1,262 miles of single track. There were fifty-four cable lines and seventy-four steam lines having altogether 1,200 miles of track. In 1902 there were 747 companies operating their lines by electricity, an increase of 492.2 per cent. They were operating over 21,920 miles of track, an increase of 1,637 per cent. The lines operated by horses, cable and steam showed decreases of from fifty to ninety-five per cent, but the total increase in mileage was 178 per cent. There are now twenty-five street railway companies in the United States which have a length of line of more than 100 miles, and 395 companies which have a length of less than ten miles. In all, there are now 987 companies, with a cost of construction of $2,167,634,077 and a capital stock of $1,315,572,960. The increase in the number of passenger cars amounted to 27,785. In 1890 there were 62,237 passengers carried per car, and in 1902, 79,774 passengers per car. In the year 1902 there were 5,871,957,830 passengers who traveled by street and electric railroads. Notwithstanding the fact that over 5,000,000,000 passengers were carried, the report shows that only 265 were killed and 26,690 were injured; 122 employés were killed, and 3,699 injured.

CUBAN ELECTRIC TRACTION COMPANY—An extensive traction and lighting system is to be constructed in the southern part of Cuba. power to be derived from an hydraulic plant which, it is announced, will be one of the largest in that part of the world. The Cienfuegos, Palmira & Cruces Railroad and Electric Power Company has been organized for the purpose of building and operating both systems. The length of the road will be about forty-three miles. Four and one-half miles of track will be constructed in Cienfuegos, and the line will run from that city to Caonao, thence over private right of way to Palmira, Horringuero and Cruces. The track will be standard gauge. Sixty-pound T and girder rails will be employed. The initial rolling stock will consist of four combination cars, thirty-two feet over all, seating twenty-four persons and operated by two fifty-horse-power motors each; four open passenger cars, thirty-five feet eight inches over all, seating sixty passengers and operated by two fifty-horse-power motors each; three closed passenger cars, length twenty-seven feet eight inches over all, seating twenty-four passenger and operated by two twenty-five-horse-power motors each; three eight-bench open cars, twenty-five feet over all; seating forty passengers and operated by two twenty-five-horse-power motors each. Five express cars, measuring twenty-one feet over all and equipped with four fifty-horse-power motors each and having a capacity of twenty tons, will be ordered also; twenty box eight-wheel freight cars, capacity twenty tons; a similar number of eight-wheel flat cars, capacity twenty tons, also sprinkler and repair cars. The company will also generate energy for the purpose of lighting Cienfuegos—about 30,000 inhabitants—and the other towns mentioned, whose population averages about 8,000 people. Power will be derived from the falls of Hababanilla which are known as the Niagara of Cuba. The voltage at which the energy will be transmitted has not yet been determined. The initial capacity of the plant will be 3,000 horse-power.

TELEPHONE AND TELEGRAPH.

CONNELLSVILLE, PA.—The Bell Telephone Company is building a line from Morgantown to Pittsburg.

SPRINGFIELD, MASS.—The Valley Telephone Company will extend its wires to connect the Leverett line with the Dunderland line.

OCILLA, GA.—C. J. O'Farrell has completed the work of installing the new telephone system of the Ocilla Telephone Company.

YONKERS, N. Y.—The Yorktown Telephone Company's stockholders have elected the following directors for the ensuing year: James E. Rice, T. F. Tompkins, Edward E. Kear, E. Munson Frost,

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Floyd White, Albert Lee, James N. Strang, James J. Mead and Cornelius Pugsley.

SARATOGA SPRINGS, N. Y.—The Easton & Buskirk Telephone Company will connect with the Hudson River Telephone Company at Greenwich.

CHEYENNE, WYO.—The long-distance telephone line of the Colorado Telephone Company, connecting Portland, Ore., and Denver, Col., has been completed.

CHARLESTON, S. C.—A charter has been granted to the Mt. Pleasant Telephone Company with a capital of $2,500. The company will do business in Mt. Pleasant.

CLARKSBURG, W. VA.—The Consolidated Telephone Company, of Clarksburg and Fairmont, has decided to extend its line to Wheeling, Uniontown and Pittsburg.

DANFORTH, ME.—The Danforth Telephone Company has been incorporated with a capital of $10,000. The officers are V. E. Price, president, and M. L. Porter, treasurer.

DES MOINES, IOWA—The Iowa Telephone Company has let the contract for a new exchange in this city, to cost approximately $37,000. Work is to be completed by January 15.

RICHMOND, VA.—The Lunenburg Telephone Company has been organized at Meherrin with A. M. Bruce as president; E. P. Wallace, vice-president; M. E. Gee, secretary, and E. T. Staples, treasurer.

PITTSBURG, PA.—The officials of the Pittsburg & Allegheny Telephone Company announce that the company's lines between Pittsburg and McKeesport will be in operation in less than sixty days.

RICHMOND, VA.—The Waxhow Telephone Company has been incorporated with a capital of $5,000 to construct lines from Monroe to Waxhow, thence to Charlotte, and to other villages in the vicinity.

SOUTH FRAMINGHAM, MASS.—The New England Telephone and Telegraph Company is laying through Framingham the underground wires which will connect Boston and Worcester with a thorough service.

DECORAH, IOWA—The Summer Telephone Company, capitalized at $30,000, and owning about 150 miles of line, has passed under the control of Victor Stevens, who controls the Standard, Interstate and Dubuque lines.

YORK, NEB.—The York County Independent Telephone Company has connected its lines with those of the Filmore County Independent Company, and also with independent liner at Beaver Crossing, Milford and Friend, Neb.

LEONARDSVILLE, N. Y.—A new telephone line will be constructed in this town, an organization having been formed with E. S. Brand, president; I. A. Crandall, secretary, and A. M. Coon, treasurer. Connections will be made with near-by towns.

FRANKLIN FALLS, N. H.—The Citizens' Telephone Company has been granted a franchise in the town of Meredith and will soon extend its lines to Meredith village. Telephones were put in at Center some time ago, and the service at Tilton is to be increased.

BALTIMORE, MD.—The roofing and exterior work on the new Chesapeake & Potomac Telephone building in this city has been completed and work on the interior of the building has commenced. The cost of the structure, which will be completed by December 1, will be $75,000.

COPPERSTOWN, N. Y.—The Westville Telephone Company has been chartered to build and operate a line from the village of Milford to the village of South Valley. The capital stock is $1,000, and the directors are Frank Green, John Cady, A. Baldwin, K. R. Baldwin, E. Coates, T. Gurney and M. Stilwell.

SHEBOYGAN, WIS.—A. B. Ferdinand, president of the Sheboygan County Telephone and Electric Company, has disposed of his interest and the company will be reorganized. Plans are to be made for giving the public better service, one of the improvements contemplated being the building of conduits for underground work on Main street.

ELECTRIC LIGHTING.

DES MOINES, IA.—At West Liberty extensive improvements are projected to the electric light plant.

INDIANAPOLIS, IND.—Frank Underwood has secured the contract for a new power-house at Hazel Kirk.

LEWISTON, ME.—Important changes and additions are being made at the plant of the Light and Water Company of Rumford.

GRAND HAVEN, MICH.—The board of public works of Grand Haven has about decided to expend $10,000 on the electric plant of the town and to install a day electric service here.

EVANSVILLE, ILL.—The Red Bud city council at its last meeting passed an ordinance granting T. C. Reed a franchise for the purpose of establishing an electric light plant in that city.

COALPORT, PA.—It is stated that Coalport will be lighted by electricity within a short time. Local capitalists have formed a company for installing an electric light plant and are now busy perfecting all arrangements.

HILLSBORO, ILL.—The city council is considering a proposition for the establishment of a municipal electric light plant. At present electric lights are furnished by a private corporation, the contract with whom expired October 1.

GRAND FORKS, N. D.—It is said that the city council of Valley City will offer the electric light plant for sale, as it is not considered a paying proposition for the city. The expenses for the past year were $7,000 in excess of the receipts. The council will offer a twenty-year franchise with the plant.

NORTHFIELD, VT.—J. M. Holland, of New York, a former resident of this town, has bought several Hillside farms, and also the water privileges, in connection with a plan to construct a system to furnish Northfield with water for domestic use, light, manufacturing and other purposes. The estimated cost is from $50,000 to $75,000.

FORT WAYNE, IND.—A company of citizens has published an address to the people offering to build the city an electric light plant which will furnish street lights for $70 a year and charge ten cents a kilowatt for commercial use. The plant is to become the property of the city in ten years, the city paying over to the company the $60,000 which has been raised by taxation for a municipal plant. The persons making the offer are Charles McCulloch, Henry Beadell, J. H. Rahe, Joseph F. Getz, A. Fuelber, Paul E. Wolf, Cooney Bayer and W. O. Gross.

ALBA, TEX.—The Lone Star Lignite, Brick and Light Company was organized here recently. The purpose of the company is to mine coal, make brick and furnish the city of Alba with electric lights. The capital stock of the company is $25,000, divided into as many shares of the par value of $1. The following directors were elected at a meeting of the stockholders: J. E. Gibson, president; A. S. Cain, vice-president; W. R. Goodwin, secretary-treasurer; T. L. Lowrie, manager; Joe McChristian, assistant manager; R. E. Bozeman, attorney.

DECATUR, IND.—The tract of land offered by the Commercial Club to the Springfield & Fort Wayne Traction Company for a power-house site has been turned over to the company and work of erecting the plant will be begun at once. The power-house will be the main station of the line and the conditions on which the site is given the company are that they have the line in operation between here and Fort Wayne by January 1, 1905, and that it be extended from Decatur to the east, west or south county line by January 1, 1906. The main offices are to be located here.

STAMFORD, N. Y.—The Schenevus village board of trustees has granted a franchise to M. E. Baldwin and to any corporation that he may organize to construct a complete electric light system in that village. A contract was also made to light the village streets with forty thirty-candle incandescent lights for $600 per year, the lights to burn every night in the year and the contract to continue for five years. The system of lighting the streets with oil costs the village about $300 per year. A corporation will be organized at once to build and operate the works and a force of men will come from New York city to push the work to completion. The water power at the White mills will be utilized. Extensive repairs to this property have been in progress since Mr. Baldwin purchased it last spring. It is expected that the work will be complete about November 1.

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ELECTRICAL SECURITIES.

About once a month for the past half year the statement has been made that prices had at last reached the lowest point possible wthout bringing about financial disaster. Notwithstanding the recurrence of this statement, prices continue to sag and droop, though at the same time there has been a lack of disaster which is remarkable and goes a long way toward establishing a precedent for hopefulness which will always be of value in financial emergencies. One thing is proved without doubt, and that is the inherent stability of a number of securities which have been pounded until they are now far short of their nominal value. During the week the speculative change was radical and of such a nature that it gave evidence that there was considerable support in favor of several industrials which have been mercilessly handled for the past five months. On Monday the market was in a state of semi-panic, and this was followed by a sharp rally which was maintained until, at closing, there was registered a very general advance of from two to five points all along the line.

There is every evidence that the bounteous crop—the product selling at higher figures than for many years—will put into circulation a large amount of buying capital, and this will be a factor in creating a demand for manufactures which will have a vitalizing effect on every industry.

The action of the United States Steel Corporation in offering to take up the securities held by its employés, while in some quarters regarded as an acknowledgment of the defeat of its copartnership plan, is in other quarters regarded as an evidence that the company appreciates the full value of its holdings. The declaration of the regular dividend—which, at the writing, seems entirely probable—will materially help the situation. According to a semi-official statement, steel earnings for the September quarter amount to $35,000,000, which is only a trifle less than for the same period last year.

ELECTRICAL SECURITIES FOR THE WEEK ENDING OCTOBER 3.

New York:	*Closing.*
Brooklyn Rapid Transit	34⅝
Consolidated Gas	172⅞
General Electric	150
Kings County Electric	150
Manhattan Elevated	131¼
Metropolitan Street Railway	106½
New York & New Jersey Telephone	145
Westinghouse Manufacturing Company	166

The annual meeting of the shareholders of the Manhattan Railway Company will be held at the company's office, No. 195 Broadway, Manhattan Borough, New York city, on Wednesday, November 11, at twelve o'clock noon. A board of directors for the ensuing year is to be elected, and three inspectors of election. The transfer books will be closed on Saturday, October 10, at twelve o'clock noon, and will be reopened on November 12, at ten o'clock A. M.

Advices from Pittsburg say that it is understood that Westinghouse earnings for August were the largest in the history of the company, the immense business of August, 1902, having been considerably exceeded, although it had not been expected by the officials of the company.

Application has been made to the New York Stock Exchange to list $625,000 additional capital stock of the Kings County Electric Light and Power Company.

Boston:	*Closing.*
American Telephone and Telegraph	127¼
Edison Electric Illuminating	227
Massachusetts Electric	77½
New England Telephone	124
Western Telephone & Telegraph preferred	80½

Rising seventy per cent of the $21,943,200 American Telephone stock subscription has been paid in, although only twenty per cent was due on September 22, and payments could have been made in twenty per cent installments ending May 6. Fully paid stock will participate in the dividend due in January, 1904. The plan of expenditure of the new stock proceeds is this: For the New England states, $1,535,900; Middle states, $6,603,000; Canada, $500,000; Middle Western states, $2,520,000; Western states, $1,458,450; Southern and Gulf states, $2,709,200; Pacific states, $501,000; for purchase of instruments and construction of long-distance lines, $4,250,000; a total of $20,077,550.

The report of the Edison Illuminating Company for the fiscal year ended June 30, 1903, shows the company's income from the sale of light and power to have been $2,663,733, and the total expense to have been $1,730,456, leaving a net income of $933,277. Other income amounted to $36,578, bringing the total net income up to $969,855. The dividends paid, interest, etc., amounted to $990,175, leaving a deficit for the year of $20,320, as compared with a surplus of $45,843 for the year ending June 30, 1902.

Philadelphia:	*Closing.*
Electric Company of America	8
Electric Storage Battery common	50
Electric Storage Battery preferred	50
Philadelphia Electric	6 1/16
Union Traction	42¾
United Gas Improvement	80

Chicago:	*Closing.*
Chicago Telephone	115
Chicago Edison Light	140
Metropolitan Elevated preferred	52
National Carbon common	18½
National Carbon preferred	88
Union Traction common	4
Union Traction preferred	30

Northwestern Elevated in September handled a daily average of 68,107 passengers, this being an increase of 4,157.

South Side Elevated handled a daily average during September of 81,887 passengers, an increase of 5,315. The report of the company for the year ended June 30, 1903, is as follows: Gross earnings, $1,555,044; expenses, $856,128, leaving net earnings of $698,916, an increase of $50,804 over the preceding year.

ELECTRIC RAILWAYS.

COALGATE, I. T.—Arrangements have been perfected for the construction of the electric road from Coalgate to Lehigh, and work has commenced.

YORK, PA.—Surveys are being made through Elizabeth for a trolley line to connect with the Conestoga Traction Company's line, joining Lancaster and Harrisburg.

NEW YORK, N. Y.—Permission has been granted to the New York & North Shore Railway Company, of Queens, to change its name to the Long Island Electric Railway Company.

PHILADELPHIA, PA.—The Central New Jersey Traction Company has completed its line from Keyport nearly to South Amboy, and expects to have it in operation before fall.

CHICAGO, ILL.—The Chicago & Milwaukee Electric Railway has opened its new westerly branch from Lake Bluff to Libertyville. It is said that the road will be extended to Rockefeller this fall and later to Fox Lake.

TRINIDAD, COL.—The actual work of construction on the Trinidad electric car line has been begun, and the entire line of twelve miles, as well as the electric power and lighting plant to be built by the company, will be completed as quickly as possible.

DOYLESTOWN, PA.—The Philadelphia & Easton trolley road will be completed between Easton and Riegelsville in about two months, when the upper end of the road will be in operation. The remaining twelve miles necessary to complete the road will be built next spring.

WILKINSBURG, PA.—A new car line is being projected which will be known as the Wilkinsburg, East Pittsburg & Turtle Creek Railway, to connect Turtle Creek with Wilkinsburg. The company is capitalized at $30,000, and the promoters are Thomas Gearing, A. J. Kent, M. Douginier and George B. McClellen.

HAVERHILL, MASS.—It is stated that the proposed electric road from Boston to Haverhill will surely be built. It is proposed to run on the Boston & Northern tracks to Maplewood in Malden, and to traverse the Newburyport turnpike for about eleven of the thirty-three to thirty-five miles between Boston and Haverhill.

INDIANAPOLIS, IND.—The Indiana Northern Traction Company has let the contract for the construction of its line from Marion to Wabash. The road is to be in operation next June. From

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Wabash it will be extended north, through North Manchester and Silver Lake to Warsaw, and later to Goshen, to connect with the Elkhart and South Bend roads.

NEWPORT NEWS, VA.—The route of the projected Jamestown, Yorktown & Old Point Electric Railway has been determined. The line will have terminals here and at Old Point. The route will be from Jamestown Island to Williamsburg, to Yorktown, to Little Bethel, branching out there to Newport News and also to Old Point. The statement is made that the first car will run into Newport News from Jamestown before January 1.

RICHMOND, IND.—By the completion of the Dayton & Western traction line into Richmond, Indianapolis and Dayton, Ohio, are joined by a continuous line which is one of the longest in the world. It not only links Ohio and Indiana, furnishing many important connections, but it will be one part of the trunk line that will eventually connect St. Louis and New York, with branches that will touch Cincinnati, Cleveland, Toledo, Detroit and other important points.

LANCASTER, PA.—A charter has been granted to the Lancaster & Coatesville Street Railway Company with a capital stock of $150,000. The incorporators of the company are A. C. Baldwin, C. R. Herr, Adam L. Landis, John L. Leaman, R. A. Baldwin, A. H. Hostetter, Adam S. Ranck, Henry S. Rutter, Willis Rohrer, John K. Diehm, A. L. Leaman, Frank G. Groff, Moses Snavely, B. S. Weiler, J. Frank Seldomridge, J. W. Stern, I. N. Hurst and H. E. Hess. The road is to begin at Witmer's Bridge and pass through the villages of Bird-in-Hand, Intercourse, Spring Garden, White Horse, Cains, Compassville, Sandy Hill, Wagontown, thence to Coatesville.

NEWARK, OHIO—The Newark, Martinsburg & Mt. Vernon Traction Company has been organized with the following officers: President, E. H. Everett; vice-president, Dr. J. F. Shrontz; treasurer, John A. Chilcote; secretary, Frank E. Elliott. The company has secured practically the whole right of way from Newark through Martinsburg and Gambier to Mt. Vernon, and it is the intention to complete the road immediately. This road will complete a traction line from Cincinnati to Cleveland, as Cleveland is now connected with Wooster, and Newark with Cincinnati. From a point between Martinsburg and Gambier the new company will build a connecting line directly northward to Wooster, thus completing the transstate line.

FOND DU LAC, WIS.—The Fond du Lac & Oshkosh Electric Railway Company and the Fond du Lac Street Railway and Electric Light Company have been consolidated under the name of the Eastern Wisconsin Railway and Light Company, capital $500,000. This means a consolidation of the Fond du Lac Street Railway and Light Company, the gas company and the interurban line into one interest. No new line will be built from this city to Oshkosh as has been announced. The officers of the new company are: President, F. B. Hoskins, of Fond du Lac; vice-president and general manager, T. F. Grover, of Fond du Lac; secretary, B. Wild, Jr., of Fond du Lac; treasurer, W. E. Cole, of Fond du Lac; directors, F. B. Hopkins, T. F. Grover, B. Wild, Jr., W. E. Cole and E. B. Herren, of Fond du Lac, and Leander Choate and Elmer Leach, of Oshkosh.

CAMDEN, N. J.—It is stated that the long-talked of trolley line connecting Philadelphia and Atlantic City will be completed and in operation by May 1, 1905. It will be a four track electric road and work upon the construction will begin within the next thirty days. Surveys have been completed, the right of way obtained and contracts entered into for the entire work. The road will be virtually an air line. It will run direct to Clementon, eight miles from the Gloucester ferry, from whence it will parallel the Reading, keeping to the south, but within a quarter of a mile of that line, for the entire distance. The estimated cost of the construction of the road is $9,000,000. Two of the tracks will be for passenger service and two for freight. Both express and local traffic will be catered to and it is expected to make the run from Philadelphia, a distance of fifty-two miles, to Atlantic City in less than an hour. Numerous stations are to be erected and an immense power plant is to be built half way between Gloucester and Atlantic City.

NEW INCORPORATIONS.

ALBANY, N. Y.—Clinton Telephone Company. $50,000.

BAY CITY, MICH.—United Traction Company. $250,000.

LINCOLN, NEB.—The Virginia Telephone Company. $4,000.

DES MOINES, IOWA—What Cheer Telephone Company. $5,000.

DILLONVILLE, OHIO—Vigilant Telephone Company. $3,000.

CRIPPLE CREEK, COL.—La Bonte Telephone Company. $25,000.

NEWPORT, ARK.—The Farmers' Telephone Company. $100,000.

COSHOCTON, OHIO—The Citizens' Telephone Company. $50,000.

LANSING, MICH.—Alpena Light, Heat and Power Company. $500,000.

KEOKUK, IOWA—Union Telephone and Telegraph Company. $1,500,000.

DES MOINES, IOWA—The Archer-Primghar-Philby Rural Telephone Company. $1,000.

HILLSBORO, ILL.—Hillsboro Electric Light and Power Company. Increased to $25,000.

FRANKFORT, KY.—The McKee & Booneville Telephone and Telegraph Company. $3,000.

COLUMBUS, OHIO—Butler County Western Telephone Company. Increased from $5,000 to $12,000.

COLUMBUS, OHIO—The Cincinnati Telephone Company. Increased from $50,000 to $1,000,000.

ELMA, N. Y.—Elma Telephone Exchange. $5,000. Incorporators: Herman Juge, R. Peter and Herbert B. Lee.

LANSING, MICH.—South Dover Telephone Company. $1,000. Traverse Bay Telephone Company. $4,000.

GERMANTOWN, PA.—The Germantown Independent Telephone Company. Increased from $2,500 to $10,000.

JOHNSTOWN, OHIO—The Johnstown & Creton Telephone Company. Increased from $30,000 to $50,000.

SPRINGFIELD, ILL.—Pitcher Telephone Company. $7,500. Incorporators: James Bayne, W. Ford and L. D. Pitcher.

MUSKOGEE, I. T.—The Muskogee Traction Company. $300,000 Incorporators: J. L. Wisornan, W. P. Dewar, W. R. Raton and Ruel Haskell.

ASHLAND, WIS.—The Bayfield County Telephone Company $30,000. Incorporators: T. C. Jacobs, C. F. Latimer and C. S. Lamoreaux.

ST. PAUL, MINN.—Thompson Electric Company. $25,000. Incorporators: William G. Jordan, Frank B. Thompson and Ralph D. Thompson.

FRANKFORT, KY.—Hickman County Telephone Company. $5,000. Incorporators: Thomas Emerson, B. A. Boone and J. R. Scarbrough.

WINONA, MINN.—The Lewiston Telephone Company. $10,000. Incorporators: John Gaffney, Henry E. Wirt, Peter C. Daley, B. S. Blanchard, M. A. Williams.

LOS ANGELES, CAL.—The Whittier Telephone and Telegraph Company. $100,000. Directors: P. T. Spencer, W. Johnson, C. L. Zahn, Los Angeles, A. Hadley and E. W. Bacon, Whittier.

GLENWOOD, MINN.—Glenwood Mill and Electric Light Company. $25,000. Incorporators: Peter Peterson, W. F. Dougherty, M. A. Wollan, George W. Brown, J. H. McCaulay and J. R. Serrin.

CHESTER, W. VA.—The Ohio Valley Street Railway Company. $25,000. Incorporators: E. D. Marshall and John A. Gardner, of Chester, Thomas C. Pitcairn and John W. Bailey, of Pittsburg, and George W. Palmer, of New Cumberland, W. Va.

SPRINGFIELD, ILL.—The Decatur, Tuscola & Champaign Railroad Company. $50,000. Incorporators: J. H. Culver, Charles S. Hankins, William H. Black, J. M. Clokey, D. L. Campbell, J. L. Ray, Ashton Campbell, Charles G. Eckhart and A. W. Wallace.

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PERSONAL MENTION.

DR. LOUIS BELL, the well-known consulting electrical engineer and electrical expert, of Boston, Mass., was a visitor to New York city last week.

MR. ROBERT SIBLEY, Berkeley, Cal., has been appointed professor of mechanical and electrical engineering at the University of Montana, at Missoula, Mont.

MR. D. M. REARDON, formerly of Flagstaff, Ariz., is now located in San Francisco, Cal., in connection with the mining interests of the General Electric Company.

MR. M. S. KETCHUM, assistant professor of civil engineering of the University of Illinois, Champaign, Ill., was married on September 17 to Miss Mary Esther Beatty, of Newton, Iowa.

MR. WILLIAM R. CORSON, consulting engineer, has removed his office to No. 724 in the Connecticut Mutual Life Insurance Company's Building, corner Main and Pearl streets, Hartford, Ct.

MR. WILLIAM R. HILL, M. Am. Soc. C. E., has tendered his resignation as head of the Aqueduct Commission of New York city, to take effect October 14. Mr. J. Waldo Smith will succeed him the following day.

MR. LEWIS G. MARTIN, the well-known cable expert of the Okonite Company, New York city, has returned from the Philippine Islands, where he was recently stationed in charge of the laying of the shore end of the Pacific cable at Manila.

MR. C. W. BARTLETT, the Nebraska representative of the Stromberg-Carlson Telephone Manufacturing Company, is now located at 1635 South Twenty-second street, Lincoln, Neb. Mr. Bartlett's previous address was Kansas City, Mo.

MR. C. C. WARREN, president of the Warren Electric Manufacturing Company, Sandusky, Ohio, stopped at New York en route to Ohio one day last week. This company's factory is especially busy at this moment in the production of alternators, most of which are of the larger units.

MR. WILLIAM H. HILL, manager of the foreign department of the General Electric Company, New York, died on the morning of September 29 at his home in Orange, N. J. Mr. Hill recently returned from a two years' stay in Mexico, where he was located in the interests of the General Electric Company.

MR. W. B. CARVELL has been appointed manager of the new electric light plant at Allensville, Ky. He has also been appointed manager of the new telephone exchange which is to be put in at Allensville by the Home Telephone Company of Tennessee. The current for the electric lights at Allensville will be taken from the electric power plant at Guthrie, Ky.

MR. C. H. BROWNELL, of Peru, Ind., manufacturer of telephone booths, was a New York visitor last week. Mr. Brownell reports that the demand for booths in the telephone field is constantly increasing, the advantages of quiet and secluded telephoning evidently growing rapidly in favor. The telephone is now considered a necessity in every modern office.

MR. BOARDMAN HALL, of Boston, Mass., representing the company of capitalists which is to build the Rockland, South Thomaston & Owls Head Street Railway, in the state of Maine, was in Rockland last week going over the survey which is being made. Mr. Hall said work on the road will be begun in the early spring and rushed so that by the time of the opening of the summer season of 1904 the road will be in operation.

MR. THOMAS E. CLARK, president and general manager, and Mr. Ackland Stiling, advertising manager, of the Thomas E. Clark Wireless Telegraph-Telephone Company, Detroit, Mich., left Thursday on a business trip to St. Louis, Mo., on matters pertaining to the company's exhibit at St. Louis Exposition. It is the intention of this company to have a most attractive exhibit, many new thoughts and features being brought before the visitors.

MR. ALEXANDER J. CASSETT, president of the Pennsylvania Railroad, has resigned from the board of directors of the Public Service Corporation of New Jersey. Mr. Cassett tendered his resignation in July, but this was not acted upon, as no meeting of the directors had been held since that time. Mr. A. H. Carleton, third vice-president of the corporation and former president of the United Electric Company, of New Jersey, has succeeded Mr. Cassett as a director.

MR. EUGENE L. ASHLEY, of Glens Falls, N. Y., president of the Hudson River Water Power Company, was given a banquet at Saratoga, N. Y., on September 24, by the citizens of Glens Falls, South Glens Falls, Sandy Hill, Fort Edward and other towns. The banquet was a testimonial in recognition of the perseverance displayed by President Ashley in successfully carrying forward the construction of the granite dam that harnesses the Hudson river at Spier's Falls, Saratoga County.

MR. L. C. VAN VESS, general manager of the Lincoln, Neb., Gas and Electric Company, has been asked by President Edgar to report to the twenty-seventh convention of the National Electric Light Association, to be held in Boston next May or June, on lost and unaccounted for current. Mr. Van Ness made a report on this subject at the Chicago meeting. He has been giving the matter considerable further study since that time, and hopes to make the next report much more valuable and interesting than any former ones.

MR. W. B. LONGYEAR has resigned his position as controller of the Brooklyn Rapid Transit Company, on account of ill health. Mr. Longyear has been ill for some time and would not risk the severe winter in New York, so has made arrangements to go to New Mexico. Mr. Howard Abel, a western man, has been chosen for the position of controller. Mr. Abel was for many years associated with Mr. Charles T. Yerkes, and was connected with the management of the North and West Chicago Street Railway companies.

SIR JOHN DICKSON-POYNDER, Bart., M. P.; Mr. George Gibb, director and general manager of the North-Eastern Railroad; Lord Ribblesdale and Sir David Barbour, K. C. M. G., members of the Royal Railroad Commission appointed to study the American street railway systems, with a view to bettering the conditions in Great Britain, and especially in London, arrived in New York on September 26 on the White Star steamship Arabic. No definite plan has been determined upon for the commission to follow out, but an investigation will be made of every branch of American street railroads. It is stated that three weeks will be spent in New York and Boston.

MR. RICHARD T. LAFFIN, for three years general manager of the Worcester Consolidated Street Railway, has resigned to accept the position of general manager of the Manila Electric Railway, Light and Power Company. Mr. Laffin's resignation will take effect on January 1, 1904, and he expects about the first of the year to depart for the Philippines to assume the duties of his new position. The company will build an electric railway system in Manila, connecting the city proper with the suburbs. It will also build an electric light station for lighting the city of Manila. The company now owns a steam road which will be converted to electric traction, and will build and equip valuable water power systems, the rights for which it already owns.

MR. F. A. STRATTON, vice-president of the Westchester Lighting Company, of New York, was tendered a complimentary dinner by a number of prominent citizens on Saturday evening, September 26. Mr. Stratton is one of the most popular railway men in the East. During the international yacht races he gave a delightful outing to a hundred or more gentlemen friends, in the form of an ocean trip on the steamer Isabella, which he chartered for the occasion. Among those in the party were many who had been Mr. Stratton's guests on former occasions, and the idea was suggested that some substantial recognition be made of his good fellowship and generous hospitality. Subsequently, Mr. William Archer, of Mount Vernon; Mr. John H. Bangs, of New Rochelle, and Mr. Frank Hardy, of Larchmont, were appointed a committee to make the necessary arrangements. The dinner was served in the large dining-room of the Hunters Island Inn, on Pelham road. A souvenir menu was prepared, containing on the front cover a reproduction of the burgee of Sir Thomas Lipton and Mr. Stratton, and on the inside front page a splendid likeness of Mr. Stratton. Speeches were made by Mayor Henry Clark, of New Rochelle; Mayor Edwin W. Fiske, of Mount Vernon; Mayor Michael J. Walsh, of Yonkers; Mr. Frank Millard, Mr. Stephen Van Tassel, Coroner Russell, of Tarrytown; Dr. James H. Brennan, of New Rochelle; Mr. Comely, president of the village of Port Chester, and others.

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INDUSTRIAL ITEMS.

THE CANADIAN GENERAL ELECTRIC COMPANY, Limited, Toronto, Canada, is now representing the Electric Storage Battery Company, in the sales of the chloride accumulator and the "Exide" accumulator throughout Canada.

J. H. BUNNELL & COMPANY, New York city, N. Y., is sending out an attractive circular descriptive of the "Beekophone." The instrument is well constructed, with solid back transmitter, double pole receiver, vibrator bell and call button.

THE STANDARD UNDERGROUND CABLE COMPANY, Pittsburg, Pa., announces the removal of its San Francisco office from the Mills Building to more commodious quarters in the Crossley Building, at Mission and New Montgomery streets.

THE WYCKOFF PIPE AND CREOSOTING COMPANY, Stamford, Ct., has issued a pamphlet descriptive of creosoted conduits for underground wires and cables, poles and cross-arms, railroad ties, bridge timber, piles, paving blocks, fence posts and lumber.

THE THOMAS E. CLARK WIRELESS TELEGRAPH-TELEPHONE COMPANY, Detroit, Mich., announces that the McCoy Engineering Company, 107 East German street, Baltimore, Md., and 23 Corcoran Building, Washington, D. C., is its eastern representative.

THE ROPE FIBRE PULLEY COVERING COMPANY, Springfield, Ohio, which a few months ago placed on the market a new adaption for facilitating power transmission, as its name would indicate, advises that it has made rapid progress in the marketing of the new invention.

THE STANLEY ELECTRIC MANUFACTURING COMPANY, Pittsfield, Mass., announces the opening of two new sales offices, one at Cincinnati, Ohio, with headquarters in the Perin Building, in charge of Mr. O. H. P. Fant, and the other in the Century Building, St. Louis, Mo., in charge of Mr. F. Johnson.

THE INTERNATIONAL STEAM ENGINEERING COMPANY, Atlanta, Ga., states that its cooling tower business is assuming large proportions. The company has recently closed a contract for a 3,000-horse-power cooling tower, with other propositions under way for apparatus up to 10,000-horse-power capacity.

THE LOS ANGELES RAILWAY COMPANY and Pacific Electric Railway Company, Los Angeles, Cal., has each placed an order with the Electric Storage Battery Company for a sufficient number of plates to increase the capacity of its respective batteries 100 per cent. Each battery will now have a capacity of 2,000 amperes for one hour.

THE NATIONAL CARBON COMPANY, Cleveland, Ohio, through its sales manager, Mr. N. C. Cotabish, reports the heaviest demand for carbon products ever known at this season of the year. The large factories at Cleveland and the company's subfactories in different parts of the country are running at practically the fullest capacity.

THE PITTSBURG BLUE-PRINT COMPANY, Pittsburg, Pa., will be pleased to mail an illustrated catalogue describing its electric blue-printing apparatus. Several types are described, including the upright wall machine and the tilting wall machine, both automatic and non-automatic. This company also makes blue-print wringers and other specialties of this nature.

THE SPRAGUE ELECTRIC COMPANY, New York city, in its bulletin No. 411, gives a complete description and illustrations of iron-armored conduit, junction boxes, fittings, tools, etc. This bulletin illustrates a very complete line of equipment of this nature and will be found of great practical value to any one having need of such material. The bulletin will be sent upon request.

THE ELECTRIC APPLIANCE COMPANY, Chicago, Ill., announces it will be pleased to send the trade, by prepaid express, upon receipt of application, its new catalogue. Applications will receive prompt attention, provided they are accompanied by business cards. These catalogues are of the latest type and are very comprehensive.

THE UNITED TELPHERAGE COMPANY, Westfield, N. J., is sending out two very attractive circulars, being No. 39 and No. 40. No. 39 treats of the electrical handling of miscellaneous freight and No. 40 treats of the handling of reserve storage, coal, coke and ashes. Circulars will undoubtedly be interesting to those interested in telpherage and will be sent on request.

THE MICA INSULATOR COMPANY, New York city, is mailing an attractive postal card bearing the title of "Let Well Enough Alone if You Are Unprogressive and 'Well Enough' Is Good Enough." The Mica Insulator Company is the manufacturer of a high-grade insulating compound for armatures, field coils, magnets, etc. This is claimed to be moisture-proof, durable, elastic and non-corrosive. The company will be pleased to send samples and descriptive booklet on request.

THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, Rochester, N. Y., and Chicago, Ill., has recently issued a very attractive catalogue which includes bulletins Nos. 6 and 7. This catalogue is fully up to the standard in completeness and design. Bulletin No. 6 treats of generator call switchboards, and embodies a very good feature in that it shows on the page opposite to the half-tone engraving of the cabinets a drawing of the same. Bulletin No. 7 treats of a generator call switchboard and parts. Net prices are therein quoted on all switchboard parts. Included in the catalogue is a summary sheet which will be found in the book. This catalogue will be sent on request.

THE NORTH ELECTRIC COMPANY, Cleveland, Ohio, is to be congratulated upon a recent publication which has been compiled and designed by its advertising department, under the direction of Mr. Frank F. Sapp. The work is entitled "The Rural Telephone." On the cover, which is a handsome rag effect in a slate black, is mounted a photographic reproduction of a rural telephone line which is highly artistic in effect. The illustrations are beautifully worked out and the processing which the paper has received after the printing has greatly enhanced the finish of the work. The reading matter is carefully arranged and of great practical value to any one interested in the rural telephone. The booklet comes in a handsome envelope made of the same quality of paper as the cover of the booklet. The whole is no doubt one of the handsomest catalogues ever produced.

THE GENERAL ELECTRIC COMPANY, Schenectady, N. Y., has just brought out a very attractive booklet, "Permanency of Transformer Insulation." It is the object of this booklet to describe how the company has developed a process to accomplish the necessary results in transformer insulation, which are not only invaluable, but necessary to a good transformer. The book will be found profitable to those who are interested in transformers, and will be sent on request. The company has also brought out a handsome booklet descriptive of its core type transformers. In this booklet it states it began the manufacture of this type of transformer in 1896, and since that time continued improvements have been made in all the features that go to make up a good transformer. Some of these features have been described therein. This booklet will also, undoubtedly, prove valuable to those interested in transformers, and will be sent on request.

THE H. W. JOHNS-MANVILLE COMPANY, 100 William street, New York city, has secured a large order for roofing from the War Department, to be used on the army buildings in the Philippine Islands. A total of 14,020 rolls of roofing, making over 900 tons, has been ordered. This is enough to cover over sixty-five acres, or will make a strip a yard wide and about 200 miles long. Ten bids were submitted, and the award was made after a careful investigation by the War Department and the supervising architect of the Treasury. Prompt delivery of the roofing was essential, and it is of interest to note that one order for 11,120 rolls was completed within thirty days, and another for 2,900 rolls within ten days after receipt. The company has just issued a unique folder, "Pictorial Prologue and Pictorial Epilogue." Pictorial Prologue shows a picture of Uncle Sam receiving bids for 11,120 rolls of roofing paper April 30, 1903, and for 2,900 rolls July 7, 1903, each to contain 216 square feet. Pictorial Epilogue shows copy of report made July 23, 1903, by the supervising architect at Washington, D. C. The company's Pittsburg branch on account of increased business has found it necessary to secure larger quarters. It now occupies the entire building at 218-220 First street, Pittsburg, Pa.

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ELECTRICAL REVIEW

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CHARLES W. PRICE . . . . . PRESIDENT AND EDITOR
STEPHEN H. GODDARD . . . . . SECRETARY AND MANAGER
WM. HAND BROWNE, JR. . . . . TECHNICAL EDITOR
AINSLIE A. GRAY . . . . . ASSISTANT EDITOR

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CONTENTS

EDITORIALS 541-548
High-Speed Electric Railroading 541
The Electrical Fire Hazard 541
Electricity on Canals 541
An Interesting Application of Polyphase Motors 542
Injuries to Shade Trees by Electricity 542
Speed of X-Light Determined by M. Blondlot 543
On Single-Phase Repulsion Motors, by William Cramp 545
Memorial to James Watt 548
Electric Railways in the United States 548
Journal De Chimie Physique 548
The New Plant of the Westinghouse Foundry Company at Trafford City, Pa. . . . 549
Electrical Notes from Europe 554
Address to the Engineering Section of the British Association for the Advancement of Science, by Charles Hawksley, President of the Section 556
Surface Contact System Accepted 558
Electric Cars on the Marienfeide-Zossen Line Breaks All Speed Records 558
On the Use of Capacities as Multipliers in Connection with Electrostatic Voltmeters on Alternating- urrent Circuits, by E. W. Marchant and G. W. Worrall 559
Injuries to Shade Trees from Electricity 560
Brooklyn Rapid Transit Men to Receive Instruction in Electrical Engineering . . . 560
Notes on X-Light, by William Rollins 561
The Reception Committee of the American Institute of Electrical Engineers 561
A Single-Phase Traction Motor 561
Gutta-Percha from New Guinea 561
The Old Time Telegraphers and United States Military Telegraph Corps 562
Annual Report of the Meridan Railroad Company 562
Professor Ayrton to Lecture before the New York Electrical Society 562
Street Railway Association of the State of New York 563
INDUSTRIAL SECTION:
A Motor-Driven Milling Machine 568
Seattle Water-Wheel Installation 568
A New Signal System for Electric Railways 569
Triplex Blocks for Hoisting Service 570
Recent Illustrated Trade Literature 571
The Ohio Electric Light Association 571
CURRENT ELECTRICAL NEWS 572-576

HIGH-SPEED ELECTRIC CAR TESTS.

The recent tests on the Berlin-Zossen experimental railroad resulted in a speed of about 125 miles an hour. This has been secured by equipping a car with sufficient power in its motors and by building a suitable roadbed. The results, while noteworthy, can hardly be said to have been unexpected, but it is nevertheless greatly to the credit of the German engineers that they have carried out the work so satisfactorily. While, from the general reports, one might be led to believe that the chief object of this work was to attain a higher speed than had been reached previously, this is only incidental to the gathering of engineering data on the high-speed running of trains. Work of this character has been done in this country, but only on an experimental scale. In the German tests the car was not only of regulation size, but carried a number of passengers, and it is said that there was no discomfort due to the exceptional speed. The work is of real importance, and it is not to be doubted that the results obtained will have a decided bearing on the operation of the express train of the future, no matter what the motive power may be.

THE ELECTRICAL FIRE HAZARD.

Why is it that insurance inspectors appear to be prejudiced against electricity? One can hardly pick up an insurance paper but what he encounters a formidable indictment of electrical wiring and a list of fires "undoubtedly caused by electricity," though seldom is a statement made as to the relative number of fires due to electricity and to other causes.

Now, it is all very well to insist upon the proper installation and proper care of electrical wiring, but these are matters which are largely under the control of the fire underwriters, and it rests with them to say whether any particular installation is safe. There is no law compelling them to ensure a building. There is a code of rules which they are perfectly able to enforce, as they have their own inspectors, and if these rules are not satisfactory they should be made so. But little good is accomplished by such unfair summaries as are frequently published. The electrical method of supplying power and light can be made as safe, or safer, than any other, and any endeavor to prejudice the public against this would seem to be working against the interests of the insurance people themselves. If they insist upon good work in the first place and proper care afterward, the result must be an improvement in the electrical hazard.

ELECTRIC HAULAGE ON CANALS.

In a recent issue of the *Revue Technique*, M. Georges Petit gives an interesting discussion of electric haulage on canals. Recognizing that the principal problem was one of traction, it is necessary to consider two methods—one in which the motor travels on an ordinary road, and the other in which it runs on rails. The first system gives a higher tractive effort for a given weight of motor, but it takes more power to move the motor itself, and the efficiency of the system is less than when the motor runs on rails. In studying the problem, the power required to overcome the inertia of the boat is easily computed from its known weight. That, however, required to overcome the friction of water when confined in a canal could only be determined experimentally, and to do this, boats were brought up to a known speed and were then allowed to drift after the tractive force had been cut off, their rate of retardation being noted. From the retardation curves and the computed inertia, acceleration and power curves were constructed, both for motors traveling on an ordinary roadbed and on rails. The results show that the rail system is superior to the other, and that it will be less expensive to keep up, although the first cost will be greater. It is the author's opinion, that mechanical haulage on canals will surely be adopted in the future, and he believes it will be entirely successful. Moreover, the systems will be operated electrically because this is the most efficient and reliable method of supplying the power.

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AN INTERESTING APPLICATION OF POLYPHASE INDUCTION MOTORS.

Some time ago we made note of an interesting adaptation of polyphase motors to pumping work, in which the objection to these motors on account of their characteristic weak starting torque was neatly overcome by starting the motors with the valves closed. Under these conditions they simply circulate the water in the pumps and do but little work. After they have reached their normal speeds, the valves are opened and they at once begin pumping.

A Peculiar Condition of Operation.

Another application of polyphase motors, possibly more interesting than the one mentioned above, is that in the sugar refinery at Cambrai, France. In this plant the most troublesome machines to operate are the large centrifugal drying machines. These machines must be started and stopped quickly and frequently, while they run but for a short time at their normal speed.

Series and Compound Motors Not Thought Suitable.

Under these conditions, the engineers naturally turned first to series or compound motors; but although these motors have an excellent torque at the moment of starting, this torque decreases as the speed increases, while, on the contrary, the power developed by the motor should increase with the increase in speed if a constant acceleration is to be given to the machine. As the kinetic energy of the centrifugal, which represents at any moment practically the sum of all the work done by the motor up to that instant, varies as the square of the speed, the energy stored up in it during the first few seconds in which the speed is brought up to 100 revolutions per minute, and at which the torque of the series motor is greatest, is negligible compared with that which must be given to the machine during the last few seconds in which the speed is increased from 900 to 1,000 revolutions per minute.

The Application of Induction Motors.

To meet this requirement the engineers decided upon a polyphase induction motor having a double winding on the rotor, and brought up to speed by connecting it to circuits supplying currents of different frequencies. The double winding of the rotor consists of a high-resistance circuit slightly embedded in the core, and a low-resistance winding deeply embedded. The former gives a large torque at starting, the latter a large torque as the machine nears normal speed. The combination gives a fairly flat torque characteristic. When starting, the motor is first connected to a circuit supplied with current at a frequency of twenty-one cycles per second. After speeding up it is connected to a circuit of which the frequency is thirty-five cycles, and finally to a circuit of which the frequency is fifty. In this way the machine is brought up to full speed in about one minute, while the energy supplied to it during this time by the driving motor, which is rated at thirty-five horse-power, is 110,000 kilogramme-metres, a performance which the engineers did not think they could obtain from a direct-current motor.

Motors Used in Braking.

Another advantage gained by the use of the three frequencies is that, by throwing the motor, which is running at full speed, successively on to the circuits having a lower frequency, the motor is made to operate as a generator, and in this way the machine is brought to rest in fifteen seconds, and returns to the circuit during this time much of the kinetic energy which would otherwise be dissipated in braking. The arrangement adopted was an ingenious solution of a difficult problem in machine driving.

DAMAGE TO SHADE TREES FROM ELECTRICAL CONDUCTORS.

A bulletin issued recently by the Massachusetts Agricultural College gives a somewhat detailed report of an investigation made to ascertain the damage caused to shade trees by stray electrical currents or by overhead wires of any kind.

Damage Due to Careless Trimming.

A good deal of damage to shade trees is not caused directly by the wires, but is done to make a clear way for them. In running wires, either for telephone, telegraph or railway systems, it is very important that there should be a clear way. For this reason it is usual for the linemen who are putting up the wire to trim those trees that interfere, and it is needless to say, that either through ignorance or carelessness, the work is done without much consideration for the trees. Probably in the greater number of instances this trimming does little harm, but it would be only just to have this work done as carefully as possible and to paint the wounds with some antiseptic so as to prevent the attacks of insects or disease.

Young trees standing under a pole line are apt to be injured if this line carries a large number of wires, as the buds on the upper branches are killed by rubbing and striking against the wires. This produces a distorted and stunted growth.

Injury from Alternating Currents.

The effect of currents leaking from wires to the ground through trees does not seem to be well understood. The report considers damage due to both alternating and direct currents, and it says that no case has been reported where an alternating current has killed the entire tree. The damage due to alternating currents usually consists of a burning at the point of contact of limb and wire. If this burning is severe it is apt to kill the entire limb, but the passage of the current through the lower part of the tree does not seem to be injurious. From laboratory studies it was found that very small currents do not affect the tree at all. Then there is a range of current intensity which stimulates. A further increase in intensity of the current produces retardation, and finally a value is reached which kills the plant. These experiments were carried out on small plants, and followed by measurements of the resistance of trees which were made to determine what danger there was of stray currents reaching an intensity sufficient to retard growth or to kill the tree. The values found were high and while the measurements were crude and can hardly be thought to give more than an indication of the resistance of a tree trunk, they show that there is little danger of death from a current leaking from an alternating-current feeder. The actual cause of the death of the small plants seemed to have been the heat pro-

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duced by the passage of the current, and was not due to any electrical effect.

Direct-Current Injuries.

Direct currents, however, are not as free from blame as the alternating. While the usual damage due to a direct current is a more or less severe burning at the point of contact, whether the damage extends further seems to depend upon the direction of the current flow through the trees. The circuits usually causing trouble are the railway feeders which carry a potential of about 600 volts and have a grounded return. Where, as is usually the case, the line is positive and the ground negative, no case was reported of the death of the entire tree, the damage being similar to that caused by alternating currents; but in a few cases, where the feeders were negative and the ground positive, the entire tree was killed. There was a burning at the point of contact and, lower down, the vital layer between the outer bark and the wood was killed entirely around the trunk. That this effect was due to the direction of current flow would seem to need verification, for, while reasons may be suggested for the difference in the action of the currents when flowing up or down the trunk, these are merely speculations. Electrical endosmose may take place and effect the flow of sap, or a migration of positive ions, of such salts as are in solution in the earth, into the roots may produce poisoning, while a similar action of negative ions may have no deleterious effect. A further study of the action of direct currents on trees would be interesting and should be made, and if the effect mentioned in the report is confirmed, the remedy is obviously to reverse the polarity of the electrical system.

Lightning.

The effect of lightning on trees is also taken up in the report. It is said that only in a small number of instances where a tree is struck is it killed. In general the discharge takes place without damage, or merely producing a vertical groove in the trunk which heals up. If, however, the discharge follow a spiral path to the ground it may more or less completely circle the tree, and in this way kill it. An effect which is sometimes noticed, but which was not mentioned in the report, is a loosening of the bark as though it were forced out by the formation of steam in the vital layer. Instances have come to our notice where trees have been killed by lightning, although the grooves caused did not circle the trunk, but where large sections of the bark were loosened apparently in this way.

SPEED OF X-RAYS DETERMINED BY M. BLONDLOT.

BY C. L. DURAND.

An interesting series of researches has been carried out by M. R. Blondlot in order to determine the speed of the X-rays and find out whether their velocity is comparable with that of the electromagnetic waves or with light. He seems to have been successful in establishing that the X-rays are propagated with the same velocity as those of light. This he proves by a very ingenious method. The poles BB′ of an induction coil (Fig. 1) have two wires connected to the poles HH′ of a focus tube which produces the X-rays. Before reaching the tube the wires, which are horizontal and parallel, are connected to the two halves of a Hertz oscillator formed of two brass cylinders AA, three inches long, placed horizontally in a tube containing oil (not shown). Below the tube is a resonator formed of a loop of copper wire DD *c*; the straight part lies just below the oscillator (it is here shown at the side, for clearness). The spark-gap C is turned toward the focus tube so as to receive the X-rays; it is protected from all other radiation by black paper and aluminum foil. By regulating the striking distance of the oscillator he succeeds in making the focus tube and the oscillator to work at the same time. At each current-break of the induction coil the difference of potential between H and H′ rises to a sufficient value to operate the tube, then as it continues to increase it causes a spark in the oscillator; the tube, suddenly deprived of its supply, is extinguished, while the oscillatory discharge of the cylinders goes on and finishes. In the first case the tube is near the oscillator and the wires AH, A′H′ are as short as possible (eleven centimetres). Place as abscissæ (Fig. 2) the time values, starting at the moment when the spark of the oscillator occurs, and as ordinates the differences of potential at AA′. Then we have, as is well known,

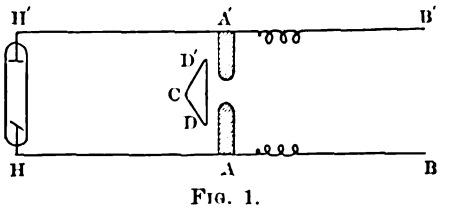

FIG. 1.

the sine curve MNPQ of the oscillatory discharge, which dies away rapidly. Once the apparatus is regulated, the potential necessary to work the tube is but little below the striking potential of the oscillator, and it suffices to diminish slightly the distance between the cylinders in order to cause all the discharge to pass by the oscillator and none by the tube. This fact is of capital importance here, and it results that the tube is extinguished when the potential is diminished slightly at the start of the oscillatory discharge, and this occurs at the end of a certain time below a quarter period of the discharge wave. The curve representing the intensity of the X-rays is therefore nearly horizontal (RS) before the discharge of the oscillator commences, followed by a quickly descending part SU.[1] By making a new curve III having as ordinates the values of the electric force produced at spark-gap by the discharge of the oscillator, the ordinate of this curve is zero, while all the discharge passes by the focus tube and thus up to the O point of the time curve; it only reaches appreciable value when the oscillator is partly discharged, and the maximum of the electric force only occurs when the oscillator is recharged in the contrary sense, or at the end of half a period. This duration is represented by OZ. It follows that when the resonator commences to oscillate the X-ray tube is already extinguished. Therefore there can be no action of the tube upon the secondary spark of the resonating loop. Experiment verifies this, for if a lead plate is placed so as to cut off the X-rays, the spark does not change its aspects, which it would do had it been previously exposed to the rays.

Leaving the focus tube in the same place the short wires AH are replaced by wires twenty-five centimetres long, folded up without angles. The length of the wire, by retarding the extinction of the tube by that length of time needed for

[1] The length of the oscillator wave is found to be 1.14 metres; its period is $\frac{114}{3 \times 10^{10}}$ seconds, and therefore OU is much less than $\frac{114}{3 \times 10^{10} \times 4}$ seconds.

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the Hertz waves to travel over 25 — 11 centimetres or fourteen centimetres; will be sufficient to delay by so much the disappearance of the X-rays at the place of the resonator spark, and give them more time to act upon this spark. This is found to be true, for the interposition of the lead screen causes the spark to become less brilliant, contrary to the former case, showing that the rays now act upon the spark. This effect of the X-rays is increased when the wires AH are lengthened to 33, 80, and 130 centimetres. The folded wires are now taken with a fixed length of fifty centimetres, then the tube is gradually removed from the resonator. By this the X-rays are retarded by the extra time taken to cover the increased distance; their disappearance at the resonator is thus retarded, and if their speed is comparable to that of the Hertz waves the effect of removing the tube to a distance will be analogous to the effect of using the longer wires, that is, it will be more favorable for the coincidence of the spark at the gap and the period when the X-rays are present there, and will thus give an increased action of the rays on the spark. We are thus brought to the paradoxical conclusion that the tube should act better upon the spark when far off than when near-by. To our surprise, the experiment succeeds completely. The brightness of the spark is increased when the tube is farther away, and this fact is certain and constant. This variation is beyond doubt due to the X-rays, for with a lead screen placed between, the spark becomes weaker and then remains invariable, regardless of the distance of the tube. This rather surprising fact is the first verification of the original idea that the speed of the X-rays is comparable to that of the Hertz rays or of light.

Taking a wire eighty centimetres long, for instance, when the tube is placed farther off it is observed that for a certain distance the X-rays have their full effect on the spark during all the time that the electric force at the gap keeps up a notable value (Fig. 3), and thus the effect of the rays is as great as their intensity will allow. When the tube is still farther removed, the effect should not be increased and the X-rays will lose their intensity more and more; therefore the action passes by a maximum. Experiment proves this, as when the tube is fifty-three centimetres from the gap the effect of the X-rays disappears (as shown by the lead plate). Thus the supposition that the speed of the X-rays is comparable to that of light leads us to predict a maximum point, and this is verified by experiment.

In a second series of researches the proof is still more conclusive. Resuming the same apparatus, with a wire eighty centimetres long. The maximum brightness of the spark occurs when the tube is fifty-three centimetres from the gap. Let V and V′ represent the respective speeds of propagation of the Hertz waves and the X-rays in centimetres per second. After finding the position of the tube

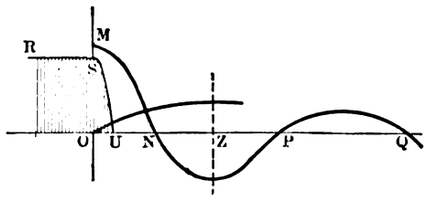

Fig. 2.

which gives a maximum spark, we now lengthen the wire by α centimetres; the cessation of the spark at the resonator is therefore retarded by $\frac{\alpha}{V}$ seconds. We must therefore, in order to reestablish the coincidence of the time and find the maximum, diminish the distance from the tube to the spark by a certain value β, such that $\frac{\beta}{V'} = \frac{\alpha}{V}$. Experiment gives us the value $\frac{\beta}{\alpha}$, and therefore in virtue of the preceding equation we have $\frac{V}{V'}$. By using a series of positions, in which α is made to vary within wide limits, it is found that $\beta = \alpha$, whence it results that $V = V'$. The author gives a table of values to show this and the experiments show a close approximation.

Another experiment is the following. In this case we still compensate the time needed for the X-rays to clear a certain space by the time required for the Hertz

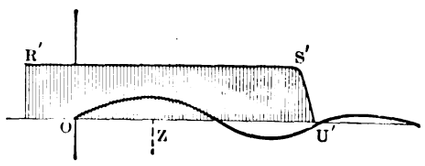

Fig. 3.

waves to travel over a given length of wire, but here it is not the transmitting wire which is changed in length, but the resonating wire itself. The ends of the resonator are separated by 0.3 centimetre and are soldered each to the two wires of a small transmission line. At the end of the line is placed a spark micrometer. The new spark-gap is brought into the position of the old by winding the small line upon itself. The action of the exciter on the resonator produces an oscillatory wave, which must pass over a certain length of wire to reach the gap and produce the spark. If, therefore, each half of the resonator is lengthened by a centimetres, the spark is retarded by $\frac{a}{V}$ seconds, and to obtain the maximum spark the distance from the X-ray tube to the gap must be increased by a certain distance b centimetres, such that $\frac{b}{V'} = \frac{a}{V}$. The observed value of $\frac{b}{a}$ gives that of $\frac{V}{V'}$. Experiment showed that when a was varied between 0 and twenty-five centimetres the value of $\frac{V}{V'}$ remained practically constant at 0.93. This method serves therefore to verify the preceding results which gave 0.97; besides, the preceding method is more accurate. By the foregoing two methods used to determine the ratio of the speeds, one gives 0.97 and the other 0.93. From these different experiments, which were carried out with great care, the author concludes that the speed of propagation of X-rays is equal to that of light.

New York Section of the American Electrochemical Society.

A meeting of New York members of the American Electrochemical Society was held at the Chemists' Club, New York city, Saturday, October 10, to consider the advisability of organizing a New York section. Owing to the bad weather, the attendance was small, but a number of those who could not attend communicated by letter or telephone. It was decided to ask for authority to organize the section and that it should be governed by a council of five. Dr. Charles A. Doremus was made chairman and Mr. Alois von Isakovics, secretary. The other three members will be appointed by the chairman.

Electricity on War Vessels.

The application of electrically operated apparatus aboard war vessels has been so extensive that practically every kind of service is now electrically performed, with the exception of the operation of the steering gear, main engine, pumps, ash-hoisting machinery and forced draft blowers. There appears to be nothing about the latter named devices that would prevent their being electrically operated. The electrical steering gear, it is asserted, is now under an experimental trial. A very interesting feature about this apparatus is that it may do away with the time-honored wheel, and a controller and handle similar to that used on an electric car be substituted for the same. The ships' boats are now handled by cranes, which are electrically operated, so that prompt and easy shipping and unshipping of boats and launches can be effected.

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ON SINGLE-PHASE REPULSION MOTORS.[1]

BY WILLIAM CRAMP.

It is a matter of common knowledge that if it were possible to construct a single-phase alternating-current motor having the characteristics of a direct-current series motor, and no serious drawback, it would find a very extensive application, on account of its extreme suitability for the transmission of power, especially in connection with railway work on long lines. There are many forms of single-phase induction motor on the market, some of which are, for certain purposes, very useful. Yet in spite of these, the single-phase motor is avoided wherever possible, as is clear from the many costly alterations which are being carried out in this country. It is only necessary to mention a few examples of this. In Croydon a direct-current plant has been laid down for the centre of the town, solely to provide for motors, in addition to the already existing alternating supply. The City of London Electric Lighting Company is slowly replacing alternating by direct current, for similar reasons. The towns of Coventry and Sheffield are introducing two-phase in place of the existing single-phase system. No doubt, much of this will be changed if the Baltimore & Annapolis Railway is successful, since that will demonstrate the existence of single-phase motors comparable to the direct-current series motor, and the extreme simplicity and flexibility of the single-phase system will again recommend its adoption in cases where three-phase plant is now in contemplation.

At present there is a choice of three types of motors on single-phase systems.

1. The Synchronous Motor—The disadvantages of this form, where starting and stopping is frequently necessary, are sufficiently obvious.

2. The Asynchronous Induction Motor—The disadvantages of this motor are that special devices, always cumbrous and often very expensive, must be employed to start it up, and even then a current usually considerably in excess of the full-load current is needed to run it up to speed under load—often a grave objection on lighting circuits. Moreover, even under favorable conditions, the power-factor is poor, the efficiency not high, the possibilities of varying the speed almost nil.

3. The Series Alternate-Current Motor—This motor bids fair to rival the previous forms for general application, and will, as we have said, be thoroughly tested on the Baltimore & Annapolis Railway. Its disadvantages are that the frequency at which it is most successful is very low, thus rendering it inadmissible on lighting circuits, while its power-factor tends to decrease with load, and pressure difficulties at the commutators are almost unavoidable.

The only other type at present practicable is the repulsion motor. For several years past I have been working to

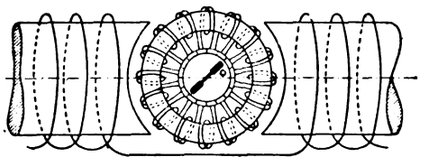

FIG 1.

ascertain the lines on which really efficient and satisfactory motors of this type might be designed, and I now believe that repulsion motors may be built, up to at least twenty horse-power, which will compare favorably with any type of motor at present in use. In its simplest form the repulsion motor consists of a laminated electromagnet or stator excited from the single-phase mains, and an armature or rotor wound almost exactly like the armature of a direct-current machine, and fitted with a similar commutator. Brushes rubbing on this commutator are set at a particular angle and short-circuited. The alternating flux set up by the stator induces in the coils of the rotor currents in such directions that the coils carrying them tend to move out of the inducing field. The action is exactly the same as that shown by Professor Elihu Thomson to exist when a plain copper ring is brought into the field of a solenoid excited by an alternating current.

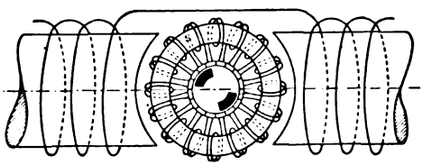

FIG 2.

Figs. 1 and 2 show clearly the two main forms of repulsion motor. In Fig. 1 the angle θ is usually forty-five degrees or less. This type has the following peculiarities: (*a*) the electromotive force of a quarter of the rotor opposes that of the other three-quarters, leaving half the rotor for useful electromotive force; (*b*) the rotor current passes through all the coils, whether in a useful position or not, thereby increasing the C^2R loss; (*c*) a quarter of the rotor gives a torque opposing rotation; (*d*) individual coils short-circuited by the brushes are constantly giving a torque opposed to rotation, and causing difficulties with commutation. These disadvantages led me to construct repulsion motors on the lines of Fig. 2; and it is partly due to the adoption of this form that I have succeeded in obtaining satisfactory commutation. The difficulties of construction, chief among which is commutation, have led most writers to speak of repulsion motors with much distrust. Thus Elihu Thomson, whose patent of 1889 covers the whole principle of repulsion motors, refers to them as capable of giving out considerable power, "though with what economy is unknown." Professor Jackson condemns them as "bulky, expensive and inefficient," though he adduces no evidence in favor of this verdict. Mr. Steinmetz writes "they have the disadvantage of using only part of the rotor," but as recently as December, 1902, he said that he believed better results were to be obtained from them than from series alternate motors. To show how very misleading are these statements, I here add: (1) That Mr. Hobart proposes using only fifty per cent of the armature for his recent direct-current machines. (2) If the coils of the rotor are only half of them used at any given instant, it is obviously possible to work at a higher current density. In one of my experimental motors I have had eight amperes through No. 21 wire without serious heating. (3) In such alternators as the Mordey-Victoria, only half the armature is ever really active at one time.

The chief difficulties in the construction of repulsion motors are: (1) liability to vicious sparking and (2) difficulty in obtaining a high power-factor. In the first form of repulsion motor which I tried I found that the spark was almost as great on closing the coil as on opening it. In order to investigate this, I had some experiments carried out on the opening and closing of circuits, of which I now relate briefly the results. With an inductive circuit there was less tendency to spark on the make than with a non-inductive circuit, and there was much less tendency to spark on the make with copper than with carbon contacts. I find, on the whole, that to avoid sparking on the make, a good, firm, clean, low-resistance contact is adequate. For this reason I have so far used copper brushes in the motor, but, despite this, the choice between carbon or copper has to be decided by the consideration of the whole of the circumstances, which would be too long to discuss now. With copper brushes I have been able to get absolutely sparkless

[1] Paper read before the British Association, Southport meeting, September 9-16.

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commutation, working from nothing to full load, on a motor whose design was in other respects distinctly faulty. These results refer more particularly to motors of the class represented by Fig. 2, whose only disadvantage is the long arc of brush contact, entailing corresponding friction. Having by copper brushes provided for closing the circuit sparklessly, I was enabled to obtain sparkless opening by means of the same principles that are employed in what is known as "resistance commutation"—that is, providing a sufficient interpolar space to enable each rotor coil to pass entirely outside the magnetic field, so that the current can die down before the opening of the circuit. It is obvious that a form of commutation might be employed corresponding to what in dynamo design I call "electromotive force commutation" (a term which explains itself); or, better still, a combination of electromotive force and resistance commutation, and as the output of the motor undoubtedly increases with pole width, it might pay to use one of these modifications, on which point, indeed, I am at present experimenting. In considering the actual design of a repulsion motor, the first object is to decide which form of commutation you are going to rely upon. Having settled this, the form of stator is practically fixed, for if resistance commutation is to be relied on entirely, the stator must have distinct poles—by this I mean that there must be considerable air space left between one polar winding and the next, as in the direct-current machine. On the other hand, if electromotive force commutation be used, the stator may be built exactly like that of an ordinary single-phase motor. I have tried both forms, and find that while both may be rendered sparkless between certain limits, the former gives good commutation over a wider range, while the latter gives better starting torque and better power-factor. But I would insist on the fact that every form of repulsion motor may be rendered sparkless if the design of the rotor winding is properly considered. Thus, what has been hitherto the great disadvantage of the repulsion motor disappears.

We therefore proceed to consider the design of the rotor winding. We may choose an arrangement such as that in Fig. 1, or a modification of Fig. 2. The salient differences between these two forms are: (1) in Fig. 1 all the short-circuited coils are in series, while in Fig. 2 they are in parallel; (2) in Fig. 1 the rotor current always passes through the whole of the rotor coils, whether active or useless; in Fig. 2 this is obviously not the case. If the rotor winding has to carry a large current, Fig. 2 is not very suitable on account of the fact of the large heating that takes place at the commutator, and the large proportion which brush resistance bears to the resistance of the coil lying between any given pair of segments. I have already stated, under the head of "commutation," other reasons for selecting windings of the type of Fig.

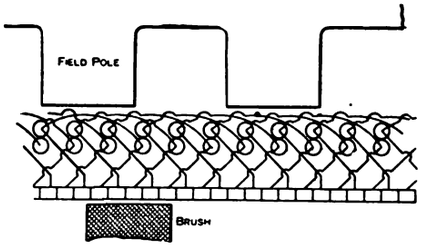

FIG. 3.

2, but I ought to add that recent experiments with windings of the type of Fig. 1 impress me very favorably, and all motors at present under construction are of this type. In actual experiment with windings like Fig. 2, I have found that if the rotor is of the closed-coil type, as shown, besides those coils actually short-circuited, there are other closed circuits carrying useless or even harmful currents. Hence, in the particular motor on which most of these experiments were made, the winding has been altered to that of Fig. 3, thus practically converting the rotor into an open-coil armature, with two coils in parallel.

These considerations determine the type of rotor winding, and we now pass to the discussion of the electromotive force, current, torque, etc., taking first the case of a bipolar motor with a single coil, as in Fig. 4A. This diagram is really a simple case of Fig. 2. If the pole arc is fifty per cent of the pole-pitch, and equal to the width of the coil, and the distribution of magnetic flux radially around this pole arc is sinusoidal, then the electromotive force set up in the coil is a pure sine wave. If, however, the flux is distributed uniformly radially over the pole arc (as is more probably in an actual machine), the lines enclosed by the coil when the field is constant are as represented in Fig. 4B. This is a sine wave with some odd harmonics which are of small importance in the present case; the third harmonic, which is the largest, has an amplitude of only one-ninth, the fundamental. I shall assume, then, for present purposes, that both the time variation of the main flux and the time variation of the area of the coil with respect to the total flux are both sine functions. We then have, if number of turns on the stator winding $= t_1$, number of active turns on the rotor $= t_2$, maximum magnetic flux per pole $=$ F, speed of motor in revolutions per second $= n$, periodicity of stator current in periods per second $= f$, R.M.S. primary E.M.F. $= e_1$, R.M.S. secondary E.M.F. $= e_2$. Then it is found that

$$e_2 = \frac{e_1}{\sqrt{2}} \quad \frac{t_2}{t_1}\sqrt{1+\left(\frac{n}{f}\right)^2}$$

which means that the secondary electromotive force may be represented by the resultant of two lines at right angles, as shown in the phase diagram (Fig. 5).

Passing on to the equations for current, we have, upon closing the circuit when one side of the coil is just coming into the field, a current made up of two terms—(A) the exponential term, (B) the ordinary sine wave. The term (A), which may usually be neglected in other alternating-current apparatus, is often, in the case of the repulsion motor, of great importance. It is extremely difficult to show the value of this term in any phase diagram, but its general effect is to shift the rotor current slightly forward in phase, and to cause the torque of the rotor to sink to zero at a lower speed. The cases in which it is of greatest importance are those of the type of Fig. 2, in which the number of turns per coil is large. I found its effects to be very strongly marked in the first two motors I made; but I do not anticipate that in

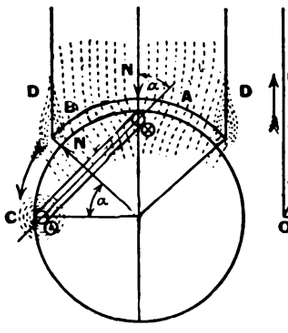

FIG. 4A.

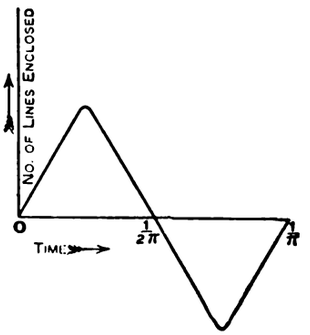

FIG. 4B.

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future designs its effect will be so marked, for two reasons: first, because I now aim at few turns per rotor coil; and, secondly, because I use a greater number of commutator segments. Coming now to term (B), I think it is easier to consider the action of the motor from the standpoint of the Heyland diagram. In Fig. 6 we have a representation of the transformer diagram. Figs. 4 and 6 are lettered alike. S is the stator, R the rotor. Let the flux at TT be represented by OF (Fig. 5).

Now, we may resolve the field OF in two directions in space—*viz.*, along the line of the brushes and at right angles thereto. FD and DO will represent these components, the point D lying upon a semi-circle, as shown. The angle DFO is that corresponding to λ in Fig. 4. DF now represents the field which vibrates through the rotor coil, and DE, at right angles and proportional to it, must represent in time the electromotive force generated in the rotor coils. (It is better to keep time and space separate by arranging all quantities in phase in time in one plane. Thus DE would be drawn in a plane at right angles to that containing DFO, as is done in the author's model.) The electromotive force, DE, may be resolved into two components at right angles in time DG, GE. Of these two, GD is proportional to the CR drop in the rotor coil and hence to scale (with constant rotor resistance) represents the magnitude and phase of the rotor current. GE represents that component of the rotor current tending to demagnetize the stator. The angle ϕ_2 is the angle of lag of the secondary or rotor current. As ϕ_2 increases, the rotor CR drop DG decreases and the rotor demagnetizing component increases till EG = ED, when the rotor current is zero and the field FD is balanced. Now, since DE is proportional to DF, it may be drawn of the same length. Then the semi-circle DGE may be applied to the line DF, so that E falls on FDG, and EG becomes FG^1, and shows the way in which DF becomes gradually balanced. The angle G^1DF then = $GDE = \phi_2$. Now, the component of DG in phase with DF or DO is the projection if DG on DF = DC = DG sin ϕ_2. The component multiplied by DO is proportional to the torque of the motor—*i. e.*, the torque varies as the area of the triangle DCO.

We have rotor current $\propto$ DG $\propto$ DE cos ϕ_2;

DE $\propto$ DF = OF cos OFD = OF cos λ;

DO = FO sin λ;

DC = DG sin ϕ_2.

Hence torque at starting = DC $\times$ DO;

= DE sin ϕ_2 cos ϕ_2 $\times$ OF sin λ;

= OF . OF . sin ϕ_2 cos ϕ_2 sin λ cos λ;

which is a maximum when

$$\left.\begin{matrix}\sin\lambda = \cos\lambda \\ \sin\phi_2 = \cos\phi_2\end{matrix}\right\} = \frac{1}{\sqrt{2}} \text{ — } i.e.,$$

when a and ϕ_2 = forty-five degrees.

Now, OF $\propto$ primary voltage (nearly). Hence the starting torque is proportional to OF^2 — *i.e.*, to the primary voltage.

These are the starting conditions.

Running Conditions—Directly the starting torque is large enough the rotor

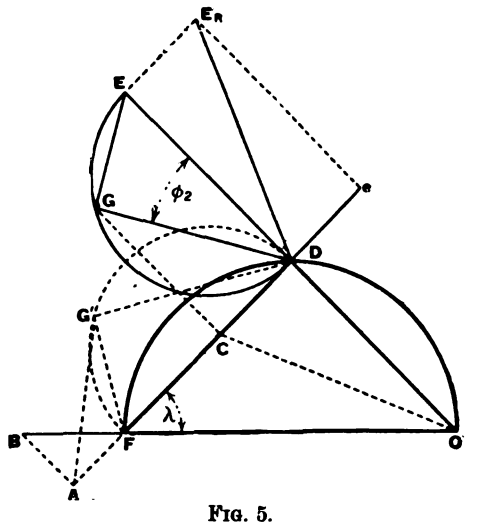

FIG. 5.

begins to revolve, the coil F (Fig. 4) tending to set itself so that it encloses a minimum of the magnetic lines issuing from the stator. Thus motion takes place in the direction of the arrow in Fig. 4; and this must be due to the fact that the current sets up a field in the rotor coils which is on the whole of opposing—*i. e.*, identical—polarity to that existing in the stator. Thus, if at a particular instant (in Fig. 4) the polarity of the stator

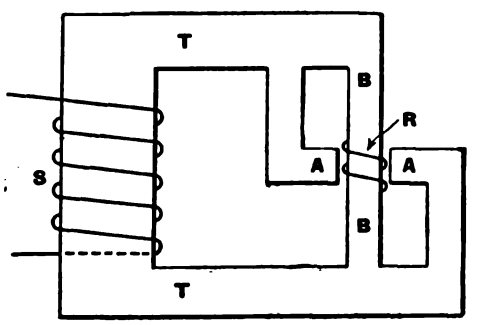

FIG. 6.

is north, as marked, the polarity of the rotor field, due to the lagging rotor current, must at the same instant be north. At this particular instant the lagging rotor current must be in the direction shown by the cross (+) and dot in Fig. 4. By Lenz's law the electromotive force set up by rotation must oppose this current. Therefore, directly the rotor begins to revolve, the rotor lagging current is reduced, or, in other words, the coefficient of self-induction of the rotor coil is virtually diminished. Suppose, now, the rotor is running, then the coil shown in Fig. 4, immediately it moves, would have its place taken by the one next it, and thus, although the rotor revolves, we may, as it were, speak of an "equivalent stationary coil," whose axis is settled by the diameter upon which the brushes are set. Considering now the coil shown in Fig. 4 as representing this equivalent stationary coil, we see that its coefficient of self-induction may be altered to a certain extent by moving it round in the direction of rotation. In this way, however, much the phase of the rotor current may be altered by the electromotive force due to rotation, the original conditions may be reproduced by moving the brushes in the direction of rotation. Theoretically, this may be carried on till the axis of the coil is at right angles to the axis of the field, when the speed of the rotor is infinite. Naturally, in practice there is a limit, depending upon the particular form of stator and the torque necessary to overcome the friction of the rotor bearings, etc.

In order to show this electromotive force due to rotation in Fig. 5, we remember that it is really produced by the field DO, and, therefore, will be at right angles to DO in space. Thus it may be represented by D e, and its effect is obviously to reduce the secondary lagging current, thus reducing the primary lagging component and the total primary current. With increasing speed, then, the point g will tend to travel along its semi-circle. The value of the component

$$\text{DE} = \frac{e^1}{\sqrt{2}} \frac{t_2}{t_1}, \text{ while D } e =$$

$$\frac{e^1}{\sqrt{2}} \frac{t_2}{t_1} \cdot \frac{n}{f}.$$

Thus at synchronism D e = DE, and if the motor started with maximum torque the point g will have arrived at E, when the motor arrives at synchronous speed.

The above results are only approximately correct, for the following reasons. We have assumed conditions of constant field which do not exist exactly in ordinary conditions. Again, we have assumed that the current-conductor distribution around the rotor is sinusoidal, which is not true, and that the number of conductors acted upon by the field DO is the same as that under the influence of the field DF. Later I hope to have an opportunity of showing how each of these peculiarities affects the phase diagrams already given. For the present it is important to note that the machine will gen-

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erate if revolved in the direction opposite to the arrow in Fig. 4.

Since the law of the diagram is so simple, a model may easily be constructed, ruled by the fact that OF is of constant length, and the point D moves along a semi-circle. From this model the values of primary and secondary current, torque, and power-factor may readily be deduced, and the following peculiarities may be noted:

1. The torque depends on the relative phases of stator and rotor currents, and at starting it is a maximum when the power-factor is about sixty per cent. At any speed the torque will always be a maximum with about this power-factor, but in order to keep this maximum torque the brushes would have to be gradually moved in the direction of rotation as the speed rose. In the case of small motors, I should say that there is no reason at all why the brushes should not be moved forward, either automatically or by hand in this way, since, as already shown, sparking difficulties may be completely overcome.

2. Power-Factor—If maximum torque is required of the motor at starting, and the brushes are to be kept fixed, it follows that the power-factor can never exceed seventy per cent. This at first sight appears a serious drawback, but in actual practice there are many cases where it will be no disadvantage at all. Take, for instance, a small printing establishment, or a tramway system of no great length. The disadvantages of the lagging current are twofold: (1) C^2R loss in the line—of small importance, as we have supposed the line short; (2) reduction of the voltage at the generating station by reaction upon the alternator fields, which is clearly counterbalanced by the fact that the power-factor of such motors is a maximum at starting and gradually decreases as the stator current decreases while running. Thus the actual value of the lagging current will not vary very seriously, and, so far as the engineer at the central station is concerned, should cause no trouble. In fact, the motor is in this respect in as good a position as a polyphase motor started with resistance in its rotor circuit, and in a far better position than any ordinary single-phase induction motor. In the case of large motors or long transmission lines, the power-factor of the motor with maximum torque at high speeds may be very materially increased. Perhaps the best way of doing this is by means of slip-rings attached to the rotor windings, just as if it were a rotary converter. Resistances inserted between these slip-rings are gradually cut out as the speed rises, so that the motor finally acts as an induction motor, a device of mine incorporated in a repulsion motor arranged at the Central Technical College three years ago, and which I see from an article by Herr Schüler in the *Electrical Engineer* of September 4 has recently been the subject of an English patent.

3. Efficiency—In any class of electromotor this is bound to depend largely on the amount of material put into it. Comparison is, therefore, admissible between motors of different types and of the same weight. In this connection my present experience does not enable me to give any definite figures, but I should say that the repulsion motor for a given power will be heavier than the corresponding polyphase motor, and lighter than the single-phase motor with its starting apparatus. Considering the enormous waste of energy in starting the latter, the repulsion motor will be far more economical for non-continuous running. Unfortunately detailed results of actual output per kilowatt during continuous running are not yet forthcoming from any source.

4. Starting Advantages—Under the best circumstances the repulsion motor may be started under full load with a current only slightly exceeding the full running current. This great advantage is obtained without any expensive and cumbersome starting arrangement, and it is this which must be put forward as the great advantage of this type of motor. Of course at starting the motor is really a special case of the split-phase type of motor, and the only reason why it is so much better than other motors depending on this principle, is that the phase splitting is performed by the motor itself, and depends on no additional apparatus. Further, by careful design the phase difference produced at starting must be so very much greater here than in any starting apparatus for single-phase motors, except such as depend on the introduction of a very large condenser.

This paper must, of course, be considered as preliminary, in that no curves of results are given, but these I hope to have ready to publish shortly.

Memorial to James Watt.

A movement is in progress in England to erect a memorial to James Watt. At a recent meeting of those interested in the project it was decided that the form the memorial should take should be an institution for scientific research, and an appeal is now being made for funds to carry out this plan. Mr. Andrew Carnegie, who is the secretary for America, has promised a subscription of $50,000.

Electric Railways in the United States.

In the early part of 1888, it is asserted, only eighty-six miles of electric railways were in operation in the United States, using about 172 cars. The census report dated June 30, 1902, showed 22,589 miles of electric road, using 67,199 cars, and requiring 1,298,133 horse-power for their operation. The number of passengers carried during the year was nearly 6,000,000,000. The total gross earnings reported were $241,584,697, and the operating expenses were $139,012,004, leaving net earnings of $102,572,693. The total number of employés was 138,183, and the wages paid them amounted to $84,636,275, or an average of about $614 each per annum. The above length of line has now been increased to nearly 26,000 miles.

The original electric cars were usually old horse cars mounted on improved trucks carrying electric motors of about twenty-horse-power capacity, having a maximum speed of about twelve miles per hour. To-day we have not only city railways, but interurban railways, operating on private rights of way, carrying passengers, express and freight matter, equipped with cars that will run at a decided increased speed, and we find some of the electric roads now putting on sleeping cars nearly sixty feet long, each equipped with 600 horse-power in electric motors, and ten compartments, with upper and lower berths that fold up during the daytime, and so arranged that the cars can be converted into parlor cars having twenty chairs for the day service.

Journal De Chimie Physique.

The first number of the *Journal de Chimie Physique*, which is edited by M. Philippe A. Guye, has come to hand. This journal will publish articles in the field of electrochemistry, thermochemistry, radiochemistry and mechanical chemistry. The list of collaborators includes a number of distinguished names, among whom may be mentioned Arrhenius, Berthelot, Curie, Heroult, van't Hoff, Nernst, Ostwald and Ramsay. This issue contains an article by W. Longuinne and A. Schukareff, upon "A Thermal Study of Certain Alloys of Copper and Aluminum;" an article by P. Duhem, on "Binary Mixtures," and one by J. H. van't Hoff, on "The Law of Phases." Brief abstracts are also given of the important scientific papers published in other journals, together with a list of electrochemical patents. The journal will be published monthly from the main office in Geneva.

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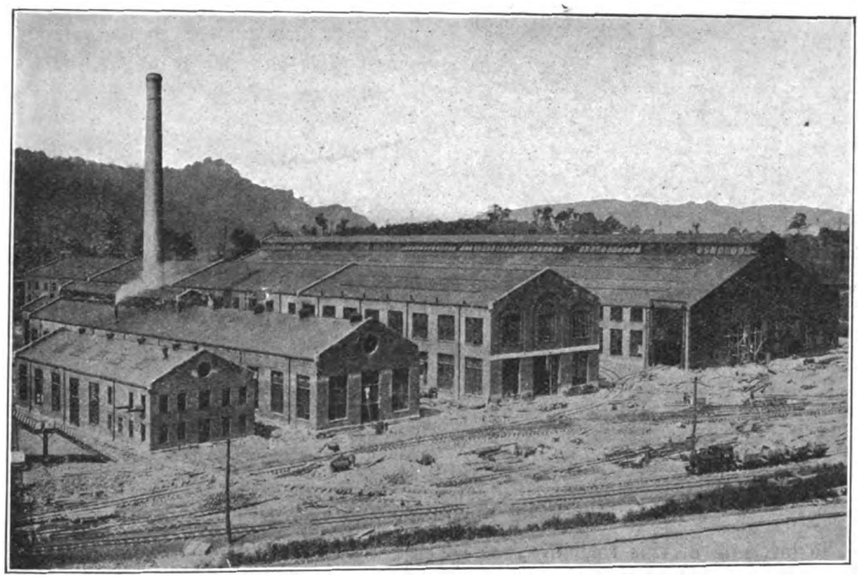
The New Plant of the Westinghouse Foundry Company at Trafford City, Pa.

THE Westinghouse Electric and Manufacturing Company and the Westinghouse Machine Company have projected a new industrial development at Trafford City, Pa., for the accommodation of their immense foundry interests. The old station for many years known as Stewart, on the main line of the Pennsylvania Railroad, seventeen miles east of Pittsburg, four miles from East Pittsburg, and about two and one-half miles from Wilmerding, Pa., was selected as the site for the new operations. The name "Trafford City" has been given to this in connection with the large interest of the Westinghouse Companies at Manchester, England, in a district known as Trafford Park. During the last four months a flourishing industrial centre has been developed as an accessory to several great manufacturing establishments located near-by. Comfortable and sanitary homes for the workmen employed in the operation of the new plant, and for others who administer to the needs of the new community, have been established. When it became apparent that additional foundry facilities would in the near future become imperative, owing to the increasing business of the Westinghouse Electric and Manufacturing Company and the Westinghouse Machine Company, the initial step in the projection of this movement was taken early in 1902. Some 600 acres of land have been secured by purchase for the Westinghouse Foundry Company, the Security Investment Company, of Pittsburg, a Westinghouse interest, being the medium employed to acquire it.



SHOWING FOUNDRY, PATTERN SHOP AND STORAGE, POWER-HOUSE AND BRASS FOUNDRY.

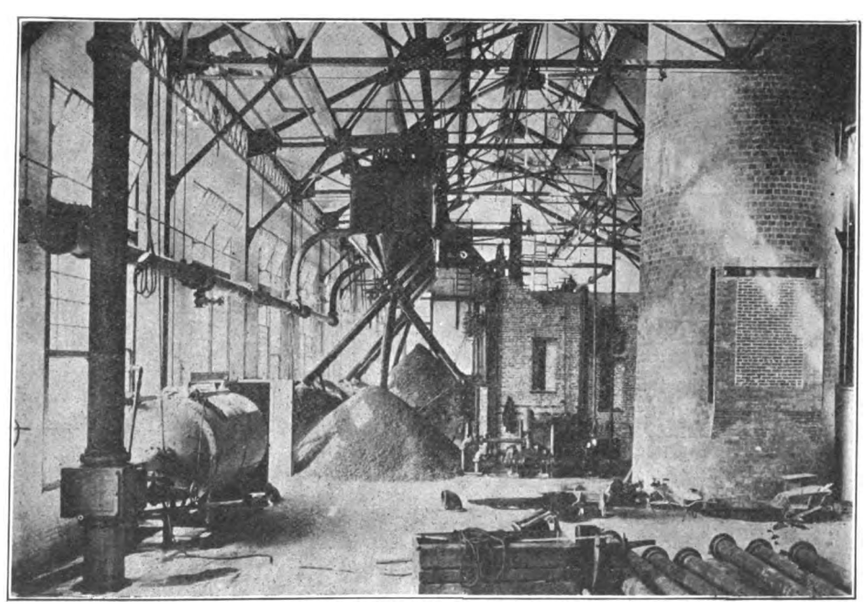
THE LOCALITY.

The contour of the land hereabouts, as everywhere in the neighborhood of Pittsburg, is hilly and rolling, with lateral streams draining the included watersheds and flowing into the Allegheny and Monongahela rivers.

One of these smaller water courses, known locally as Turtle creek, winds through the site of Trafford City, having in past ages, when it could boast of more majesty than it now possesses, worn down the land where it was softest and left it at this place with a slope composed of several terraced levels, and taking advantage of this natural arrangement, the Westinghouse Foundry Company has established its plant on the lowest level on the same grade as the main tracks of the Pennsylvania Railroad, which pass adjacent to the site and connect with it, thus obtaining convenient facilities for the importation of raw materials without unnecessary handling.

On the several terraces, rising in front of the foundry, yet shielded from its too obtrusive appearance by the ample foliage of large and handsome trees, lies the town proper, enjoying every natural advantage that can be desired, both from a sanitary standpoint and from the picturesque beauty of its surroundings. This locality is sufficiently remote from the manufacturing environs of Pittsburg to escape the pall of smoke which envelopes the latter, and on that account, if for no other, should be most inviting to the home-seeker.

The suburban train service of the Pennsylvania Railroad gives access to Stewart by a run of about forty minutes from the Union station in Pittsburg, and a still shorter run from the suburban stations of East Liberty, Wilkinsburg and Swissvale. The Pittsburg trolley system, by an approach over a steel viaduct 1,000 feet long, especially constructed for the purpose, makes its terminal by a loop through the city streets. Another trolley line enters the city from Greensburg, the county



POWER PLANT 1,000-HORSE-POWER BABCOCK & WILCOX BOILERS, EQUIPPED WITH RONEY STOKERS—BRICK STACK IN FOREGROUND.

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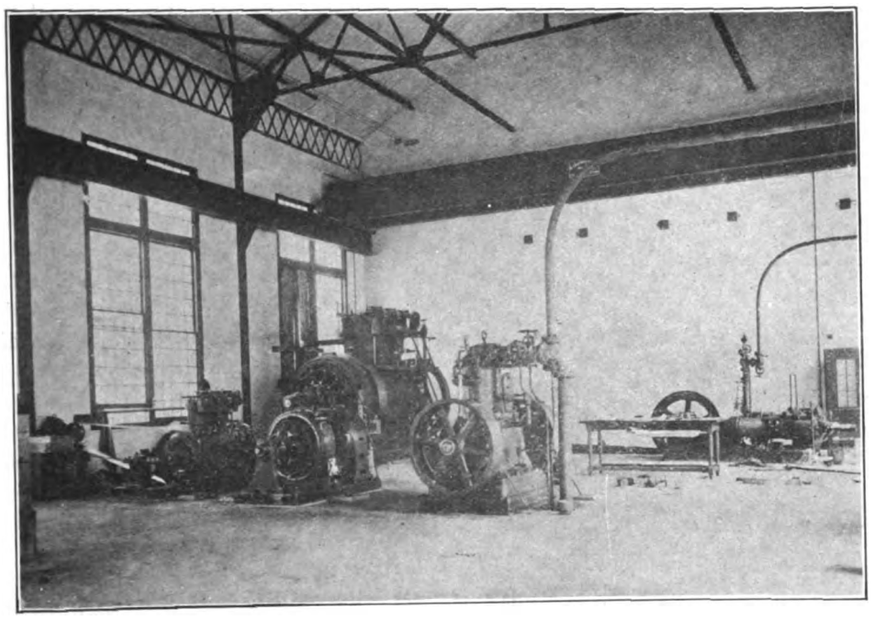
seat of Westmoreland County, thirteen miles to the east, which, with its surrounding boroughs, claims a population of 25,000 inhabitants. Although actually a rural settlement, Trafford City is so accessible to the conveniences of the city of Wilmerding, situated about half way between Trafford City and East Pittsburg, where the great works of the Westinghouse Air Brake Company are located, and are thus connected with the new industrial plant at Trafford City.



GAS ENGINE SIDE OF POWER-HOUSE.

that as a residence suburb there is little to be desired that is not already supplied.

THE FOUNDRY SITE.

The site selected by the Westinghouse Foundry Company for its plant is formed by a bend of Turtle creek, in the shape of a reversed L, and consists of about 130 acres in area of level bottom land. Here is sufficient room to provide for the present foundry buildings, including the iron foundry, the brass foundry, the pattern shop, pattern building, and power-house, all of which are now completed, and afford room for the future construction of additional manufacturing plants equal to the combined capacity of all the plants now located in the Turtle creek valley.

RAILROAD CONNECTIONS AND FACILITIES FOR HANDLING MATERIALS.

The site is connected with the main line of the Pennsylvania Railroad by the Turtle creek valley branch, providing a link with the outside world as an inlet for supplies. As an outlet for product, a single-track railroad of standard gauge and of the very heaviest type of construction has been built connecting the foundry site with East Pittsburg, at which point the castings will be delivered for machine finishing at the plants of the Westinghouse Companies previously mentioned.

This road, built by the Westinghouse Companies and named the Westinghouse Interworks Railroad, intersects the town

The terminal of this road at Trafford City has been amplified by a system of tracks connecting with the Pennsylvania Railroad. This terminal system comprises a railroad yard for storage purposes, connected by suitable switches and turnouts with each building and equipped with a system of overhead cranes for handling the heavy and bulky materials used in the operation of the plant. A narrow-gauge industrial railway, operated by ten-ton locomotives impelled by electric storage batteries, serves as an adjunct to the main system of railways in transporting about the yards and buildings the lighter and smaller supplies and accessories to the foundry service.

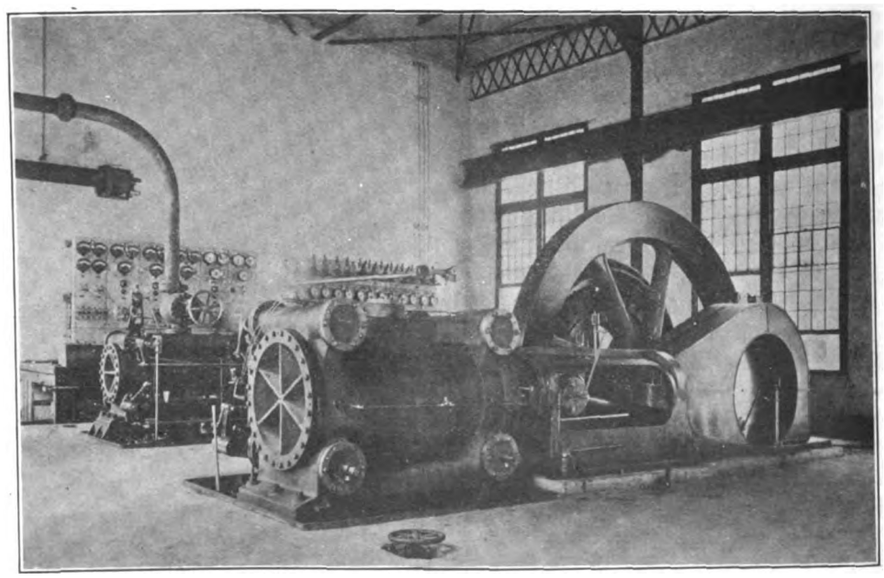
THE POWER-HOUSE.

The power-house, which includes under its roof a machine shop as well as a power plant, is 320 feet long by fifty-six feet wide. The building is of steel and brick construction, on concrete foundations, and with steel trussed roof covered with slate. The chimney is of Custodis construction, seven feet inside diameter and 175 feet high.

This building contains an engine room in the centre, with a boiler room immediately adjoining in the rear, the repair machine shop connecting at the front. At the rear of the boiler room is a pump room containing the fire service pumps and those for serving the hydraulic hoists, both of which are connected with the city water main and with a reservoir in Turtle creek, and back of this room is the locomotive room with provision for housing the two locomotives required for shifting purposes about the plant.

THE POWER PLANT.

The boiler plant at present consists of two 5,000-horse-power Babcock & Wilcox boilers, ample space remaining for the accommodation of double this equipment when the future growth of the foundry plant will require it. These are supplied with Roney automatic stokers operated by standard Westinghouse engines, and fuel in the shape of coal slack coming from local mines at the terminal of Turtle Creek Railroad is furnished to



CROSS-COMPOUND, CORLISS ENGINE—SWITCHBOARD IN BACKGROUND—ENGINE WITHOUT LAGGING AND JACKETS.

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them from steel hoppers overhead, to which it is carried by a "link belt" conveyor from a 100-ton storage pit outside of the building, into which the coal cars dump their contents while running over it.

The engine room is sufficiently large to accommodate two horizontal cross-compound Corliss steam engines of the Westinghouse type, having a capacity of 1,000 horse-power. One of these only is at present required and is already installed and coupled direct to a 600-kilowatt alternating-current, three-phase electric generator. A vertical gas engine of the Westinghouse type, having a capacity of 175 horse-power, is also in place and is direct-connected to a 120-kilowatt, alternating-current, direct-current generator. This engine draws its supply of gas from a well 1,900 feet deep, drilled on the property adjacent to the buildings.

The electric current from the steam-driven plant is used during the day for operating the cranes and other power motors about the foundry, and for such arc and incandescent lighting of buildings as may be necessary during the daytime. The current from the gas engine plant is used for such lighting and power as is required at night only. An underground tunnel, six feet square, thoroughly water-proofed, connects the power-house with the other buildings, and in this are installed all electric light and power conduits and the piping for steam, air and water.

THE MACHINE SHOP.

This room is equipped with lathes, planers, drill presses, and pipe threading and cutting tools, and such other appliances as would be required in the maintenance of a plant of this character. They are operated by an electric motor.

THE PATTERN SHOP AND STORAGE BUILDING.

This building, located at the extreme southern portion of the site, is 603 feet long by eighty feet wide. The foundation is of concrete and the superstructure of brick and steel, with floors of slow-burning mill construction. The pattern shop occupies 160 feet of the north end and is two stories high. The floor of the second story is suspended from the roof trusses to free the first story from columns, thus providing ample space for handling large patterns which will be made there. Adequate facilities have been supplied for the kiln-drying and storing of wood, and for the handling of the latter and the manipulation of patterns. The building is equipped with hydraulic elevators of ample size.

The shop is supplied with a most complete equipment of tools and appliances for wood-working. The windows and skylights have been made large to admit plenty of light. Artificial illumination of the most approved character has been supplied, whereby the general lighting of the building is accomplished by arc lamps and the direct illumination of the tools and work is effected by means of Nernst lamps. In winter a mean temperature of between fifty and sixty degrees Fahrenheit is preserved by means of a hot air system of heating, the air being forced by rotary fans through coils heated by either exhaust or live steam furnished from the power-house. Ample lavatories and toilet

General View of Foundry Showing 100-Ton Sellers Crane.

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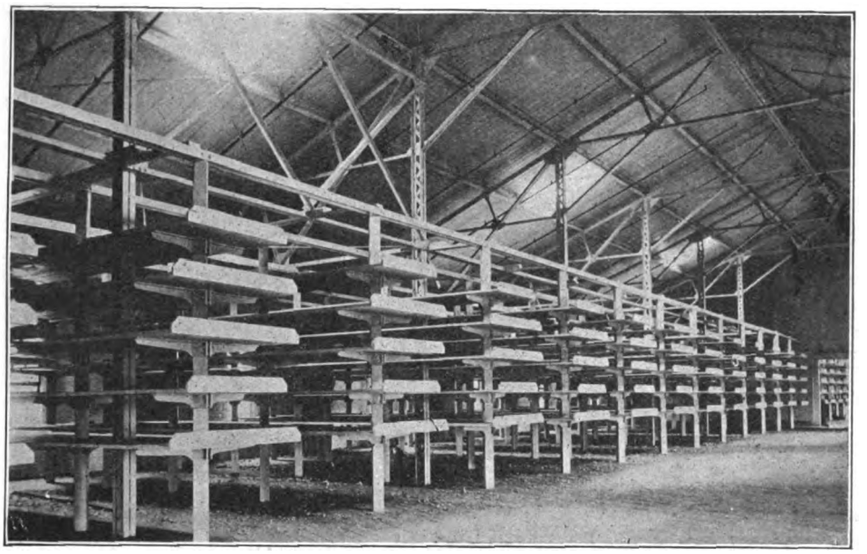
conveniences are supplied on each floor, and in every way the comfort of the employés has been studied.

The remaining portion of this building, which is devoted to the storage of patterns, has three floors, the two upper ones being divided by interior firewalls into three separate compartments. The floors themselves are of three-inch yellow pine covered by one thickness of maple flooring. The roof purlins are steel I-beams spaced eight feet *c* to *c* and covered with three-inch roof sheeting and slate.



SHOWING RACK FOR PATTERN STORAGE—THIRD FLOOR OF PATTERN STORAGE BUILDING.

Automatic sprinklers are installed throughout this building, and the system of hot air heating previously referred to keeps a mean temperature about thirty-five degrees Fahrenheit in zero weather, to prevent freezing of the water in the pipes. Risers for hose connection are supplied for additional fire protection.

Ample elevator facilities have been provided for handling patterns and a system of racks, each containing several tiers of shelving subdivided into sections, has been installed on each floor for the storage of those of the smaller sizes. A system of marking and recording the patterns by the number of rack, tier and section to which they have been assigned, secures their permanent location.

THE FOUNDRY BUILDING.

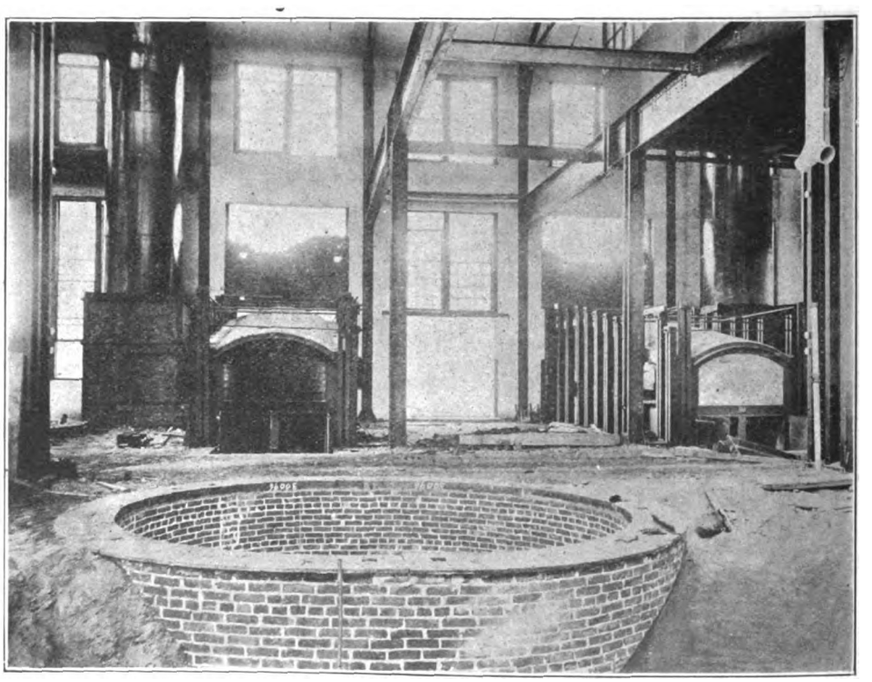
The first building for foundry purposes, which is now erected and in operation, adjoins the pattern shop, with a space of 100 feet between them. It is of brick and steel construction on concrete foundations, and is 612 feet long by 184 feet wide. The walls are thirty-six feet high at eaves and eighty feet at peak. It is divided transversely into three bays, the centre bay being eighty feet wide and those on either side fifty feet six inches wide. These bays are traversed by traveling cranes, the centre having one of 100 tons and two of sixty tons capacity, all of the Sellers two-trolley type, and each of the side bays has three of the Morgan type of twenty tons capacity each.

The centre bay has in addition on either side special runways underneath those for the cranes just mentioned, and these accommodate four traveling jib cranes, two on each runway. These cranes reach out into the centre bay about thirty-five feet, and as the largest moulds will be arranged close to the side posts they are thus intended to handle all the work of setting and drawing patterns, setting cores, and, in fact, are capable of doing all the work of the foundry except that of the very heaviest nature. A track from the main railroad system runs through each end of the building to cooperate with the larger cranes in the transportation of material to and from the foundry, and the narrow-gauge railroad traverses the side bays from end to end and works conjointly with the smaller cranes previously mentioned.

At the side of the building is a space 100 feet wide which serves as a storage yard for flasks and heavy apparatus connected with the foundry operations. In the centre of this yard also is stored the fuel and raw material for charging the melting furnaces. To serve the yard, runways are provided and equipped with a Sellers double trolley traveling crane of fifty tons capacity.

THE MELTING DEPARTMENT.

At the middle of the north bay is located an elevated charging platform to which the raw material is raised on lifts operated by hydraulic power supplied from the power plant. The melting equipment consists of three cupola furnaces of eighteen tons capacity per hour each, located on this platform, and two air furnaces each of thirty tons capacity placed close by on the ground. As it is not uncommon practice in foundry work to hold molten metal for three hours or more, it would easily be possible here to pour a casting of 200 tons in weight, should such a requirement ever be made.



SHOWING TWO 30-TON AIR FURNACES AND LADLE PIT.

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By the use of the air furnace method of melting iron, metal fifty per cent stronger than that obtained from the cupola may be obtained, so that all large and important castings are usually made of the former metal. Across the building and opposite the melting plant are the core ovens. These are arranged to be heated either by coke or natural gas, as may be deemed expedient.

THE HEATING SYSTEM.

Rotary blowers are placed on platforms under the roof and operated by two-speed motors. These blowers force air through coils heated by either live or exhaust steam from the power plant, and, by means of ducts, properly distribute heat throughout the building at a minimum temperature in zero weather of fifty degrees Fahrenheit.

The automatic sprinkler system is installed and adjusted to operate at varying temperatures according to the nature of the work in different localities.

THE OFFICE, BRASS FOUNDRY BUILDING.

Close to the viaduct and adjacent to the main approach to the foundry buildings is located a brick building of two stories in height in front, which part is occupied on the first floor by the business office of the Westinghouse Machine Company's foundry department, and the superintendent and his staff. The second floor is used as a drafting room. The rear of this building, from which the floor of the second story has been omitted, serves as the brass foundry. This room is forty feet by eighty feet in size and contains six pit furnaces, together with the usual accessories of a modern brass foundry.

The quotum of brass moulders which this building can accommodate is about twenty.

THE SAND HOUSE.

This building is of wooden frame construction, thirty-four feet wide by 128 feet long, located adjacent to the foundry building. It is paralleled by a track of the main railroad system for receiving the sand, and a track of the narrow-gauge railway leads into the building to receive the sand from the mixers for the foundry.

THE LABORATORY AND LAVATORY BUILDING.

In the space between the pattern storage building and foundry is a two-story building thirty-four by sixty feet, of brick and steel construction.

The rear of the upper floor of this building is equipped as a chemical laboratory, and the front part is devoted to offices for the foremen of the foundry.

Intermediate between the front and rear are quarters for the janitor and a room to be devoted to first aid to the injured.

The lower floor is devoted to lavatories. It is equipped with the best modern outfit of wash-basins, shower baths, and closets, and is so arranged that each employé is supplied with his individual locker.

By isolating this building for its specific purposes, the foundry buildings can be kept in the very best sanitary condition, and attendants ensure the safe keeping of the clothing and property of the employés during their hours of service.

The total number of men which this foundry is prepared to employ in normal times, in all the varied occupations incident to its operation, is about 600. In busy times, however, as many as 1,000 men can be readily accommodated through the adjustability of the facilities for expansion that have been provided.

In the preparation of the design, construction and equipment of this foundry, which was carried out under the direction and supervision of the Westinghouse Machine Company, of East Pittsburg, a most complete study of the great foundries of the world was made and the best features of all are here embodied, so that the arrangement, as here shown, represents the most approved characteristics of modern foundry practice.

SIDE BAY OF FOUNDRY, SHOWING TRAVELING CRANE.

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Electrical Notes from Europe.

From Our Special Correspondent.

ONE of the large hydraulic plants of Italy is that which has been erected at Bussi for supplying an electrochemical works in the vicinity. The plant has been installed by the Volta Electrochemical Company, of Rome. The electrochemical works, which belong to the same company, produce for the most part caustic soda and chloride of lime. The hydraulic station at Bussi is equipped with seven direct-coupled turbine groups of 450 horse-power each, operating at 450 revolutions per minute. The turbines have been supplied by Piccard and Pictet, of Geneva, one of the largest Swiss firms. They are coupled to direct-current generators of the Oerlikon type, which have been specially designed to give a high current capacity for electrolytic work. The output of these machines is 1,500 amperes at 180 volts. At present there are six machines which supply current, while the seventh is used as a reserve. Each of the generators supplies one of the electrolytic apparatus which are installed in the neighboring factory. The seventh machine is used to supply current for six motors, ranging from 20 to 100 horse-power, which are needed in the different processes. Each of the generators is provided with a small switchboard. Besides the heavy-current groups, the hydraulic plant contains two turbine-driven alternators of 450 horse-power each, working at 450 revolutions per minute. The alternators give three-phase current and work at 6,000 volts and forty-five cycles. These machines are used to supply a high-tension line which runs from Bussi to Piano d'Orta, at nine miles distance. The line uses three wires of seven millimetres diameter. At the last-named point the current is received in a substation containing a switchboard, which distributes it to two different lines. One of these circuits is used to supply two non-synchronous motors which use the high-tension current of 5,000 volts, directly. These motors give 220 horse-power each. The second line feeds three step-down transformers of thirty kilowatts each for the local lighting circuits. The entire plant has been installed by the Oerlikon Company, of Zurich.

A very successful tramway system is that which has been lately installed by the Fives-Lille Company, one of the large Paris electrical firms, in the Alpine region of France. It connects the Moutiers railway station with the town of Brides-les-Bains which is a well-known health resort of the region, and it is proposed to extend the line as far as Villard, when its length will be doubled. The tramway is supplied with current from an hydraulic station which is situated on the Alloues, a mountain torrent which pours into the Doron river at Brides-les-Bains. A head of water of 360 feet is secured at this point. From the dam which is erected across the stream, the water is sent into several settling reservoirs and is then taken to the hydraulic station by a penstock three feet in diameter which descends along the mountain side for 2,500 feet. The station contains three main turbines, each of which is built for 260 horse-power, and works at 370 revolutions per minute. These turbines are provided with an improved form of automatic governor and each is direct-connected by an elastic coupling with a direct-current machine of the Fives-Lille pattern, which is over-compounded and furnishes 160 kilowatts, with a voltage varying from 500 volts no load to 600 full load. From the main switchboard start the circuits which supply the tramway. When completely finished the road will be about eight miles long. The current is taken from a double trolley wire, with rail return. The cars have been equipped by the Fives-Lille Company and are mounted upon a double-axle truck, with a motor on each axle. The gauge of the road is one metre and the cars, which are twenty-six feet long, hold forty to fifty passengers. The motors are built to give twenty-five to forty horse-power each, with a voltage varying from 400 to 600. The controllers of the series-parallel type, which are mounted upon each platform, contain two cylinders which are operated by levers. The larger cylinder serves to give the different connections of the motor circuits which correspond to various speeds, while the second is used to give the forward or reverse movement, with one or both motors in circuit. The controller has a special contact which allows the motor to act as an electric brake. This manœuvre is carried out by a simple movement of a lever. At present but one of the generators of the hydraulic plant is in use for the tramway lines, but when the road is extended as far as Villard two of the machines will be needed, with the third as a reserve. It is expected that the company will establish a system of freight traffic and use trains made up of a motor car, trailers and freight cars, as the road covers a region which contains a number of large factories. Among the latter may be mentioned the works of the Compagnie Generale d'Electrochimie which uses the current of an hydraulic plant for manufacturing various electrolytic products. The station, which has been erected for the purpose, uses a fall of 800 feet with a penstock 7,500 feet long and three feet diameter. The plant contains six turbine and dynamo sets of 500 kilowatts each. These machines, which have been supplied by the Fives-Lille Company, are of the eight-pole, direct-current type and work at 300 revolutions per minute, furnishing 200 volts. Adjoining the station is the large electrolytic works which is chiefly engaged in the production of carbide of calcium and ferro-silicon.

A Danish scientist, Th. Sundorph, has been making a series of experiments upon the passage of current between two bodies which are but slightly in contact. This question is one of great interest as it relates to the phenomena which take place in coherers. The experimenter examines in the first place the action which occurs at the point of contact of two wires which are laid one across the other at right angles. According to his researches, the resistance of the contact between the two wires depends upon different factors, namely, the pressure existing at the contact, a counter-electromotive force which seems to be set up in such cases, and also upon the resistance of a thin layer of water vapor which is condensed upon the surface of the wires and that of a layer of metallic oxide which may exist between the two bodies. In the case of such contacts he observes that the resistance increases considerably as the current is diminished. With two wires touching each other there is a considerable adhesion between the two, which is kept up even after the current has ceased to pass. This adhesion is probably due to the action of particles of metal which are detached from the wire and form a bridge between them, and this phenomenon occurs under the action of the spark of the extra current each time that the wires are separated from each other. Analogous phenomena are presented in cases where there are several points of contact, for instance, where metal filings are used. The filings

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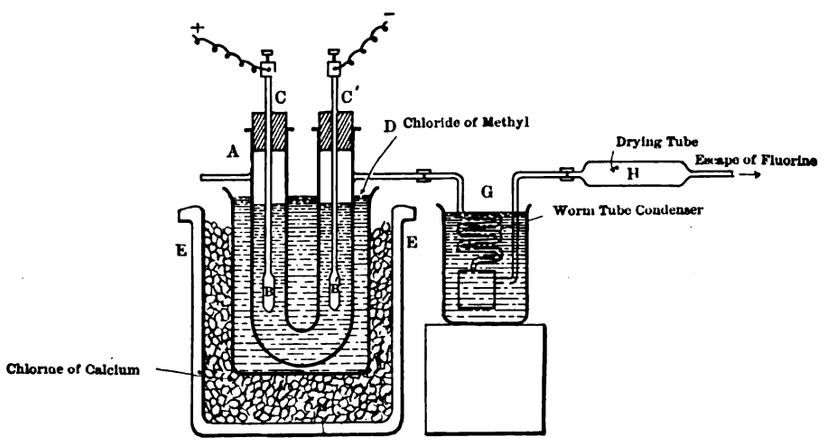
are placed between two brass points. When examined under the microscope the filings are observed to take a back and forward movement which is quite characteristic.

Professor Henri Moissan has lately perfected his electrolytic apparatus for producing pure fluorine, and has been making a number of interesting experiments with it at the laboratory which has been fitted up for him at the Sorbonne. It will be remembered that M. Moissan was the first to produce fluorine in the gaseous state and set it free from its compounds. He afterward examined the properties of the gas and its different compounds. More recently in connection with Professor Dewar, he succeeded in liquefying and even in solidifying fluorine, by using liquid oxygen and finally liquid hydrogen. The gaseous fluorine is produced in an electrolytic apparatus which is shown in section in the diagram.



MOISSAN ELECTROLYTIC APPARATUS FOR PRODUCING FLUORINE.

It consists of a copper U-tube A, about eight inches high and one inch diameter. Each arm of the tube is corked by a stopper of fluorspar CC', through which passes a platinum rod B serving as an electrode. The rod is somewhat enlarged at the base so as to provide for the attack of the liquid. The electrolyte is hydrofluoric acid, which is specially prepared in a pure state. The U-tube has a small tube at each side for the escape of the hydrogen which is given off at one pole and the fluorine gas which comes off at the other. The hydrogen is allowed to escape into the air, while the fluorine is taken off by a small copper tube which is connected to a purifier. The U-tube is placed in a vessel D filled with chloride of methyl which has a temperature of minus twenty-three degrees centigrade, as the apparatus tends to heat up under the action of the current. The whole is surrounded by a larger vessel E filled with fragments of chloride of calcium. The fluorine gas which comes off is freed from impurities by passing it into a small worm condenser G of platinum surrounded by a cooling bath of chloride of methyl, in order to condense the vapors which come over. Beyond the condenser is a drying tube H filled with chloride of calcium. In this way M. Moissan obtains fluorine gas in a practically pure state. The gas can be ignited on coming out of the apparatus and it burns with a blue flame. A current of forty to fifty volts and fifteen amperes is generally employed. The fluorine thus produced is a seemingly colorless gas with a strong odor. When viewed in a tube three feet long the gas is seen to have a slightly yellowish color, but is less so than chlorine. Fluorine is remarkable for its powerful chemical affinity which is greater than for any other element. Different bodies, such as carbon, sulphur and phosphorus, burn in the gas with a brilliant incandescence and form a series of compounds which are of great interest. Fluorine has been liquefied by cooling it to minus 187 in liquid oxygen and gives still more powerful reactions. When a piece of phosphorus is dropped into the liquid, it burns with a bright flame, accompanied by clouds of fumes. Crystallized anthracene causes a violent explosion when placed in the liquid fluorine. The last step has been to solidify fluorine, and this has been accomplished recently by placing liquid fluorine in a narrow tube and cooling it by dipping into liquid hydrogen. The fluorine then solidifies in a yellowish mass. The experiments with liquid fluorine are remarkable as showing that chemical affinity still holds good, and, even in a large degree, at as low a temperature as minus 187 degrees centigrade.

Apropos of Professor Moissan's production of the diamond in the electric furnace it appears that in spite of the conclusive results which he obtained, there are some persons who remain sceptical as to the formation of the diamond by artificial means. It is stated that M. Charles Combes, a prominent engineer of Paris, has recently challenged Professor Moissan to produce the diamond before a committee of specialists to be named by both parties. He offers to lay a wager of $1,000 to this effect. This question has awakened considerable interest, owing to the prominent position of both parties. It is not as yet known whether Professor Moissan will consider it necessary to respond to such a proposition.

The electric lighting of St. Peters at Rome was decided upon over a year ago, and has since been carried out with great success. The new electric lighting has proved much more satisfactory than the former system of gas lighting, as the latter gave a greater fire risk and it was not always possible to hide the unsightly pipes among the interior decorations. The current is taken from the city mains, which furnish alternating current at a tension of 2,000 volts. The high-tension current is taken off by Siemens concentric cables which are brought to the rear of the church and into a small chamber which is situated on the ground floor at the bottom of the winding staircase which leads to the cupola. In this chamber are located two primary switchboards. From this point the wires mount the opening of the staircase and come out at a considerable height, on a level with the main cornice which runs around the dome. At this point is a roomy chamber in which has been installed a set of two transformers of 110 kilowatts capacity each, in order to lower the tension to 110 volts for the lamp circuits. On the outside of the chamber has been placed a marble switchboard which is used to make the connections of the primary and secondary circuits. From the switchboard start the four main 110-volt lighting mains, each of which has a double-pole switch and a fuse block. The main circuits are laid around the dome, where there are different corridors and staircases, so that the lines are easily accessible. From this main circle are four branches which pass to the front and rear and on either side. To light the immense interior of St. Peters requires 628 incandescent lamps, which are generally of twenty-five candle-power each; in some cases ten-candle-power lamps are used. These lamps are usually distributed in large chandeliers which are hung from the ceiling. The total lighting represents 14,000 candle-power. The lighting circuits have been laid out so as to provide for considerable increase and this can be raised as high as 80,000 candle-power. The main circuits have been laid out so as to secure a nearly uniform voltage, they have a total length of nearly two miles. For the lamp circuits the total length of copper wires or cables is fifteen miles.

C. L. DURAND.

Paris, October 3.

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ADDRESS TO THE ENGINEERING SECTION OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.[1]

BY CHARLES HAWKSLEY, PRESIDENT OF THE SECTION.

TECHNICAL EDUCATION.

The subject of the technical education of engineers was treated very fully in the interesting address delivered by Professor Perry, as president of Section G at the meeting of the British Association in Belfast last year. This question also received thorough consideration at the meeting of the engineering conference held in London in June last, as well as at recent meetings of the Institution of Mechanical Engineers and of the Institute of Naval Architects. The systems in vogue in the United States of America and on the Continent of Europe were on those occasions brought forward in carefully prepared papers and fully discussed. The main points at issue are: (1) whether actual handicraft should be taught in the technological school or college along with the principles underlying the engineers' art; (2) whether the year should be divided into periods in one or more of which the science of engineering should be taught, and in another or others of which craft skill should be acquired at works; (3) whether the principles should be first acquired, during a longer or shorter term, leaving experience in applying those principles to be gained at the termination of the course. As regards the first of these suggestions it appears to be in opposition to the judgment of the most experienced teachers. In respect to the second, the Admiralty has carried it out for the last forty years, and with satisfaction to the service; it is also common in Glasgow, and Mr. Yarrow has included this system in the apprenticeship rules he has recently laid down, while it is to be tried experimentally in the engineering course at King's College, London. At the engineering conference it was determined that the subject was of such importance that its further consideration should be left to a committee, to be subsequently appointed.

Before leaving the subject of technical education, I venture to express the hope that in the training of engineering students increased attention will be paid to the combination of artistic merit with excellence of structural design, so that in respect to artistic treatment our engineering structures may not remain so far behind those of our Continental brethren as is unfortunately now frequently the case.

[1] Paper read before the British Association for the Advancement of Science, Southport, 1903.

ENGINEERING STANDARDS.

A very important work has been going on quietly and unostentatiously in our midst for some time past, the results of which must affect the engineering profession at home and abroad. I refer to the work of the Engineering Standards Committee, which, as many of my hearers know, was appointed in 1901 and is now composed of 178 members, among whom are many government officials. The committee has received not only the moral but the financial support of his Majesty's government, and the results of its labors are being adopted by all the leading government departments.

In addition to the main committee there are no fewer than twenty-five separate committees and subcommittees engaged on work, covering a wide range of operations, many of the members sitting on more than one committee.

After careful deliberation the committee published its first series of British standard sections, covering all rolled steel sections used in constructional work, shipbuilding and so forth. The committee on rails has just issued the standard sections and specification for British girder tramway rails, and it is now actively engaged in drawing up a series of standard sections of bull-headed and flat-bottomed rails for railway work.

Another committee is occupied in drawing up a standard specification and standard tests for cement.

The government of India controls to a very considerable extent the working of railways in India, and has referred to the Standards Committee the important question of drawing up a series of standard types of locomotives for use on the Indian railways. The committee which investigated this difficult subject has just forwarded its report to the Secretary of State for India. Other committees are preparing standard specifications for locomotive copper fire-box plates and steel boiler plates, which it is hoped will be published at an early date.

Other committees are considering screw-threads, standard flanges and standard cast-iron pipes and specifications for material used in shipbuilding. There are about a half dozen committees engaged on various important electrical subjects.

In my presidential address before the Institution of Civil Engineers in 1901, I raised a note of warning in regard to the stereotyping of design and the consequent cramping of originality. The constitution of the Standards Committee and the professional standing of its members afford a guarantee that its work will accord with the best practice of this country, since those engaged in drawing up the standards are not only in the forefront of engineering practice, but are alive to the necessity for extending the number of standards if and when needed to meet the requirements of the engineer.

NATIONAL PHYSICAL LABORATORY.

An outline scheme for a National Physical Laboratory was set forth in 1891, by Sir (then Dr.) Oliver Lodge, F. R. S., in his address at Cardiff to Section A of the British Association. In his presidential address to this association in 1895 at Ipswich, the late Sir Douglas Galton, F. R. S., emphasized the importance of such an institution, a committee of this association reported in favor of it, and later, when after forwarding a petition to the late Lord Salisbury, a treasury committee with Lord Rayleigh, F. R. S., in the chair was formed, Sir Douglas Galton gave evidence to the effect that if Great Britain was to retain its industrial supremacy, we must have accurate standards available to our research students and to our manufacturers.

In 1901, the National Physical Laboratory was inaugurated at Bushy House, near Teddington, and an annual grant of £4,000 toward its support was made by the government. It is divided into three departments, of which the one dealing with all branches of civil, mechanical and electrical engineering is chiefly interesting to us in Section G. In this department tests are now undertaken of the strength of materials of construction, of pressure and vaccum gauges, of indicators and indicator springs, and of length gauges and screw gauges, and photomicroscopic investigation is made of metals and alloys, and especially of steel rails.

But besides the ordinary work of testing, various investigations are in progress, such as measurement of wind pressure, elastic fatigue in nickel steel and other materials used by engineers, and the magnetic and mechanical properties of aluminum-iron and other alloys. For the British Association a set of platinum thermometers has been constructed and subjected to stringent tests, and an investigation has been undertaken for the Engineering Standards Committee into the changes in insulating strength of various dielectrics used in motors, transformers, etc., due to continued heating. In the language of Dr. Glazebrook, F. R. S.,

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the director, who it may be mentioned was previously principal of University College, Liverpool, science is not yet regarded as a commercial factor in this country, but it is one of the aims of the National Physical Laboratory to bring about the alliance of science with commerce and industry. The expenditure of the National Physical Laboratory is met by an annual Treasury grant of £4,000; £500 a year from an endowment; fees for tests, now amounting to about £3,500 annually; and from donations and subscriptions.

The director is anxious that the revenue derived from fees for testing should be largely augmented, and I would urge on engineers, contractors and manufacturers, as well as on private individuals, that they should avail themselves of the opportunity to have tests and experiments of interest to them, and which will be generally accepted as unimpeachable, conducted at this laboratory. I may add that an appeal has been made for further donations and annual contributions, as the funds now at the disposal of the board of management are insufficient to carry on the work of the laboratory on a sound financial basis, and I venture to hope that many of those who are interested in the practical applications of science will assist in supporting the work of this national institution.

INTERCOMMUNICATION—GENERAL PROGRESS.

At the commencement of the nineteenth century the population of the United Kingdom was nearly fifteen and three-quarter millions, at the beginning of the twentieth nearly forty-one and one-half millions. Then there was not a mile of railway in the United Kingdom: now there are about 22,000 miles. Here, too, is evidence not only of the prosperity which has prevailed throughout Great Britain during the century that has passed, but also of the enormously increased demands which have arisen during the same period on the means of locomotion.

In 1803, just one hundred years ago, Telford reported to the government on the state of the roads, and as a result the great road to Liverpool from the metropolis and the other great highways were constructed. It was enlightened wisdom that eighty years ago placed intercommunication in the forefront of the definition of engineering; it still maintains that position, and I purpose to say a few words on the present aspect of the question.

ROAD TRAFFIC—MOTORS.

Speed in locomotion appears to be now the first consideration, whether as regards mails, passengers or goods. I would refer in the first instance to locomotion on our main roads. Here three or four classes of machines appear to be ambitious to drive pedestrians, horsemen and horse-drawn vehicles off the road.

The first practical steam carriage was used by Trevithick in the year 1802; and now a hundred years later, it is found that for the traction of heavy loads on the main roads steam is still most suitable. The points of importance in connection with traction engines and their trailers are their speed, weight and width; of course, there is no question that, as regards facilitating traffic, the large heavy wagon replacing many smaller horse-drawn ones will be found a boon, but it must be remembered that the momentum of heavily laden wagons drawn by a powerful traction engine at the maximum speed of five miles an hour, is very great and causes uncomfortable vibration in the houses along the main thoroughfares of our towns; on the other hand, light traction engines are now being successfully used, drawing from four to five tons of market produce through the streets of London without causing undue vibration, and at a cost, I am informed, of about one-half that of horse traction.

But a far more burning question is that of the speed of motor cars along our public throughfares. Between racing speed and ordinary traveling speed there is necessarily a great difference, and our twenty miles maximum on country roads is in excess of that allowed in France, where it is now fixed, though I believe not enforced in the open country, at eighteen and one-half miles, and at twelve and one-half miles where there is much traffic. The two classes of motors used for higher speeds are the petrol and the electric. The former are mainly internal-combustion engines; having to be light, they run at the comparatively high speed of 800 revolutions per minute. They are generally used in connection with bicycles, tricycles or light carriages. They have also been used for light vans and coaches, and successful trials have been made with self-propelled lorries for military purposes, and by local authorities for watering and dust collecting. Their application to omnibuses has not proved economical, owing to the difficulty of providing pneumatic tires for such heavy vehicles.

The electric motor depends on storage batteries; those in general use are of Planté's lead-couple type. Like the petrol motor, the electric motor is rather a luxury; most of the automobile carriages used in London are of this class; there is liability of injury to the batteries by over-discharging them. Colonel Crompton, in a paper recently read at the engineering conference suggested the use of "standardized accumulators," to be supplied to the owners of electrical vehicles at depots on production of the subscription ticket, and the Engineering Standards Committee has appointed a sub-committee to consider the question. Motor cars are now used by some of the railway companies as feeders to their lines, and also in competition with tramway lines.

The increasing use of motor cars renders more than ever necessary the regulation of traffic in crowded thoroughfares, a subject which will doubtless be dealt with in the paper on "The Problem of Modern Street Traffic," which Colonel Crompton is about to read before this section of the British Association.

The use of motor-driven vehicles for road traffic is so intimately associated with improvements in prime movers that it will interest the members of this section to be reminded of the opinion expressed more than twenty years ago by Sir Frederick Bramwell, who presided over the meeting of the British Association at Bath in 1888. In a paper read before this section at the jubilee meeting of our association at York in 1881, Sir Frederick Bramwell said: "However much the mechanical section of the British Association may to-day contemplate with regret even the mere distant prospect of the steam engine becoming a thing of the past, I very much doubt whether those who meet here fifty years hence will then speak of that motor except in the character of a curiosity to be found in a museum." In a letter addressed to the president of this association on July 2 last, Sir Frederick Bramwell drew attention to the largely increasing development of internal combustion engines, and expressed a feeling of assurance that although steam engines might be at work in 1931, the output in that year would be small of steam as compared with internal combustion engines.

To keep alive the interest of the association in this subject, Sir Frederick Bramwell has kindly offered, and the council has accepted, the sum of £50 for investment in two and one-half per cent self-accumulative consols, the resulting sum to be paid as an honorarium to a gentleman to be selected by the council to prepare a paper having Sir Frederick's utterances in 1881 as a sort of text, and dealing with the whole question of the prime movers

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of 1931, and especially with the then relation between steam engines and internal combustion engines. That paper will doubtless prove to be a very valuable contribution to the proceedings of this association, and one can only regret that many of those assembled here to-day can not hope to be present when it is read, and to listen to an account of the nearest approach which has then been made toward the production of a perfect prime mover.

ELECTRIC TRAMWAYS AND LIGHT RAILWAYS.

I now pass to the application of electricity to tramways, and in so doing may quote from the careful expression of opinion given in this town from this chair twenty years ago by the late Sir (then Mr.) James Brunlees, president of the Institution of Civil Engineers: "The working of railways by electricity has not advanced further than to justify merely a brief reference to it in this paper as among the possibilities, perhaps the probabilities, of the not distant future."

It was stated in a paper read by Mr. P. Dawson in April last before the Tramways and Light Railways Association, that the total route-length of electric tramways and light railways in the United Kingdom, either completed, under construction or authorized, amounted at the end of last year to 3,000 miles, the length of single track being 5,000 miles, on which some 6,000 cars were running.

It can not, in my opinion, be regarded as being fair to the railway companies—which have to pay large sums of money for the land on which their lines have been constructed—to have to compete with tramways which are laid along the public roads without any payment being made for their use. The roads are disfigured by aerial conductors and the supporting posts by which the electric current is conveyed to the cars, except in those comparatively rare instances in which the conduit system is used; nor can it be denied that tramways greatly interfere with the use of the roads for ordinary traffic. The effect of electrolytic action on iron pipes laid beneath the roads is still undergoing investigation.

RAILWAYS.

Railway companies are turning their attention to the introduction of electric traction wherever it can be beneficially used, as for instance on the Mersey Railway, the North-Eastern Railway between Newcastle-upon-Tyne and Tynemouth, and the Lancashire & Yorkshire Railway between Liverpool and Southport. With the object of facilitating the introduction and use of electrical power on railways, Parliament has passed an act entitled the "Railways (Electrical Power) Act, 1903," which will come into operation on January 1 next.

The electrical service on the Mersey Railway has now been in regular and uninterrupted operation since the beginning of May in the present year. Trains are run at three-minute intervals, there being 750 trains in all between 5 A. M. and 12 midnight; and as it is the first example of a British steam railway converted to the use of electric traction, a short description if it can not fail to be of interest.

Of tube railways with electric traction there are three now working in London, two between the city and the south side of the river Thames, using the ordinary two-wire 500 volts continuous-current system, and another (the Central London) extending from the city to Shepherd's Bush, using the composite system. This railway conveyed during the year 1902 no fewer than forty-five million passengers. There are eight other tube railways now in course of construction in London. The recent terrible catastrophe in Paris must serve as a warning in the future equipment of such lines where currents at high tension are employed, and where short-circuiting may bring about disastrous results.

WIRELESS TELEGRAPHY.

In addressing this section I feel that I ought to say a few words on the subject of "wireless telegraphy." With regard to signaling Signor Marconi certainly seems to have made progress. In January, 1901, signals were conveyed from Poldhu in Cornwall to the Isle of Wight, a distance of 200 miles, and in December of the same year, between Cornwall and St. John's, Newfoundland, a distance of 2,000 miles. In the year 1902 signals were transmitted from England to the Baltic and the Mediterranean, which had thus passed over both sea and land. It seems to be not improbable that signals can be sent any distance, so long as the sending station can develop sufficient energy. The question of "syntonism," by which it is proposed to assure the secrecy of messages, appears to be still *sub judice*, but is undergoing further investigation.

There appears to be a practical field for the development of "wireless telegraphy," more especially where ordinary telegraphy can not be applied, as, for instance, between shore and ships at sea or between one ship and another.

The Marconi Wireless Telegraph Company has obligingly furnished me with a list of eighteen land stations fitted on the Marconi system for commercial ship signaling, together with a list of forty-three passenger steamers already furnished with the Marconi apparatus, thus affording evidence of its application to practical purposes.

The system of "wireless telegraphy" by Sir Oliver Lodge and Dr. Muirhead has, I understand, been fitted to cable steamers of the Eastern Extension Telegraph Company, to enable communication to be made with its cable stations.

The remainder of the address was given to the discussion of sewage disposal, irrigation and water supply.

Surface-Contact System Accepted.

After a long period of waiting, the council of the city of Wolverhampton, England, has decided to accept the surface-contact system built for it by the Lorain Steel Company, Lorain, Ohio. The Lorain Steel Company built the line, and installed it free of cost, the city agreeing to purchase it if at the end of a stated period it should be found that the system was practical. The system is the invention of Mr. W. Milt Brown, of the electrical department of the Lorain company.

Electric Car on the Marienfelde-Zossen Line Breaks all Speed Records.

On October 6, an electric car on the Marienfelde-Zossen experimental line reached a speed, it is reported, of 125.45 miles per hour, or a kilometre more than the highest previous record. The machinery and roadbed were unimpaired. The engineers are determined to try for still higher speeds and venture the opinion that they will be able to attain the rate of 140 miles per hour.

The current was between 13,000 and 14,000 volts, capable of driving the car at the rate of over 200 miles. This power is reduced by transformers to about 450 volts. The car used in this test had four motors, having together about 1,100 horse-power. It was the car used in the previous tests this year, and is constructed on the Siemens-Halske system. Another car of somewhat different equipment as to motors and transformers has been built for additional high-speed tests.

There were twelve to fourteen persons on board the car, all technical men. They affirm that the motion of the car was no greater than that of an ordinary express train. A curious phenomenon accompanying the car is the continuous sparkling of electricity from the six trolley arms.

While the engineers do not believe a speed of 125 miles is practicable at present on the state railroads, they are prepared to recommend a speed of ninety-three miles an hour between Berlin and Hamburg.

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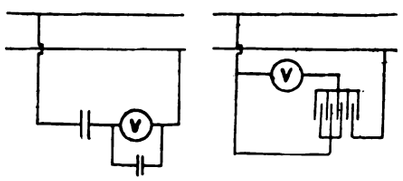
ON THE USE OF CAPACITIES AS MULTIPLIERS IN CONNECTION WITH ELECTROSTATIC VOLTMETERS ON ALTERNATING-CURRENT CIRCUITS.[1]

BY E. W. MARCHANT AND G. W. WORRALL.

The measurement of high-potential differences necessitates the use of voltmeters more or less cumbrous and expensive, since in all electrostatic instruments there is a liability to sparking between the plates. High-potential differences may, however, be measured by lower-reading voltmeters in several ways. The only methods hitherto adopted have been by the use of non-inductive resistances connected in series with the voltmeter, either shunted or unshunted, and by the use of transformers. The first method becomes quite impracticable with high pressures on account of the large waste of power involved, while the latter method becomes equally cumbrous on account of the difficulties of insulation and the length of wire required in winding the apparatus. The experiments described below have been directed to the construction of a simple and easily



FIGS. 1 AND 2.

made apparatus by which low-reading electrostatic voltmeters may be employed on circuits of much higher tension. The voltmeters used were of the Kelvin multicellular and Ayrton and Mather electrostatic types. The method of combining the voltmeter with the capacities is to connect a capacity in series with the voltmeter across the mains and shunt another capacity across the terminals of the voltmeter, the latter capacity being large compared with the capacity of the voltmeter. Fig. 1 is a diagram of the connections.

Consider two capacities connected in series across the mains.

Let C_1 and C_2 be the values of the capacities in farads;

R_1 and R_2 be their respective insulation resistances;

V_1 and V_2 be the respective potential differences between the terminals of the capacities;

E be the total potential difference between the mains;

I_r be the resistance current between the mains;

I_c be the capacity current between the mains;

I be the total current between the mains;

p be 2π (frequency per second).

Total current in capacity 1 =

$$V_1\sqrt{\left(\frac{1}{R_1}\right)^2+(C_1p)^2}$$

Total current capacity in 2 =

$$V_2\sqrt{\left(\frac{1}{R_2}\right)^2+(C_2p)^2}$$

These two currents being one and the same,

$$V_1\sqrt{\left(\frac{1}{R_1}\right)^2+(C_1p)^2}=$$

$$V_2\sqrt{\left(\frac{1}{R_2}\right)^2+(C_2p)^2}=I.$$

Now,

$$E=\frac{I_c}{\frac{C_1C_2}{C_1+C_2}p}=I_r(R_1+R_2).$$

Hence,

$$I_c=E\frac{C_1C_2}{C_1+C_2}p, \text{ and } I_r=\frac{E}{R_1+R_2}.$$

Now,

$$I=\sqrt{I_c^2+I_r^2}=$$

$$E\sqrt{\left(\frac{C_1C_2p}{C_1+C_2}\right)^2+\left(\frac{1}{R_1+R_2}\right)^2}=$$

$$V_2\sqrt{\left(\frac{1}{R_2}\right)^2+(C_2p)^2}.$$

Hence, $\frac{V_2}{E}=$

$$\frac{\sqrt{\left(\frac{C_1C_2p}{C_1+C_2}\right)^2+\left(\frac{1}{R_1+R_2}\right)^2}}{\sqrt{(C_2p)^2+\left(\frac{1}{R_2}\right)^2}}.$$

Let $R_1=\frac{x_1}{C_1p}$, and $R_2=\frac{x_2}{C_2p}$. Then

$$\frac{V_2}{E}=\frac{\sqrt{\left(\frac{C_1C_2p}{C_1+C_2}\right)^2+\left(\frac{1}{\frac{x_1}{C_1p}+\frac{x_2}{C_2p}}\right)^2}}{\sqrt{(C_2p)^2+\left(\frac{C_2p}{x_2}\right)^2}}=$$

$$\sqrt{\left(\frac{C_1C_2p}{C_1+C_2}\right)^2+\left(\frac{C_1C_2p}{x_1C_2+x_2C_1}\right)^2}$$

$$\sqrt{(C_2p)^2+\left(\frac{C_2p}{x_2}\right)^2}=$$

$$\frac{C_1}{C_1+C_2}\frac{\sqrt{1+\left(\frac{C_1+C_2}{x_1C_2+x_2C_1}\right)^2}}{\sqrt{1+\left(\frac{1}{x_2}\right)^2}}$$

Expanding and neglecting higher terms—

$$\frac{V_2}{E}=\frac{C_1}{C_1+C_2}\left\{1+\tfrac{1}{2}\left(\frac{C_1+C_2}{x_1C_2+x_2C_1}\right)^2-\tfrac{1}{2}\left(\frac{1}{x_2}\right)^2+\ldots\right\} \quad (1)$$

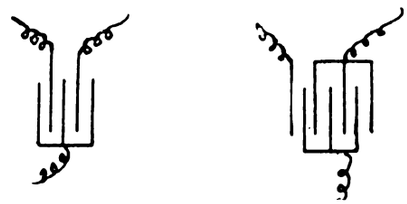
If x_1 and x_2 are very large—that is, if the insulation resistances of the condensers are high—then

$$\frac{V_2}{E}=\frac{C_1}{C_1+C}.$$

From equation (1) it will be seen that if $x_1=x_2$, that is if

$$\frac{R_1}{R_2}=\frac{C_2}{C_1}; \text{ then } \frac{V_2}{E}=\frac{C_1}{C_1+C_2}.$$

This will most probably be the case if the plates of both capacities are of the same size and the sheets of dielectric of the same material, size and thickness, the difference in the values of the capacities being produced by using different numbers of sheets, since, then, both leakage currents through the material and those over the surface of the dielectric will be proportional to the number of plates forming the condensers. If an electrostatic voltmeter, therefore, be connected across the capacity 2, its reading bears a constant ratio to the potential difference between the mains, and by varying C_1 and C_2 any desired ratio may be obtained. Several advantages, such as compactness and saving of material, are gained by forming the two capacities into



FIGS. 3 AND 4.

a condenser, in which one of the two sets of plates is itself divided into two groups, each group connected to its own related main, one group to the voltmeter, and the voltmeter again to the undivided set, as in Fig. 2.

Two instruments have been constructed up to the present on the principles described. One suitable for measuring potential differences up to 300 volts on a 150-volt instrument and having a ratio of $\frac{1}{2}$, and the other suitable for potential differences up to 10,000 volts having a ratio of $\frac{1}{40}$. Fig. 3 is a diagram showing the arrangement of the low-tension instrument. This is formed of alternate sheets of mica and tin-foil of equal dimensions respectively, held together between strong plates of ebonite. Fig. 4 is a diagram showing the arrangement of the high-tension instrument. This is similarly formed, except that copper-foil is substituted for tin-foil, the dielectric varies in thickness directly with the tension, and the whole is clamped between brass plates. The dielectric plates in the

[1] Paper read before the British Association, Southport meeting, September 9 to 15.

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higher-tension portion are made larger than those in the lower-tension portion to avoid sparking over the surface, and the entire instrument is suspended in oil for the same reason. The accuracy of the apparatus made has been tested by careful experiments. The measuring instruments used were calibrated at the time of the experiments by comparison with a Kelvin standard balance, and the potential differences for the high-tension instrument were obtained by means of a transformer of known ratio. This ratio was determined at a low-potential difference, and found to be 55.42 and assumed constant; thus the actual voltage in all cases given below is that measured on the primary multiplied by 55.42.

RESULTS OF EXPERIMENTS.

LOW-TENSION INSTRUMENT.

Total Potential Difference Between Mains. E	Reading of Voltmeter. V_2	Ratio. $\frac{E}{V_2}$
139.9	73.4	1.906
149.3	77.7	1.921
162.4	85.1	1.908
174.7	91.0	1.920
185.9	97.2	1 912
196.0	102.5	1.913
204.1	107.8	1.893

HIGH-TENSION INSTRUMENT.

Total Potential Difference Between Mains. E	Reading of Voltmeter. V_2	Ratio. $\frac{E}{V_2}$
6,761	174	39.48
7,426	186	39.92
7,980	204	39.12
8,534	213	40.09
9,089	231	39.34
9,643	243	39.68
10,197	259	39.75
10,751	268	40.11
11,305	283	39.94

The ratios given above in all cases differ by less than one per cent from their mean value, and in most cases agree much more closely. Any variations that exist are well within the limits of experimental error. It is hoped that this device may be of considerable practical utility, not only in simplifying the construction of high-tension voltmeters, but in laboratory and experimental work, where it frequently happens that measurements of potential have to be made with voltmeters, the best parts of whose scales are too low. The invention has been provisionally protected.

Injuries to Shade Trees from Electricity.

Bulletin No. 91 of the Massachusetts Agricultural College contains a report by Dr. George E. Stone, state botanist, upon the effects of electricity and electrical conductors on shade trees. Injuries may be caused by interference with the tree growth by a mass of wires overhead or by contact with wires carrying currents or by lightning. Of the two systems of electrical supply, alternating and direct current, the former is less disastrous to plant life than the latter. When a certain current strength of either kind flows through a tree it accelerates growth and development. There is a minimum strength of current which just perceptibly acts as a stimulus; an optimum, that producing the greatest stimulus, and a maximum, that causing death. Between the optimum and the maximum there is a strength of current that causes retardation. Direct current stimulates less than alternating, and on account of its polarizing effect appears to cause more injury to vegetable life than the same strength of alternating current. Most of the injurious electrical effects to trees arising from trolley or electric light wires are, as a rule, local—that is, the wire causes an injury at or near the point of contact of the wire to the tree. This injury is produced in moist or wet weather, when the tree is covered with a film of water, the result being a burning of the limb. The vital layer of the limb may become partially or entirely killed at the point of contact, and this gives rise to an ugly scar. In a large number of tests made by the aid of sensitive instruments, the author has not in any case found any leakage during fair weather. Results are given of tests made to determine the electrical resistance, but as the measurements were made by means of two nails driven into the wood, much dependence can not be placed upon the relative values for the outer bark, inner bark, the cambium or vital layer, and the wood. However, the minimum value found was about 11,000 ohms for ten feet of the trunk of an elm tree eighteen inches in diameter.

According to observations of the author, the effect of alternating currents on trees is local, injury being produced only near the point of contact. This may result in the death of that portion of the tree; but if it is a leader or a large limb, it frequently has to be sacrificed. He knows of no instance in which alternating current caused the complete death of the tree, though that it is capable of killing small plants has been shown by laboratory experiments. In these experiments the current necessary to kill the plant generated a considerable heat, and this probably caused the death.

The direct currents most usually contended with are those carried by railway feeders. The great majority of burns resulting from the direct current are similar to those produced by alternating currents. They are largely local. These burns are not caused except when the trees are moist, as the high resistance of the wood furnishes a means of protection against death from contact with ordinary currents. The burning in all cases is caused by arcing. Tests were made to determine the amount of current which could be carried by a tree, the current being led in by means of nails driven in the wood. The values found were only a few hundredths of an ohm, and no heating was caused. During wet weather, however, there was always a considerable amount of heat developed while the positive wire was connected to the tree. An examination of this tree ten months later—the connections having been left for several months—showed that the portions of the tissues near the electrodes had been killed.

There are certain cases where large trees have been killed by direct currents from railway circuits. In some of the cases which have come under the author's observation, escaping current has girdled the tree at a distance of five to ten feet, whereas the point of contact of the feed wire with the limb is sixteen or eighteen feet above the ground, and showed none of the characteristic burning effects. An investigation of these unusual results showed that in these cases the positive bus-bar of the system was connected to the rails, and the negative to the overhead conductors; and in all instances where trees were killed by electricity, this was found to be the case.

Lightning, in striking a tree, does not always produce the same results. Trees may be killed outright without exhibiting the common effects of shattering. Quite frequently the tree is girdled by the discharge taking a spiral course to the ground. In a large number of instances lightning strokes cause neither death nor mechanical injury of importance. Hundreds of trees are annually struck by lightning, but this is not recognized except by those who are familiar with the scars which subsequently make their appearance on the trunk.

Brooklyn Rapid Transit Men to Receive Instruction in Electrical Engineering.

At the Railroad Men's Building, Jamaica avenue, Brooklyn, N. Y., on Monday evening, October 5, Mr. Sidney W. Asche, of the Brooklyn Polytechnic Institute, delivered his first lecture to an audience of one hundred and eighty-five men. Thirty-five men enrolled for the course of forty-eight lessons. A complete laboratory is being fitted up by the Brooklyn Rapid Transit Company, which will enable Mr. Asche to give practical as well as theoretical instruction. It is expected that the enrollment will soon reach fifty. On Wednesday classes were organized in arithmetic, penmanship and English.

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NOTES ON X-LIGHT.

BY WILLIAM ROLLINS.

NOTE CLXX—ON PREVENTING WATER VAPOR FROM ENTERING THE MERCURY PUMP USED IN EXHAUSTING X-LIGHT TUBES.

In exhausting X-light tubes the presence of water vapor in the pump delays the production of a vacuum. Keeping the pump hot was recommended in earlier notes. In the present note apparatus will be described for keeping water vapor out of the pump. Considering how many able men have worked with mercury pumps it is a little strange that water vapor has been allowed to enter the mercury reservoir at every stroke of the pump and to pass up between the mercury and the inner wall of the fall tube into the pump chamber where it has delayed the production of a vacuum in any apparatus attached to the

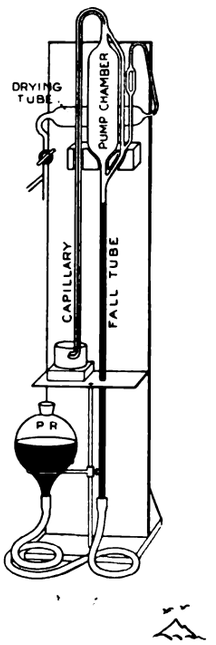

FIG. 1.

pump. Fig. 1 is an illustration of a mercury pump copied from the latest work on gases—"The Study of Gases," by Travers. The pump reservoir PR, containing mercury, is in free contact with the air. The results mention follow, particularly in the morning when the temperature of the pump room is made higher than at night. Under these circumstances when the pump is operated water may be seen in minute drops to collect between the mercury and the inner surface of the fall tube. If an X-light vacuum was left in the pump it may have deteriorated, and bringing it back to the degree it was left may take some time as the water continues to enter the pump chamber with the rise and fall of the mercury. This increase in pressure has been attributed to leaks in the pump and to fine defects in the seals of the X-light tube.

The difficulty can be made less by placing a drying arrangement in the

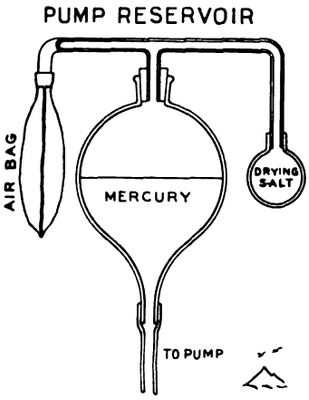

FIG. 2.

path of the air entering the mercury reservoir. To avoid rapid deterioration of the drying chemical it is desirable to close the air inlet with a flexible diaphragm which can expand and contract as the mercury flows into or out of the reservoir. A simple method of applying the principle to the mercury reservoir of the pump shown in Fig. 1 is illustrated in Fig. 2. The mouth of the reservoir is closed by a rubber stopper through which passes a T-shaped tube, on one end of which is a drying bulb, on the other, a tight rubber bag. As no

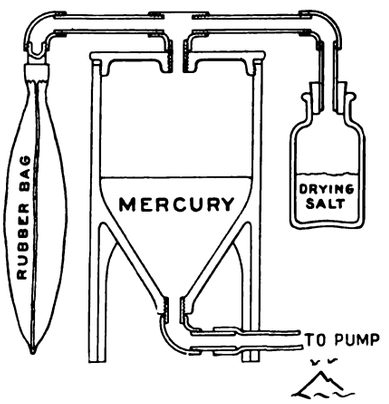

FIG. 3.

external air enters the pump through the mercury reservoir the contained air is kept dry by the drying chemical. To ensure rapid work a mercury pump for exhausting X-light tubes should have a large pump head. Forty kilogrammes of mercury is a considerable mass to have in a glass reservoir, therefore pump reservoirs should be made of iron. One of this kind is shown in Fig. 3. Drying tubes should be also placed at the outlet of the pump. Where the pump is operated by a mechanical air pump which exhausts the air from the pump reservoir, air being admitted by a valve to cause the mercury to rise at each stroke in to the pump chamber, the same precautions against external air should be used.

The Reception Committee of the American Institute of Electrical Engineers.

President Bion J. Arnold has appointed the following gentlemen as members of the local reception committee of the American Institute of Electrical Engineers: Mr. Calvin W. Rice, chairman, Mr. F. C. Bates, Mr. B. Gherardi, Jr., Mr. William J. Hammer, Mr. T. C. Martin, Mr. E. H. Mullin, Mr. Charles W. Price, Mr. Calvert Townley and Mr. Arthur Williams.

A Single-Phase Traction Motor.

A consular report from Berlin gives a brief account of tests made recently in that city with a railway car which is equipped with a single-phase alternating-current motor. The motor was built by the Union Electric Company according to the designs of an Austrian engineer. Power is supplied to the trolley at 6,000 volts and the regulating devices are said to be quite simple. The full voltage is applied to the motor; the frequency is not mentioned. The experimental line is about four miles in length, and the motor is said to have run sparklessly without trouble.

Gutta-Percha from New Guinea.

The Colonial Economic Committee of Berlin announces that the utility of the gutta-percha discovered by the expedition which was undertaken to New Guinea, under the leadership of Herr Schlechter, has been so far established that the gutta-percha from the low-lying country may be regarded as suitable for cable purposes as an admixture, and if carefully obtained, be fit for cables in a pure condition. Large quantities of gutta-percha have been obtained from New Guinea and are at present being tested. It is proposed by the Colonial Economic Committee to establish a gutta-percha enterprise for the education of the native population of New Guinea, in the cultivation of the plant and the harvesting of the gum. For this purpose a fresh expedition will be sent out for a period of three years, and assistance will be given by natives of Borneo and others familiar with the question of rubber production.

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The Old Time Telegraphers and United States Military Telegraph Corps.

The twenty-third annual meeting of the Old Time Telegraphers' and Historical Association, together with that of the United States Military Telegraph Corps, was opened on Wednesday morning, September 23, at 11 o'clock, in the rooms of the Merchants and Manufacturers' Association, of Milwaukee, Wis. The opening session was called to order by Mr. John Brant, secretary-treasurer of the association. He requested Mr. S. A. Duncan, of Atlanta, Ga., to present the badge of the presidential office to President U. J. Fry. This badge consists of a miniature portrait of Professor Morse, and it is always worn by the president of the association on the lapel of his coat during the term of each annual meeting.

The Hon. Carl Runge, city attorney of Milwaukee, greeted the 400 attendants who had responded to the invitation of Milwaukee to the Old Timers. President Fry delivered his annual address, and Colonel William B. Wilson, of Philadelphia, thanked the representative of the city of Milwaukee for his warm welcome. On behalf of the Old Timers and Military Telegraphers, Colonel Wilson gave a brief history of the telegraph and the part it plays in the management of the railroads and the transaction of the commerce of the world.

The secretary's report showed that the affairs of the association were in a satisfactory condition.

Mr. C. A. Stimson, of Philadelphia, invited the Old Timers and Military Telegraphers to visit that city on October 30 and 31, to take part in the telegraph tournament. A resolution endorsing and encouraging the tournament was passed.

Atlanta, Ga., was selected as the next place of meeting in 1904, the date of which is to be determined by the executive committee.

The committee on nomination, time and place, consisting of D. C. Sims, W. G. Moffet, John Winthrop, George Henderson and S. A. Duncan, reported the following named as officers for the ensuing year: C. C. Adams, general superintendent of the Postal-Telegraph Cable Company, Atlanta, Ga., president; J. M. Stephens, superintendent of the Western Union Telegraph Company, Atlanta, Ga., first vice-president; W. H. Adkins, traffic manager of the Southern Bell Telephone Company, Atlanta, Ga., second vice-president; John Brant, of New York, secretary-treasurer. An executive committee comprising the following was also elected: U. J. Fry, Milwaukee, Wis.; G. H. Corse, of Ogden, Utah; L. B. McFarland, of Montreal, Quebec, and H. C. Hope, of St. Paul, Minn.

Resolutions of thanks were voted to the railroads for their courtesies and to Colonel Robert C. Clowry, president and general manager of the Western Union Telegraph Company, of New York, for many favors extended. Both telegraph companies and the long-distance telephone company were also thanked for courtesies of free service extended to the members. The convention then adjourned.

UNITED STATES MILITARY TELEGRAPH CORPS.

The meeting of the United States Military Telegraph Corps was called to order at 12.30 o'clock on Wednesday, September 23, by Colonel W. B. Wilson, of Philadelphia, president of the society. There were twenty-five telegraph veterans of the Civil War and four ex-Confederate operators present, in addition to a large number of the members of the Old Time Telegraphers' and Historical Association.

Following President Wilson's report, Mr. J. E. Pettit, of Chicago, secretary-treasurer of the society, read the report, which showed a balance of considerable money on hand.

A vote of thanks was given to Governor Pennypacker, of Pennsylvania, in connection with the presentation of a gold medal by the state of Pennsylvania to Colonel W. B. Wilson, the president of the society, in recognition of faithful services performed during the war.

The old offices were reelected as follows: Colonel W. B. Wilson, of Philadelphia, Pa., president; W. L. Ives, of New York, vice-president, and J. E. Pettit, of Chicago, secretary-treasurer. Executive committee: E. Rosewater, chairman, Omaha, Neb.; A. H. Bliss, W. R. Plum, Chicago, Ill.; Colonel A. B. Chandler and R. B. Hoover, New York; George C. Maynard, Washington, D. C.; D. W. Smith, Breckenridge, Minn.; L. A. Somers, Cleveland, Ohio, and J. D. Cruise, Kansas City, Kan. Atlanta, Ga., was chosen as the next place of meeting, and a vote of thanks recorded for favors extended.

On Wednesday, September 23, the entire party boarded special trolley cars for a trip to the Marconi Wireless Telegraph Company's station on the shore of Lake Michigan, where a demonstration was given and several messages exchanged with Chicago. On the return, a trip was made through the principal streets of the city and suburbs, including a visit to the Soldiers' Home.

The performance of "King Dodo," at Davidson's Theatre, was witnessed by some 300 visitors on Wednesday evening.

Thursday, September 24, was given up to various expeditions about the city, and after luncheon the entire party went for a three-hour sail on Lake Michigan, refreshments being served during the trip.

The annual banquet was held at the Hotel Pfister at 8 o'clock on Thursday evening. Mr. William J. Lloyd was introduced as toastmaster. Vocal selections were rendered by Miss Bessie O'Brien, of Chicago, and City Attorney Carl Runge was introduced, making a brief address in which he thanked the telegraphers for their visit to Milwaukee. Following this there were short addresses by Colonel W. B. Wilson, and by Senator W. C. Burton, of New York, who spoke on "The Right Arm of Commerce." Mr. William O. Maver, Jr., of New York, responded to the toast "Wireless Echoes." Mayor Cochrane, of Montreal, was the next speaker, and Mr. L. B. McFarland, of Montreal, a former president of the association, followed with a brief address. Addresses were also made by Messrs. H. A. Tuttle, of Minneapolis; M. J. O'Leary, of New York; S. A. Duncan, of Atlanta, Ga., and Henry W. Pope, of New York.

The morning of September 25 was given up to a trolley ride to White Fish Bay, on the shore of Lake Michigan. Short addresses were made and the party returned at 2.30 P. M., when the Milwaukee festivities were at an end.

Annual Report of the Meridan Railroad Company.

The annual report of the Meridan Electric Railroad Company, which is owned by the New York, New Haven & Hartford Railroad Company, shows that during the past fiscal year cars were run an aggregate of 701,424 miles. The number of passengers carried was 3,470,480, and the number of paying passengers per mile of main track operated was 136,016. The gross earnings from operation were $149,469, and the operating expenses were $94,588, leaving the net earnings from operation $54,880. The deduction from the income includes interest payments aggregating $33,533. The total deficit for the fiscal year ending June 30, 1903, was $3,219 as against $15,601 for the previous year. Various additions to the equipment and permanent plant were made last year.

Professor Ayrton to Lecture before the New York Electrical Society.

Professor W. E. Ayrton, of the Central Technical College, London, will lecture before the New York Electrical Society, in the lecture room of the American Institute, 19 West Forty-fourth street, New York city, Monday, October 19, at 8 P. M. The subject of the evening will be "An Informal Talk on Some Electrical Measuring Instruments and Recent Use of Them."

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Twenty-first Annual Meeting of the Street Railway Association of the State of New York.

Held at the City Hall in the City of Syracuse, N. Y., October 6 and 7, 1903.

THE meeting was called to order by Mr. G. Tracy Rogers, president of the association, at 10.35 A. M.

The secretary, Mr. Henry A. Robinson, called the roll, and the minutes of the preceding meeting, as printed, were approved.

Mayor Jay B. Kline, of Syracuse, was introduced, who welcomed the attendants after which President G. Tracy Rogers delivered his annual address.

The thanks of the convention was extended to the president for his very sound, able and instructive address.

Secretary Robinson read the report of the executive committee, and the special minutes.

The treasurer's report was read by Mr. Robinson, and this was accepted and approved.

The secretary read a communication from Professor George F. Comfort, inviting the members of the association to visit the Museum of Fine Arts, and another from the Central New York Telephone and Telegraph Company, tendering to the association the use of its service during the convention.

The first paper was read by Mr. James E. Duffy, Syracuse, N. Y., on "Transfers, Their Use and Abuse."

Mr. Duffy's paper detailed the condition of the transfer system in the city of Syracuse, and no claim was made that the conditions enumerated and met with would be applicable to any other locality. Whenever it is possible, it should be the duty of the manager, in routing lines, to so arrange them that as large a percentage of his patrons should have the benefit of a continuous passage as is possible from the standpoint of economical operation. There is no part of the successful operation of a street railway that has caused the management more thought and worry than the adoption of a transfer system that would prove satisfactory to its patrons and not leave loopholes that could be taken advantage of by dishonest people. The more attractive riding on street cars becomes, the larger will be the proportion of the riding population, and managers are to-day providing parks, pleasure resorts, etc., with beautiful cars, and all manner of transfer privileges, to attract passenger traffic. The liberal giving of transfers has to a large extent aided in increasing the business of the system with which the writer is connected. The author concludes that the transfer has come to stay, and that companies, while desiring to be as liberal as is consistent with good business policy, must adopt such measures as will prevent them from being imposed upon too generally.

Mr. W. B. Rockwell, of Syracuse, N. Y., took exception to the statement that the transfer had come to stay. It is the most burdensome thing that has been imposed upon railroad companies. He would rather give the passengers a four-cent fare, and abolish the transfers altogether.

Mr. W. W. Cole, Elmira, N. Y., thought the transfer had effected an increase of riding in those cities where the transfer was inaugurated. The transfer was not entirely an evil. The evil comes from the abuse and improper handling of them. If the misuse of transfers could be done away with, he thought there was no question that their use would lead up to a great increase in receipts.

Mr. T. J. Nicholl, Rochester, said there should be some action taken in the way of standardizing transfers, although he could see difficulties which would come up in that respect, because all cities are not laid out the same and would require different forms of transfers; but at the same time he thought there might be something done to educate the people to the use of a certain form of transfer, so that there would be no mistake, and a conductor going from one road to another would understand it easily without receiving fresh instructions.

Mr. Thomas E. Mitten, Buffalo, said he used the transfers as a method of building up the newer districts, and where there is the issue of a transfer upon a transfer, if that is confined to pleasure travel, he did not think its effect upon the earnings would become very detrimental.

Mr. Orin W. Root, New York, stated during the discussion his road was using on the average about 550,000 transfers a day.

Dr. J. J. Moorehead, New York, read a paper entitled "Methods of Discovering Fraudulent Claims for Injury."

Dr. Moorehead's paper enumerated a number of instances of the claims and statements which impostors make in attempting to secure damages for minor accidents. Claimants, he said, were divided into three classes—honest, partly honest and shammers. He also showed the ridiculous fashion in which all manner of diseases was traced to accidents incident to car travel, and the many times which these troubles, upon proper examination, had been distinctly traceable to other causes.

Mr. Don R. Almy, New York, mentioned several cases wherein the value of a physical examination of a claimant for damages was very evident, and stated that in his opinion there was no one element in the investigation of an accident which is so valuable.

This paper was followed by one on a similar topic, entitled "Physical Examination in Accident Cases," by Mr. W. A. Dibbs, of New York.

Mr. Dibbs dwelt strongly upon the great practical value of physical examinations. Too often, he said, the physician who happens to have charge of the case, either from a superfluous sentimentality or from a spirit of charlatanism, takes up the case both as an adviser and as a physician. In cases of this kind the only thing to do is to get a thoroughly reliable medical examiner to go into the case from the company's standpoint. He cited many instances of claims for damages which, upon examination, proved to be entirely without ground.

This paper was briefly discussed by Messrs. Rogers, Danforth, Allen, Smith and the author.

A paper on "Hydraulics in Connection with Street Railway Operation," was read by Mr. C. E. Parsons, of Glens Falls.

Mr. Parsons called attention to the necessity of developing hydraulic plants because of the demand for cheap transportation by electric railway systems. He took the new hydroelectric development at Spier's Falls, on the Hudson river, as a typical example of the important part in the operation of street railways which a hydroelectric plant may take. Six different railway systems are located within a radius of forty-five miles of this plant. Three of these are now using power from Spier's Falls and Mechanicsville, a plant in the same territory. The railroads are operated by means of transmission lines carrying high-tension currents to substations, where the current is stepped down and transformed by rotaries for

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operating the lines. He detailed the question to be decided in laying out water power plants, as to the size of the units—both wheels and generators. The question of the building of the dam and the protection of the canal and forebay was also taken up, and considerable detail given to the question of the governing of the hydroelectric plant. The switchboard is another part of the system which needs careful study, and should be modern in every respect, in order that any possible chance of shutdown may be minimized.

This paper was discussed briefly by Messrs. Pardee, Clark, Mitten and Rogers. In reply to a question as to the distribution of pole lines and the labeling of poles carrying high-tension conductors, Mr. Parsons said that all high-tension wires were labeled dangerous where they passed through villages. Usually where it is twenty or thirty thousand volts the danger signal is put up.

On motion, the meeting was adjourned until 2.30 P. M.

TUESDAY AFTERNOON SESSION.

The first paper to be read was by Mr. T. W. Wilson, Buffalo, on "Track Construction and Maintenance."

The track upon which all the traffic is to be carried is one of the most essential parts of a railway. The author states, however, that the importance of the track and trackwork, in relation to the operation of the railway, and the proportion which the maintenance of track bears to the total operating expense, does not seem to be fully recognized by street railway officials. Mr. Wilson detailed the effects of operation with several forms of rail, and stated that the practical solution of the rail question would seem to be the use of nine-inch Trilby-type in the busiest thoroughfares of large cities, where the trucking is heavy; the grooved girder rail in quieter streets and those districts which, by reason of architectural construction, have been fixed as residential districts; and tee rails in smaller towns and cities and in the suburbs of large cities. Besides the shape of the lip of the girder rail there are two other important points to be carefully considered—the width of base and the depth of groove. The base on a nine-inch girder should not be less than six inches. The depth of groove should not be less than one and one-quarter inches. With the use of a concrete roadbed the wear upon the head of the rail is undoubtedly greater than with a flexible roadbed, and every one-thirty-second inch of increased depth means a longer life for the track. With the advent of the welded joint has come a great decrease in maintenance. The question of ties, roadbed and paving costs, construction and maintenance, were all thoroughly taken up and presented in a concise and readily understood manner.

Replying to a question by Mr. Cole, Mr. Wilson stated that he allowed cement grading to set for seventy-two hours before beginning to run cars over it.

Mr. R. E. Danforth spoke of the use of a "Tee" rail in small towns where there was little vehicular traffic and of the difficulty from snow and ice which has been experienced with the use of a grooved rail in Rochester.

Mr. Lewis, Schenectady, said the question of track construction is becoming very important. It has not had attached to it the importance in the past that it should have had; the necessity of having a better roadbed than has been had in very many instances is being recognized. Concrete construction in paved streets is absolutely essential, for this reason. In open track work, where the joints can easily be got to at any time of the year, flexibility is correct theoretically and practically; but when it is not possible to get at the joints a construction must be used which will make the joints practically indestructible. If a road is so small that it can not afford to put in electric or welded joints, it should use the very best type of mechanical joint, such as a bridge joint of some kind. He thought that other railway engineering associations should take up the question of track construction and give it careful attention.

His company is building some road from Troy to Schenectady, and nowhere is it putting less than a foot of ballast under the ties. On the Albany road it is putting in a foot of crushed stone. The conditions of the traffic warrant it, and the maintenance will be sufficiently less to justify it. On its other interurban proposition it is putting in a foot of gravel, as good as it can get.

Mr. M. A. Starrett, New York, spoke of the use of a proper wheel flange with a grooved rail as a self-cleaning proposition, and stated that this was found successful in New York city operation.

Mr. C. L. Allen described the work which had been done on the Utica & Mohawk Valley Railway, ninety miles out of the 114 of which runs over a private right of way. Many difficulties in the way of drainage had been encountered. On the uphill side of the roadway are constructed two ditches; one near the line of the right of way, just within the right of way, which receives the water that comes from the hillside; and from this outer ditch it is conducted to and through and under the roadbed and under the track structure. About four and one-half feet outside of the end of the ties on the hillside is constructed still another ditch, which gathers what water falls on the right of way and would overflow the outer ditch.

The question of drainage structures beneath the roadbed is one with which has been taken a great deal of pains. Culverts throughout are built of concrete, and are sufficient to take care of all the drainage. The roadbed is made of the excavated material which has been found in the cuts. On top of this roadbed is placed eight inches of gravel or crushed stone ballast. Upon the crushed stone ballast is laid oak or long-leaf yellow pine ties, spaced from eighteen inches to two feet centres, depending upon their proximity to joints. The rail used has been the American standard eighty-pound tee rail, in thirty-foot lengths, and supported by one or the other of two types of iron joints—the Webber and the continuous joint. The greater portion of this road has been in operation something over a year. The cost of maintenance has varied as the quantity of the gravel under the track structure has varied. He believes that if he had the roadbed to build over again, instead of spending the labor and energy in placing the gravel which had been found and which has been accessible to the work trains, it would pay to put broken stone under the track structure. The first cost of crushed stone would be perhaps twenty-five per cent greater, but the cost of maintenance would be considerably less.

The paper was further discussed by Messrs. Mather, Nicholl, Wilcoxen, Wilson, Rockwell Lewis and Pearsall on the compositive merits of different weights and lengths of rail, and on the subject of ties and tile conduit for drainage purposes.

The president then called upon F. J. Pearsall, of New York, to open the discussion of the Railway Young Men's Christian Association work.

He said that the way a man spends his time when off duty has a direct relation to the efficiency of his service when on duty, and a significant thing is a recognition on the part of employers that their full duty is not done when the employé is given his wages.

It was thirty-one years ago that the first Railroad Young Men's Christian Association was organized, and that was in Cleveland. The growth of the organi-

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zation in the last ten years has been by far greater than its growth during the first twenty years. Now after close contact with the kind of work that the Railroad Young Men's Christian Association has done through these years, the managers are giving their hearty cooperation in extending these organizations among their men, more than ever before, because the organization is better understood.

At the present time, after this thirty-one years of effort, it is rather significant that the organization possesses a membership of sixty-two thousand railroad men. It owns in buildings and real estate property amounting to $1,250,000.

Mr. T. J. Nicholl described the formation of the association work in Rochester, and said that between five and six thousand dollars had been spent in fixing up the rooms. The Young Men's Christian Association had been a valuable ally in creating a healthy moral tone and he was heartily in favor of it.

In closing the discussion on this topic, Mr. Pearsall said that he hoped that the support which steam railroad managers had given this movement would be emulated by electric street railway men all over the United States.

Mr. Nicholl moved that the matter be referred to the executive committee to take it into consideration and under investigation through the proper channels and make recommendation as to what should be done at another meeting. Carried.

Mr. J. B. Storer, Syracuse, read a paper entitled "Power Transmission for Interurban Lines."

Mr. Storer compared the losses in the transmission circuit—including the generator and substation apparatus—with the losses in the locomotive on the regular steam road. In considering possible improvements that may be made in the electrical system, as now used on interurban lines, the separate sources of loss must be considered independently to see where and how they may be decreased. The question of frequency for railway circuits is considered, under existing conditions, not so much as what may be the best for the purpose, as by conditions imposed by something which may be quite at variance with what is considered strict railway practice. There would be greater reliability of operation on a system with two complete lines of No. 6 wire, than on one having one line of No. 3 wire, and the cost would be practically the same.

Replying to an enquiry from Mr. Barnes as to the reason for labeling a pole carrying a high-tension conductor, Mr. Storer said that if a transmitting line is operating successfully he saw no reason why the pole should be labeled "Dangerous" with a 20,000-volt circuit any more than with a 2,200. The general conditions, of course, are such that if a high-voltage circuit drops on a cross-arm or on a pole, it must be noticed, because it generally sets fire to the pole or the cross-arm and begins to burn it up. But the amount of leakage that would come from an ordinary pole he did not think would be sufficient to injure any person. It is more with the idea of keeping people away from it and impressing them that it is not safe to throw wires across transmitting lines than it is from any actual danger of the operating line itself.

Mr. Danforth asked Mr. Storer concerning his statement or recommendation of six wires on single-pole lines, for instance, in preference to three heavy wires, in giving more reasonable, proper or continued service. In case of the breaking of an insulator on one circuit, or the breaking down of the insulation in any way, or a wire dropping off from the insulation upon a cross line and the cross line may be burned off, and very frequently the pole is burned to the ground. Would this endanger the other circuit?

Mr. Storer replied that it certainly endangers it, but in general the damage is not carried that far before it is discovered that one circuit is in that condition. The ground detector should enable one to know that there is a grounding of one wire, and that circuit should be thrown out of service at once and the service put on the idle line before the damage could have reached any such serious stage as a person operating a system with one line would be forced into on account of the necessity of keeping the cars moving. With merely one transmission line the cars must be kept moving and the line kept in service, whereas with duplicate lines one could detect it almost instantly and could take advantage of the ground detector and transfer the pressure over to the idle circuit and let the defective circuit remain idle.

Mr. Pardee enquired whether any one had any experience with municipal interference with high-voltage lines near highways.

Mr. Allen stated that his company has a transmission line operating at 22,000 volts, and of about thirty-one miles of that line 1,000 feet is in a street in a village of about twelve hundred inhabitants. A resident on that street made a complaint to the State Board of Health, claiming that they were operating a line at 22,000 volts pressure over and above his sidewalk, and that he thought it was dangerous. That communication was referred to the board of Railroad Commissioners, and the matter is now being held without determination. He knew of one situation on this line now, in a city of 25,000 inhabitants, where a transmission line of 16,000 volts is being held up awaiting the determination of the State Board of Railroad Commissioners in this matter.

Mr. Barnes said the question should receive the serious consideration of the convention. When poles are set through the streets and labeled "Dangerous," the public has a right to believe that they are so; and if they are not dangerous the public should be informed and not be mislead into believing that they are dangerous.

Mr. Brady said this question of high voltage is one that immediately affects the matter of insurance. The Board of Underwriters presented some resolution on the subject at their last meeting, and which was held up for the time being, suggesting the restriction of these high-voltage transmission lines to a certain distance from buildings. That matter is pending at the present time before the National Board of Underwriters. It would not surprise him to see an effort made to have legislation enacted that would be very detrimental to the transmission lines where high voltage is being used, and, inasmuch as the railroad business is developing so fast, that would be very bad.

Mr. Storer, during the discussion, referred to a conversation that he had some time ago with Professor Ryan, of Cornell University, who had been conducting some experiments in connection with the protection of transformers and high voltages, and he ventured the prediction that in a lifetime one would see power transmission circuits operated at not less than 500,000 volts.

He thought that any steps that the legislature or the underwriters may take with reference to transmission lines and regulations as to their position and construction should be taken with a great deal of care, for if it is done unwisely it will certainly restrict transmission line construction and the distribution of power to such an extent as to be very detrimental to all railroad interests.

Mr. Barnes said that he thought what Mr. Brady suggested was so: that the legislature may be called on to take some steps to prevent a danger which perhaps does not exist, and he thought the associa-

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tion can do a great deal in heading off unnecessary legislation in that direction by taking some initiative action in the matter. Without expressing an opinion, there is a great question whether the current transmitted at that voltage in the way it is at present is a danger to the community.

Mr. Barnes suggested that a committee be appointed by the convention that shall undertake an investigation of the conditions as they exist to-day, and report at the next convention.

Mr. E. F. Peck, Schenectady, moved that the association appoint a committee of three to act jointly with the American Institute of Electrical Engineers and the National Board of Underwriters, the committee to be appointed by the chair, and report later. The motion was seconded and carried.

The president appointed as members of the nominating committee Messrs. T. E. Mitten, H. A. Nicholl and J. T. Smith, and the convention adjourned until 9.30 A. M. Wednesday.

WEDNESDAY MORNING SESSION.

The first paper to be read Wednesday morning was entitled "Despatcher's Duties and Electric Signals," by Orlando W. Hart.

Electric railways, in but few instances, have not the advantage of manned stations along the line, with telegraphic communication with the despatcher's office, as is the case with steam roads. They are also at a disadvantage owing to the large number of operating units and the fast schedules maintained on their urban and interurban divisions. Some system of signals should be installed and maintained, enabling the despatcher to set an order signal at any desired point or telephone station at any point along the line, and to receive an answer back recording same, together with the date, hour and minute of the operation, on an instrument in the office provided for the purpose. All movements should be simple and automatic in their action, and positive in their reply, but in no case should the answer back be received until after the signal is at full danger and locked in that position. Only one signal should be operated at a time, but so arranged that in case of the setting of two or more signals, two or more movements of the office instruments should be made and their replies recorded.

The discussion on Mr. Hart's paper was postponed and Mr. Barnes's paper on "Steam Railroad Crossings; or Right-Angle Crossing of Electric Lines," was read by Mr. Clark.

Mr. Barnes opened his paper with the statement that the danger caused by railroad operation at grade crossings of streets or highways is directly proportionate to the number of trains operated on railroads and the amount of pedestrian and vehicular traffic on the street or highway. The board of railroad commissioners, acting under the authority conferred upon it by the laws of the state, caused an examination to be made of every grade crossing of steam and electric railroads in the state. Realizing the liability of accident at these points, and that the most perfect rules, as rigidly enforced as possible, were not sufficient protection, even where gates were maintained, additional protection has been ordered. In all cases where the traffic on the steam and electric roads warranted, the commission has ordered derail switches operated from a tower. The ideal protection at the crossings of steam and electric tracks consists of derail switches in the electric tracks, interlocked with home and distance signals on the steam road, arranged so that after a train has reached the home signal, the derail can not set for an electric car to proceed until after the train has passed the crossing.

Mr. Barnes replied briefly to several questions and the president called for a discussion of the subject, "The Advantages and Disadvantages of Oil Tail-Lights for Interurban Cars."

Mr. Barnes said that a number of accidents have occurred in the state which have been caused by cars breaking down, being derailed, or stopping from other causes, and losing their supply of electric current, leaving them in darkness, and cars following have run into the rear end of them, and the number of those was so great that the board of Railroad Commissioners has suggested to the managers of the roads the plan followed by steam roads, of having an oil light or signal on the rear end of each car, and especially on suburban on interurban cars, and not only on those operating at high speed, because we have had a number of accidents of that character occurring on what might be termed ordinary interurban or suburban roads.

The next topic was "Street Car Controllers, Their Proper and Improper Operation," which was discussed briefly by Messrs. Barnes and Cole.

This was followed by a discussion on "Interurban Service." This topic was divided under three heads—*a*—"Standard Equipment" was opened by Mr. C. L. Allen, of Utica, who said, in part:

"Whether it is possible to adopt a standard car for interurban service is a question. Each system or each road has some peculiar condition that must be dealt with. As to the electric equipment on a standard car for interurban service, I hardly think it is possible to attain that point. There are so many local conditions controlling: grades, frequent stops, and the alignment of the road should determine the question of the size of equipment to be placed under an interurban car. As to the trucks, I think interurban practice has settled down practically to three types of trucks for interurban service: first, the master car builders' truck which has come into general use; second, the large, heavy truck, as built by the Brill Company and sold for heavy elevated service and for heavy interurban service; and practically the same type of truck which is built by the Peckham Company. When we take up the question of trucks the question of wheels comes to us. The question whether a chilled wheel or a steel wheel is the proper thing to use on interurban cars from an economical standpoint is one that should be investigated very carefully. On the question of safety, I think general practice has shown that there is but one wheel to adopt, namely, the steel wheel. The question of whether the steel wheel is economical or not depends very largely upon the dimensions of the flange and tread; the greater the depth of the flange and its width the greater the life will be of that wheel. What I have said of the dimensions of the steel wheel is true also of the chilled wheel. Steel wheels that by reason of local conditions have to be designed with shallow treads and with shallow flanges will not, of necessity, give the service that a wheel that has the large tread and the deep flange will give. I think the consideration of safety alone should control the question of wheels."

Mr. Rockwell asked Mr. Allen whether he considered an inch flange sufficient for a fifty-mile-an-hour car.

Mr. Allen said that he had operated cars having a seven-eighths inch flange and a thickness of three-quarters of an inch at speeds up to fifty miles an hour. His company has adopted on the Utica & Mohawk Valley the standard master car builders' wheel with this exception, in the width of the tread. The flanges are one and one-eighth inches in depth, and one and one-eighth inches in thickness, and the tread is two and three-quarters inches. Its special work has been designed and built for that. It has operated chilled and steel wheels over old girder rail sections which had originally only a depth of one inch from the head, which was difficult and which beyond doubt was expensive as far as the item of power was concerned, because the car was riding practically on the face of the flange. But since that time it has been operating those wheels and not confining them to any one piece of track, but has operated them all over the whole system.

"Car Despatching" was the next subhead under the title of "Interurban Service." Mr. Wilcoxen, of Rochester, responded to this.

Mr. Wilcoxen compared the advantages and disadvantages of the telegraph, as used in the steam road system of despatching; the electric block

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signal system, and the practice of using the telephone. The Rochester & Sodus Bay division of the Rochester Railway system has been in operation for four years, using a telephone system for despatching trains. This is a single-track line extending from Rochester to Sodus Point, a distance of forty miles, thirteen of which is on private right of way, with sidings every mile, a majority of these being used only for freight and meeting points when trains become late. Telephones are in agencies at each village, in substations and on each car, and plugging boxes are provided at every siding. The despatcher is located at Rochester, the western terminus of the division. The train crews receive written orders, issued in triplicate, the motorman, conductor and despatcher retaining copies. The paper describes in detail the system of despatching, and the author states that the method has been found to work very satisfactorily.

The discussion on this paper was taken up in connection with Mr. Hart's paper.

Mr. Barnes said that nine-tenths of the collisions occurring on electric railroads to-day is the direct result of defects in train despatching. It is a branch of the operation which should be improved for the protection of the public and for the financial interests of the companies. A serious question, and one which should receive proper consideration, is whether it is advisable to give trains operating in either direction a superior right on electric roads. In deciding that question the class of employés on electric railroads must be taken into consideration. While that is the plan employed by steam roads, with their experienced engineers and conductors and train crews, it is a question whether to-day accidents would not be lessened by not giving either direction trains superior rights. The standardizing of equipment is a good thing, but the standardizing of train despatching is more important and will prevent more accidents.

Mr. C. L. Allen moved that a committee be appointed by the president to take up the question of train despatching and see if some system of train despatching can not be adopted by the association, and that the committee be appointed by the chair. The motion was seconded by Mr. Cole and carried.

Upon discussion as to the appointing of this committee conflicting with the already existing Rules Committee, Mr. Allen amended his motion and the matter was referred to the Rules Committee.

The next topic was "Standard Methods of Fare Collection and Ticket Taking."

This paper was not discussed and the next subject taken up was "Extra Freight and Baggage Service on Interurban Lines." The first, "Traffic Arrangement with Steam Roads and Boats," was not responded to as it had been difficult to find a road in the state that had any extensive arrangements of that kind. "Traffic Arrangements with Other Interurban Lines" was responded to by Mr. Nicholl, of Rochester.

Mr. T. J. Nicholl, of Rochester, opened the discussion on the topic "Traffic Arrangements with Other Interurban Lines." He said his company had quite a number of contracts with other interurban lines or lines entering the city, and possibly the form of contract is a little peculiar. The company's policy has been to welcome any reliable promoters who were really going to build a road, to welcome them to the city and to the use of its tracks under proper restrictions. One of the restrictions is that it retains the right to change the crews at the point of junction. That is, although it generally allows the new company crews to come into the city, at the same time it retains the right to put its own crews on their cars; and the crews of the entering company have to be under its orders and under its control. The incoming roads, in consideration that they are allowed to do such traffic as they wish on his company's streets, are required to pay the gross earnings on that line per car-mile. They can pick up passengers or drop them off anywhere, or do a city business on the street on which they come in, but if the car earnings on that line are twenty cents it requires them to pay it twenty cents for the use of track and power. They supply their own cars and provide their own men to run the cars and indemnify it from accidents.

The last paper, "Freight Development by Interurban Roads," on the programme was contributed by Mr. E. F. Seixas, of St. Catharines, Ontario. Mr. Seixas was not present, and his paper was received and spread on the minutes.

This paper related the experience of the Niagara, St. Catharines & Toronto Railway in carrying freight. The gross annual freight earnings of the line prior to 1900—at which time it was a steam road—were less than $20,000, and the freight handled was confined to low classes of car-loads, such as coal, this, in fact, being the principal traffic handled. Very little attention was paid to the higher-class traffic, such as package merchandise, and it was not until 1901 that any marked increase was shown. During 1899 and 1900 the system was converted to electricity, the first electric car running July 19, 1900. The revenue for the year ending August 31, 1903, shows an earning of 120 per cent more than in 1900, and an operating expense of fifty-two per cent, as against a previous loss. On the whole, freight business will pay interurban roads if confined to the higher classes of traffic and particular attention is paid to despatch and accommodation to the public.

The president appointed a committee of three to act with the National Underwriters and the Electric Light Association, consisting of Mr. S. R. Storer, of Syracuse, Mr. W. F. Rockwell and Mr. R. E. Danforth.

Mr. Connette, of the Committee on Rules, reported a recommendation that the association adopt the report that was recently adopted by the American Street Railway Association, because it differed but very little from the one which is already in vogue. As to rules governing interurban service, it was suggested that action be deferred until the State Board of Railroad Commissioners can have an opportunity to examine it and pass upon it, and it was recommended, therefore, that the association adopt the report so far as the rules governing conductors and motormen are concerned, and that the recommendations governing interurban service be postponed until the State Board of Railroad Commissioners can have a chance to examine it and pass upon it, and that the committee make its final report on the interurban service rules at the next meeting.

Mr. Allen moved that the report of the Committee on Rules be accepted, and that the committee be continued for another year.

The nominating committee submitted in nomination for officers and members of the executive committee of the association for the coming year, the following:

For president, Mr. G. Tracy Rogers, of Binghamton, N. Y.

For first vice-president, Mr. E. G. Connette, of Syracuse, N. Y.

For second vice-president, Mr. Addison B. Colvin, of Glens Falls, N. Y.

For secretary and treasurer, Mr. W. W. Cole, of Elmira.

For members of the executive committee: Mr. C. Loomis Allen, of Utica; Mr. B. B. Nostrand, Jr., of Peekskill, and Mr. W. H. Pouch, of Newburgh.

Mr. Rogers thanked the nominating committee for again tendering him the honored position as president, but said he was compelled to decline, because of force of business circumstances.

In moving the acceptance of Mr. Rogers's declination, Mr. W. Caryl Ely paid a splendid tribute to the work which Mr. Rogers had done and placing in nomination Mr. E. G. Connette, of Syracuse.

Although Mr. Connette declined the honor, the secretary was ordered to cast one ballot, and Mr. Connette was declared elected.

The secretary was empowered to cast one ballot for A. B. Colvin, of Glens Falls, as first vice-president; for Mr. Heins as second vice-president; for Mr. W. W. Cole as secretary and treasurer, and for Mr. C. Loomis Allen, B. B. Nostrand, Jr., and W. H. Pouch as members of the executive committee.

A formal expression of thanks and gratitude was extended to the local committee of Syracuse which had so generously arranged for the splendid and hospitable entertainment.

A committee was appointed to draft suitable resolutions of recognition of the services rendered by the various officers of the association, particularly Mr. Henry A. Robinson, the retiring secretary-treasurer, after which the officers went into executive session.

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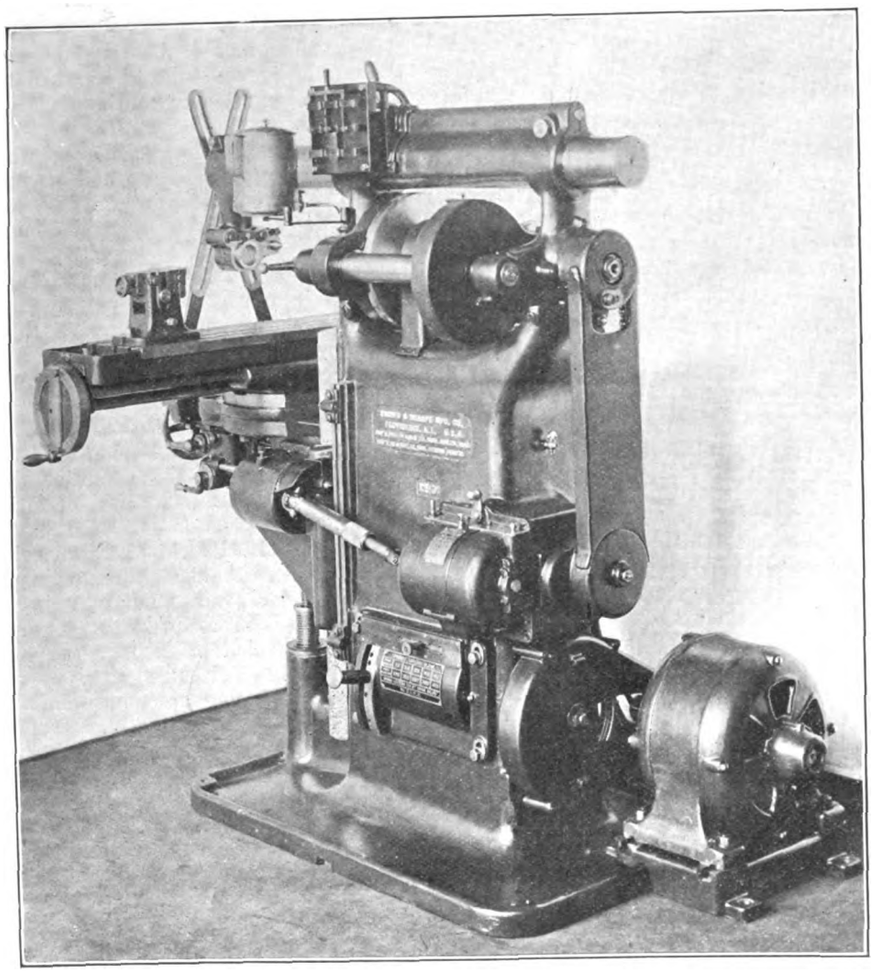
Vol. 43—No. 16

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

A Motor-Driven Milling Machine.

The accompanying illustration shows the No. 3 universal milling machine built by the Brown & Sharpe Manufacturing Company, Providence, R. I. This machine, in addition to being motor driven, possesses several distinctive features which make it of great value in machine shop work. The spindle is of crucible steel. The bearings are ground and lapped, and run in phosphor-bronze boxes which are provided with means of compensation for wear. The cone has four steps and is back-geared. Sixteen changes of speed direct are made, from 13 to 392 revolutions per minute. Eight reverse speeds are made, from 14 to 353 revolutions per minute. The speeds are made in geometrical progression.



MOTOR-DRIVEN MILLING MACHINE.

The overhanging rod is of solid steel, with both bearings clamped with one lever. The arbor support is equipped with a bronze bushing and adjustable centre. The table, including oil pans and channels, is fifty and one-quarter inches by ten inches. The working surface is forty-five and one-half inches by ten inches. There are three key slots five-eighths of an inch in width. The longitudinal feed, automatic in either direction, is twenty-eight inches. The transverse feed, automatic, is eight and one-half inches. The vertical feed is nineteen inches. A quick return is operated by internal gear. The power feed can be used with table set to fifty degrees either side of zero.

Two supporting gears are driven by chain. There are twelve feed changes, varying in geometrical progression from 0.005 to 0.153 inch to one revolution of spindle. The feed tripping mechanism is of the double plunger type and can be set to prevent throwing in of the wrong clutch. The index has a swing of twelve inches in diameter and takes twenty-six inches in length. The vise swivels and has a graduated base. The jaws are hardened and are six and one-eighth inches wide, one and nine-sixteenths inches deep, and open three and five-eighths inches.

The countershaft is supplied with three friction pulleys—two twelve inches in diameter and one fourteen inches in diameter, using three and one-half inch and four-inch beams.

The net weight of the machine is 3,930 pounds.

The machine shown in the accompanying illustration was fitted up for the Mare Island Navy Yard, and is driven by an alternating-current motor connected with a variable speed changing mechanism by a Hans Renold chain, the speed mechanism being connected in the same manner to the machine spindle. The motor runs at constant speed, the feed changes being obtained by the simple manipulation of the sliding knob and lever shown at the lower part of the base.

There are sixteen spindle speeds, which are secured as follows: The locking pin of the lever shown at the left is first pulled out and the lever thrown down as far as it will go. The sliding knob is then unlatched and moved until it is over the column in the table in which the required spindle speed is given. The lever is then unlatched and moved up until the proper gears mesh, when the locking pin will drop into the correct hole.

The feed mechanism is driven from the spindle of the machine by chain and sprocket wheels, varying in geometrical progression as described above.

Seattle Water-Wheel Installation.

The city of Seattle municipal lighting and power plant has awarded the Pelton Water-Wheel Company, San Francisco, Cal., the contract for supplying water-wheels for its power-house. The main wheel units will be two in number, each direct-connected to a 1,200-kilowatt, 2,300-volt, sixty-cycle, three-phase, alternating-current, revolving-field generator. The wheel unit will operate under an effective head of about 550 feet and will have a capacity sufficient to develop fifty per cent overload in each generator. Two seventy-five-kilowatt, 125-volt, compound-wound, multipolar, direct-current generators will furnish exciting current. Each of these machines will be direct-connected to a Pelton wheel running at 550 revolution per minute. The transmission line into Seattle will be approximately forty miles long, and current will be stepped down to two-phase at 2,200 volts for city distribution for lighting, through constant current transformers.

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A New Signal System for Electric Railways.

The accompanying illustrations show the details of a new two-line wire block system which is being placed on the market by the Uni Signal Company, 42 Osborne street, Cambridge, Mass. The standard equipment consists, for a complete block, of the following apparatus—two signal movements, two iron signal boxes, two double-acting trolley switches and two terminal boxes, each containing three

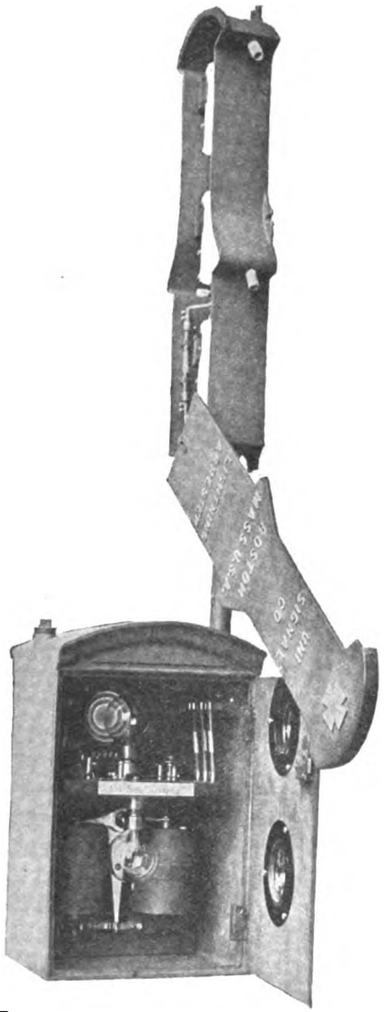

FIG. 1.—SIGNAL BOX WITH COVER OPEN.

Garton-Daniels 500-volt, direct-current, railway lightning arresters.

This system is stated by the manufacturer to be applicable to all electric railway systems, and is especially adapted for single-track trolley electric railways where it is desirable to protect any section of track from both a head or rear-end collision.

In installing the signaling apparatus a trolley switch is clamped to the trolley wire and supported by a span wire from the nearest pole, or by a bracket arm. This switch is placed at a point as near the bifurcation of the single section of track as practicable. On the next pole in advance to that supporting the trolley switch the signal box is placed. Directly above the signal box is installed the terminal box containing the lightning arresters. Connection between the signal box and the terminal box is made by a lined iron conduit pipe, one inch in diameter, of sufficient length to allow the terminal box to be among the cross-arms and the signal box at a clearing distance from passing cars, or as other conditions may determine.

The signal box is attached to the pole so as to show both the green and red signal lamps of the trolley switch or the entering end of the block. From the trolley switch are run two switch wires to the adjacent terminal box containing the lightning arresters, and which, in turn, connects with the signal box by heavy insulated rubber-covered wires. The two signal boxes are connected together through their respective terminal boxes by two signal line wires. Each signal box likewise has a permanent feed-wire connection with the trolley wire and one with the track. Thus six wires enter the terminal box. These wires are known, respectively, as lighting switch wire, extinguishing switch wire, lighting line wire, extinguishing line wire, permanent feed wire and ground wire. The same arrangement is installed at the leaving end of the block, which is the entering end if the block is entered from that direction.

In operation this system shows whether the section of track to the next turn-out is free or occupied by another car; also, if occupied, the direction in which the car has entered the block. A car, on entering a block station—usually a single track—has its trolley wheel run under an automatic trolley switch which lights a green lamp in the signal box directly in advance of the car, and also lights a red lamp wire in series with it in the signal box at the distant or leaving end of the block. On the car passing under the switch at the leaving end of a block, both lamps are extinguished. Where neither lamp is lighted the section contains no car. A car entering from the other end will, under normal conditions, do the same—that is, the signal is double-acting.

Fig. 1 shows the signal box with the cover open and also the manner of connection to the terminal box containing the lightning arresters. This is the apparatus required at each end of the block.

Fig. 2 shows the terminal box with the cover removed, exhibiting three Garton-Daniels 500-volt lightning arresters which are furnished with each terminal box. The heavy fuse wire in the leg to ground is seen at the lower left-hand side. The porcelain tubes where the wires enter the terminal box are also clearly shown, as

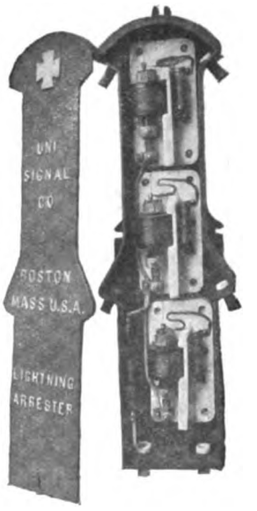

FIG. 2.—TERMINAL BOX WITH COVER REMOVED.

well as the lugs for attaching the box to the pole.

Fig. 1 shows the signal box with the door open and the movement in place. By turning a lock button in the back of the box and removing the enclosed fuses at the side of the movement, the entire signal movement can be removed from the box by a handle cast integral with the back plate. The green and red semaphore lenses can be seen in the hinged door of the terminal box.

The movement is shown in Fig. 3, showing the three magnets, the switch, the aluminum lever and balance arm, and the two signal lamps. Two circuit-breaking contacts not in the illustration are located on the top slate. The third cir-

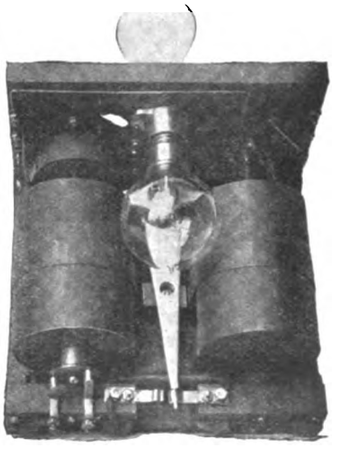

FIG. 3.—SHOWING THE THREE MAGNETS, SWITCH, LEVER BALANCE ARM, AND TWO SIGNAL LAMPS.

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cuit-breaker contact is shown at the bottom of the left-hand magnet.

Fig. 4 shows the iron back plate with top and bottom slate. At the left-hand are shown the two fibre tubes enclosing the connection between the top and bottom slates. Resting at the left of the back plate is the ribbed iron resistance plate, and in front of the back plate is the aluminum lever and balance arm Standing at the right is the lighting magnet with its armature. Lying on its side at the left of the back slate is the extinguishing magnet with its two armatures.

The main body of the trolley switch is of malleable iron. The supporting frame is cast in one piece and holds all the operating parts of the switch. When the hood is placed in position contact is made between two flat springs and two brass plates at the top of the hood. The electrical features embodied in the apparatus

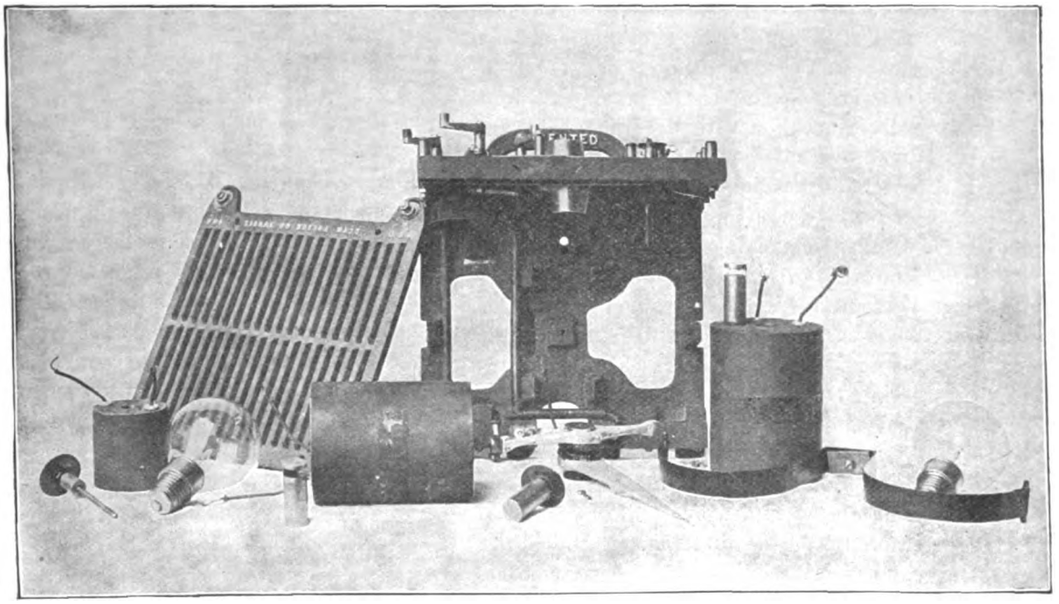

FIG. 4.—SHOWS IRON BACK PLATE WITH TOP AND BOTTOM SLATE.

are simple in design. The magnets are of the iron solenoid type and were adopted because their armatures could be internal and magnetic leakage thus obviated. The magnet coil is wound on a brass spool insulated by oiled silk, and is removed from the magnet by unscrewing the magnet end. The terminals are brought out through lava bushings. The magnets are tested against a 2,000-volt breakdown test.

In series with the red lamp is the locking magnet, which is energized as soon as any current passes through the red lamp. This holds the armature core against the locking magnet and at the same time a tail rod connected with the armature presses against the balance arm of the movement and prevents the lighting magnet from operating. The function performed is to prevent the extinguishing of the red lamp signal should a car attempt to enter a block with a red lamp set against it.

Triplex Blocks for Hoisting Service.

The accompanying illustrations show several typical Triplex hoisting blocks made by the Yale & Towne Manufacturing Company, 9 to 13 Murray street, New York city. Fig. 1 shows a Triplex block in an erecting shop. One man can pick up a heavy load in half a minute by means of this block and move it to the other end of the shop in a minute more. Fig. 2 shows a Triplex block serving the benches in a shop by means of overhead trolleys, Fig. 3 showing a Triplex block serving a heavy turret lathe by means of overhead trolleys.

The saving of time and labor effected by the Triplex block is accomplished by separating the suspending mechanism from the hoisting gear, so that the operator is not wasting the larger part of his effort in overcoming friction. The hoisting mechanism consists of a direct train of spur gears from the small pinion on the central shaft to the internal gear wheel cast within the main frame. The two intermediate gears between the pinion and the internal gear are carried on the circular frame or cage, and roll around within the internal gear, thus forming a sun-and-planet movement, giving the desired leverage.

The great advantages of the double arrangement of intermediate gears are balanced journal pressures, increased wearing surface, subdivision of strains, and an accurate equalizing of the load, resulting in diminishing friction and wear.

The frame carrying these intermediate gears is keyed fast to the hub of the hoist chain sheave, and the central pinion shaft is driven by the hand chain wheel, so that the power is transmitted from the hand chain to the load chain through a direct spur gear train of high efficiency. The sustaining mechanism at the hand chain end

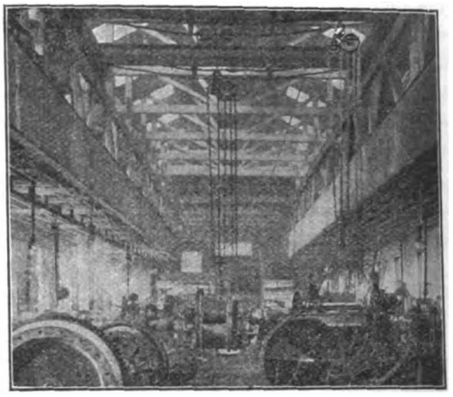

FIG. 1.—TRIPLEX BLOCK IN AN ERECTING SHOP.

of the block (the left of Fig. 5), consists of a set of discs, one of which has external ratchet teeth engaging with a drop-forged pawl. The hand chain wheel is screwed upon the central spindle as shown, and clamps the discs tightly to the shaft in hoisting, or if the shaft tends to revolve under the pull of the load. The parts thus clamped together act as one, and the ratchets offer no resistance in hoisting. When the direction of the hand chain wheel is reversed in lowering, it unscrews, the ratchet disc being held by the pawl, and the load is lowered against the friction of the discs under control of the hand chain, the stoppage of which causes the discs to tighten and sustain the load perfectly.

Many important improvements have recently been incorporated in the Triplex blocks which permit of

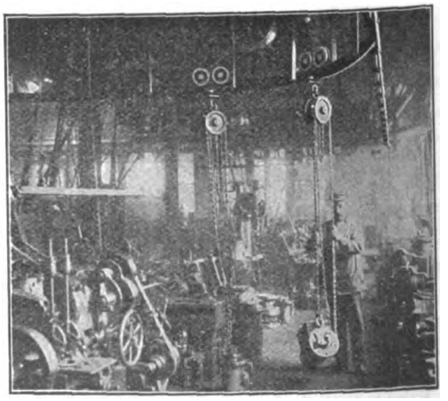

FIG. 2.—TRIPLEX BLOCK SERVING THE BENCHES IN A SHOP.

very easy and rapid lowering, with a spinning motion of the hand wheel. The friction discs never re-

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quire adjustment and are positive in their action. The load automatically tightens the discs and takes up wear; it can not run down of itself, as the only result of such a tendency is

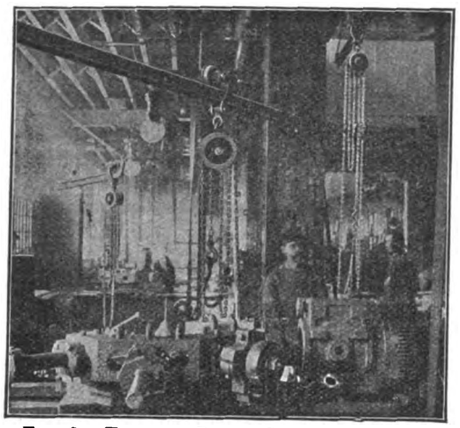

FIG. 3.—TRIPLEX BLOCK SERVING A HEAVY LATHE.

to further tighten the discs. To unlock the disc and start lowering easily, give the hand chain wheel a half turn in the direction for hoisting and then reverse quickly.

The trade name Triplex was selected because the block is triple-geared, having the equivalent of three parallel shafts connected by power multiplying gears, and giving nearly threefold the efficiency of its predecessors.

The United States Army has adopted the Triplex block for serving heavy ammunition in the coast defense magazines because of its safety and speed.

FIG. 4.—TRIPLEX HOISTING BLOCK.

In the twelve, sixteen and twenty-ton sizes an important advantage is their two independent hand chains, which may be worked both together or one at a time.

The full load may be raised by two men pulling on one hand chain, or at double speed by four men.

In like manner lowering may be effected at varying speeds by using either or both of the chains.

Light loads may be handled easily at higher speeds than with smaller blocks, because two men can work more freely at the separate hand chains, which are clear of the load and in the most convenient position for effective use.

These blocks are very compact and occupy little headroom. For use on hand cranes this is the most rapid and efficient and least expensive hoisting mechan-

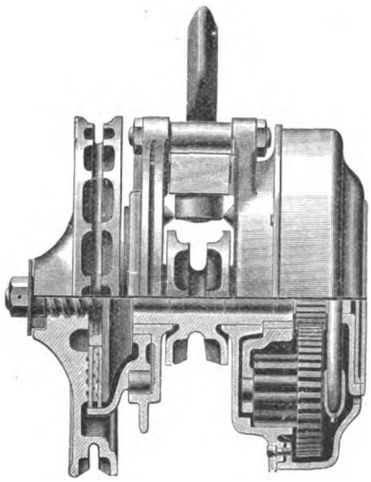

FIG. 5.—SUSTAINING MECHANISM OF TRIPLEX BLOCK.

ism yet devised; the speed in hoisting is from four to six times that of the ordinary worm-wheel construction.

Recent Illustrated Trade Literature.

The publishing department of the General Electric Company has recently issued to the trade a series of fliers and bulletins of more than ordinary interest.

Three fliers—Nos. 2114, 2116 and 2117—describe and illustrate, respectively, concentric light diffusers, meter jewels, and combined switch and enclosed fuse cutout for car lighting. A splendidly printed booklet, entitled "Core-Type Transformers," is a short treatise on the development of the core-type transformers of the General Electric Company. Another booklet in a handsome green cover, entitled "The Permanency of Transformer Insulation," gives a number of views of type H transformers and a study of the process of making transformer insulation. Supply catalogue No. 7583 details parts of U. S. trolleys, giving the dimensions and characteristics of every part of the union standard trolley. In addition to those already mentioned, bulletins for August and September Nos. 4334, 4335, 4336, 4337 and 4338 have been issued. Bulletin No. 4334 is an illustrated description of direct-driven continuous-current generators for lighting and power. Bulletin No. 4335 is an illustrated description of engine-driven revolving-field alternators. Bulletin No. 4336 is an illustrated description of isolated plant switchboards for continuous-current two-wire service. Bulletin No. 4337 describes and illustrates blower sets for air-blast transformers, and Bulletin No. 4338, power-factor indicators for balanced systems.

THE OHIO ELECTRIC LIGHT ASSOCIATION.

NINTH ANNUAL CONVENTION AT THE HOTEL CHITTENDEN, COLUMBUS, OHIO, OCTOBER 13, 14 AND 15.

The following programme was announced for the ninth annual convention of the Ohio Electric Light Association, held at the Hotel Chittenden, Columbus, Ohio, October 13, 14 and 15.

TUESDAY, OCTOBER 13, 10 A. M.

Roll call. Presentation of candidates. Reading of minutes of last meeting. President's address. Announcements. Executive session.

TUESDAY, OCTOBER 13, 2 P. M.

"Equipment and Boilers," Mr. W. D. Chester, Babcock & Wilcox Company, Pittsburg, Pa., followed by general discussion opened by Mr. D. S. Kohler, of the Columbus Edison Company, Columbus, Ohio.

Tuesday afternoon there was an entertainment for the visiting attendants.

WEDNESDAY, OCTOBER 14, 9.30 A. M.

"Engine Economy and Equipment," Mr. E. J. Bechtel, Toledo Railways Company, Toledo, Ohio. "Development in the Engine Room," Mr. J. H. Perkins, Consolidated Gas and Electric Company, Youngstown, Ohio. A paper was also contributed by Mr. W. F. Raber, Mansfield Electric Light and Power Company, Mansfield, Ohio. Mr. George Hayler, Van Wirt Gas, Electric Light and Power Company, Van Wirt, Ohio, contributed a paper on "Steam Records," and Mr. A. C. Blinn, Sandusky Gas and Electric Light Company, Sandusky, Ohio, contributed a paper on "The Value of Station Records." This was followed by a general discussion on engine room and station records.

WEDNESDAY, OCTOBER 14, 2 P. M.

A paper on "Distribution," by Mr. K. C. Randall, of the Westinghouse Electric and Manufacturing Company, Pittsburg, Pa. "Notes on Certain Three-Wire Systems," Charles Mosman, General Electric Company, Schenectady, N. Y. This was followed by an address on "The Municipal Code," by D. L. Gaskill, Greenville, Ohio.

In the evening a trip was made to the Ohio State University, by invitation of the faculty.

THURSDAY, OCTOBER 15, 10 A. M.

Paper on "The Combined Use of Direct and Alternating Currents for Central Stations," by Professor F. C. Caldwell, Ohio State University, Columbus, Ohio. "Methods and Means of Securing New Business," W. J. Hanley, General Electric Company, Cincinnati, Ohio.

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Vol. 43—No. 16

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

CANADIAN WESTINGHOUSE COMPANY INCORPORATED—At a meeting held October 9, in Hamilton, Ontario, and presided over by Mr. George Westinghouse, the Canadian Westinghouse Company, Limited, was organized with a capital of $2,500,000. The new company is a consolidation of all the Westinghouse interests in Canada, which have heretofore been conducted individually.

LONDON-BRUSSELS TELEPHONE SYSTEM EXTENDED—The existing telephone system between London and Brussels is to be extended to Antwerp, Bruges, Charleroi, Ghent, Liege, Louvain, Malines, Mons, Namur, Ostend, Termonde and Verviers. Communication will also be opened between Birmingham, Brighton, Bristol, Cambridge, Cardiff, Derby, Ipswich, Norwich, Nottingham, Sheffield, Southampton, Leicester, Lowestoft, Newport and Yarmouth.

ELECTRICITY FOR AUSTRALIAN RAILWAYS—Plans are being considered for adopting electric traction on some of the railways in the state of Victoria, in the Australian Commonwealth, particularly on the suburban railway system of Melbourne. The possibilities of the proposed change from steam to electric traction have been the subject of discussion with the railway commissioners of the state for some time past. The matter has also come under the notice of the Victorian parliamentary standing committee on railways, and a subcommittee of that body has been appointed to make enquiries on the whole subject. The committee is now busily prosecuting its enquiries in Sydney, where a large scheme of conversion from steam to electric traction on the state tramways is nearing conclusion.

THE NEW YORK SUBWAY—Chief Engineer William Barclay Parsons, in a recent report upon the progress of the subway work to the rapid transit commissioners, shows that the work of excavation, including work at Fort George and the Harlem tunnel, is ninety-seven per cent completed and practically all of the three per cent incompleted work is at the two points just mentioned. Of the construction, seventy-five per cent is completed and installed. Fully three-quarters of the remaining twenty-five per cent is well in hand. The strike on the power-house has delayed work more than anything else. Tracks have been laid from Grand street to Twenty-third street, and ballasted from Twenty-third street to Thirty-third street. From Forty-seventh street to Sixty-fifth street the tracks are ready for cars.

GEORGIA POWER PLANT—The Winding Shoals Electric Power Company, recently incorporated at Buford, Ga., will install a 6,000-horse-power hydroelectric plant on the Chattahoochee river, four miles west of Buford. The plans contemplate the construction of a crib dam, for which an abundance of material can be secured in close proximity to the plant, as the location selected for the dam and power-house lies between high bluffs which are composed almost entirely of solid granite. The power-house will be of stone and concrete construction. The first equipment of wheels and generators will be for about 3,000 horse-power, ultimately increasing it to 6,000. Part of the power will be utilized by local factories in Buford, which is the largest leather manufacturing district in the South, and for the Atlanta, Buford and Gainesville Railway, for which surveys are now being made. The balance of the power will be transmitted to Atlanta and surrounding towns, the bulk of it being likely to be taken to Atlanta. The Electrical Equipment Company, Chicago, Ill., is preparing plans and specifications for the work.

NEW BRIDGE TRAFFIC PLAN TESTED—A fifty-four-minute test was made last week on the Brooklyn Bridge of what is known as the Poulson plan to relieve congestion of the trolley car patrons at the Manhattan terminal. Mr. Niels Poulson, who is president of the Hecla Iron Works, of Brooklyn, N. Y., and the inventor of the plan, was practically in charge of the test. The scheme of relief was to utilize all available space at the bridge entrance; to have a single-loop track at the extreme western end of the surface car terminal; to unload them in groups of five on the north track and to load them in groups of five on the south track, and to have no passengers board or leave the cars on the loop. At the beginning of the test, cars were started on the afternoon schedule, or 160 to the hour, for half an hour. The employés worked in good faith, getting eighty-five cars through, or at the rate of 170 to the hour, without a hitch. Then extra cars were switched on, making up a rush hour condition. In twenty-four minutes 100 cars were put through, or at the rate of 117 in half an hour. This resulted in completely blocking the north track of the bridge, when the trial was called off and the usual afternoon schedule resumed. Although Mr. Poulson claimed that the plan would ultimately be a success, the bridge officials are inclined to believe that no further trial will be made of the scheme.

REPORT OF INTERURBAN STREET RAILWAY COMPANY—The first report of the Interurban company (New York), which includes the operations of the Metropolitan Street Railway, the Third avenue and the suburban lines in the Union system, including about 480 miles of electric and horse lines in the boroughs of Manhattan and the Bronx and in Westchester County, shows gross earnings of $21,549,545, an increase of $618,377 over last year and the largest in the history of the combined concerns. The entire revenues of the Metropolitan system were $16,178,563 and the surplus $3,509,339, which is $130,452 less than the amount required for the seven per cent dividend on Metropolitan. This was paid by the Interurban. The Third avenue and the suburban lines earned $5,370,882 and showed a deficit of $141,684. The statement was looked upon as satisfying in view of the deficits alleged in the recent Amory suits. It has been realized for some time that the dividend guaranteed to the Metropolitan was not being earned and that the balance would have to be made up by the guaranteeing corporation. President Vreeland has stated that adverse conditions, such as the torn up condition of the city's streets and the installation of an underground system on some of the crosstown lines made inroads into profits and that operating expenses were increased through the same conditions and the higher cost of labor, fuel and material. The plans for 1904 include the extension of the lines of the Union system in the borough of the Bronx and the adjacent territory and to install in the borough of Manhattan the underground electric system upon most of the lines now operated by horses.

PERSONAL MENTION.

MR. J. C. CADMAN has been elected president of the British Institution of Mining Engineers.

MR. N. ADELBERT BROWN has been appointed professor of civil engineering in the University of Washington, Seattle, Wash.

MR. BENJAMIN CHEW HOWARD, the well-known electrical contractor of Baltimore, Md., passed through New York city last week after a lengthy sojourn in the Adirondacks.

PROFESSOR ROBERT H. THURSTON, of Cornell University, has resigned as a member of the City Water Commission of Ithaca, N. Y.

DR. F. R. TUFTS, tutor in physics at Columbia University, has been given a year's leave of absence to spend in research in Germany.

DR. NORMAN E. GILBERT, A. B. (Wesleyan), Ph. D. (Johns Hopkins), of Hobart College, has been appointed assistant professor of physics at Dartmouth College.

MR. C. L. EDGAR, president of the Boston Electric Light Company, Boston, Mass., was a New York visitor last week, and spent a day with his friend, Mr. Edison, at his laboratory at Orange, N. J.

MR. HARRY S. KRUMM, who has been superintendent of the People's Telephone Company, at Paducah, Ky., since its organiza-

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tion, has gone to Fort Washington, Pa., to assume the position of toll line wire chief for the Consolidated Telephone Company.

MR. A. W. HENSHAW, formerly with the General Electric Company, Schenectady, N. Y., has been appointed to take charge of the motor department of the Stanley Electric Manufacturing Company, Pittsfield, Mass.

MR. DAVID HALL has tendered his resignation as chief engineer of the Milwaukee Electric Manufacturing Company to accept a position on the engineering staff of the Bullock Electric Manufacturing Company.

MR. C. W. BARTLETT, the Nebraska representative of the Stromberg-Carlson Telephone Company, Rochester, N. Y., is located at 1635 South Twenty-second street, Lincoln, Neb. His previous address was Kansas City, Mo.

MR. W. G. McKENNAN, for a number of years connected with the Shelby Electric Company, will have charge of the sales department at the New York office, 225 Fourth avenue, in the place of Mr. J. C. Wormley, who has resigned his connection with the Shelby company.

MR. R. F. MAHLER, formerly Chicago manager of the De Laval Steam Turbine Company and the Curtiss-Crippen Engineering Company, has been appointed manager of the St. Louis office of the Bullock Electric Manufacturing Company, with offices at 1501 Chemical Building.

MR. MARTIN D. ATKINS has tendered his resignation as head of the department of physics and electrical engineering at the Michigan Agricultural College, Lansing, Mich., where he has been for the past four years, to accept a similar position at Lake Forest University, Lake Forest, Ill.

MR. MALCOLM C. RORTY, traffic engineer in the main office of the American Telephone Company, Boston, Mass., has recently been elected vice-president of the Telephone Society of New England, an organization for the study of telephone improvement and the advancement of the interests of telephone business.

MR. SIDNEY W. ASCHE, of the Brooklyn Polytechnic Institute, Brooklyn, N. Y., on Monday, October 5, delivered the first of a series of lectures in engineering which he will deliver the coming year at the Railroad Men's Building, Brooklyn, N. Y. There were 185 men present, and thirty-five enrolled for a course of forty-eight lectures.

MR. REYNOLD JANNEY, for the past two years superintendent of the locomobile works at Bridgeport, Ct., has accepted the managership of the Edison Storage Battery Works, Glen Ridge and Silver Lake, N. J. On resigning his position at Bridgeport, he was presented with an elegant solid silver tea service and a beautiful water-color painting by the employés of the company.

MR. CHARLES CUTTRISS, chief electrician of the Commercial Cable Company, returned last week from the Philippine Islands, where he has been superintending the connecting up of the new Pacific cable belonging to his company. Mr. Cuttriss was quite ill while in Manila, but is now much improved in health. He reports the cable working nicely and its service in much demand.

MR. WM. C. L. EGLIN, of Philadelphia, is chairman of the committee for the investigation of the steam turbine which has been appointed by President Edgar, of the National Electric Light Association. The other members are Mr. Frederick Sargent, of Chicago, and Mr. A. C. Dunham, of Hartford. A plan for the work will be outlined immediately and the investigation will be conducted in a careful and thorough manner.

MR. JOHN A. DREW, of the Worthington Company, read an interesting paper, entitled "A History of Pumps, Ancient and Modern," at the first meeting of the season of the Brooklyn Engineers' Club, on the evening of October 8. Mr. Drew sketched the development of pumping machines from the early Egyptian "Noria," resembling the familiar well sweep, to the latest triple-expansion condensing waterworks engines. The paper was illustrated by a large number of lantern slides.

ELECTRICAL SECURITIES.

During the past week, the sensational allegations made in the ship trust suit might have been expected to contribute largely to a general mistrust of the speculative public in financiers in general. The cutting of the dividend on the common stock of the United States Steel Corporation and the statement of the shrinkage in earnings also might have been expected to have its debilitating effect. Then along comes the report of the Interurban Street Railway Company, the operating company which guarantees seven per cent dividend on the Metropolitan Traction and the Third Avenue system of New York city. While the combined earnings of the several properties included in the Interurban company were largely in excess of any previous year in the history of any of the companies, it was not enough to pay the dividend guaranteed by the Interurban company, and, in the case of both the Metropolitan Street Railway and the Third Avenue line, a deficit had to be made up. This, however, is thought to be due entirely to the deplorable condition of the streets of New York for the past year owing to the subway and other engineering operations.

While all these disturbing effects have had more or less to do in influencing speculative conditions, the fact must not be lost sight of that the cereal crop for this year in all probability will eclipse anything which has been known before, and it must also be remembered that the railroads have passed through a record-breaking year and this condition is likely to be continued for some time. On the whole, it is not hard to accept the hope that even though there is evident a slight industrial reaction, it can not in the light of present indications reach any disastrous dimensions.

New York:	*Closing.*
Brooklyn Rapid Transit	32¼
Consolidated Gas	170
General Electric	144
Kings County Electric	150
Manhattan Elevated	130¼
Metropolitan Street Railway	103
New York & New Jersey Telephone	145
Westinghouse Manufacturing Company	172

It is stated that the current fiscal year of the General Electric Company, which ends on January 31 next, will be the best in the history of the company. It is estimated that the decline in the price of iron will add from ten to fifteen per cent to the profits on all machinery turned out by the company. The profits of the company, including the plants recently absorbed, are said to be running at about $1,000,000 a month. The net profits for the year, it is estimated, will probably be equal to the regular dividend three times over.

The earnings of the Brooklyn Rapid Transit Company for the first twenty-nine days of September are as follows: Gross, $1,208,367, against $1,042,944 last year, an average increase of $6,000 a day. From July 1, the gross earnings are $3,837,074, against $3,003,434 in 1902.

Boston:	*Closing.*
American Telephone and Telegraph	122
Edison Electric Illuminating	235
Massachusetts Electric	77½
New England Telephone	122½
Western Telephone and Telegraph preferred	80

The directors of the Edison Electric Illuminating Company have declared the regular quarterly dividend of 2½ per cent, payable November 2 to stockholders of record October 15.

Philadelphia:	*Closing.*
Electric Company of America	7½
Electric Storage Battery common	52
Electric Storage Battery preferred	52
Philadelphia Electric	6
Union Traction	42½
United Gas Improvement	78

The increase in the net earnings of the Electric Company of America for the eight months ending August 31, over the corresponding period of last year, is officially given as 19.6 per cent.

Chicago:	*Closing.*
Chicago Telephone	115
Chicago Edison Light	142
Metropolitan Elevated preferred	53
National Carbon common	17
National Carbon preferred	88
Union Traction common	4
Union Traction preferred	32

The Chicago Telephone Company has issued $1,000,000 of new stock to stockholders, completing the $2,000,000 of new stock put out this summer under the offer of the board of directors last spring. The company's outstanding stock is now about $14,000,000. The authorized capital is $15,000,000.

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ELECTRIC LIGHTING.

DES MOINES, IOWA—At West Liberty extensive improvements are projected to the electric light plant.

HICKORY, N. C.—The Thornton Light and Power Company has secured a contract for lighting the city streets.

RAYNE, LA.—The electric light and waterworks plant has been officially tested. It operated satisfactorily.

ALLENSVILLE, KY.—Arrangements have been completed with the electric light company at Guthries to furnish lights to Allensville.

SPOKANE, WASH.—Alexander M. Winston and J. C. Odell have applied for a franchise for an electric light system for the town of Newport, Wash.

HILLBURN, N. Y.—The Rockland Electric Company has secured the contract for furnishing light for several stations on the Erie in this vicinity.

BURLINGTON, VT.—At a meeting of the board of aldermen it was voted to issue bonds to the amount of $50,000 for the construction of an electric lighting plant.

WYTHEVILLE, VA.—The town's electric lights were turned on recently with appropriate exercises at the power-house of the Stone Electric Light and Power Company.

WOODLAND, CAL.—It is stated that an effort will be made to utilize the waters of Cache creek for electric power, to operate street railroads in Yolo and adjoining counties.

MANKATO, MINN.—A new ten-year contract with the Mankato Gas and Electric Light Company for the lighting of the city streets with electricity has been granted by the city council.

PORTSMOUTH, OHIO—The Sciotoville brick plants are installing an up-to-date electric lighting plant. It will have a capacity for at least 1,000 sixteen-candle-power incandescents.

NORTH YAKIMA, WASH.—At a meeting of the city council the ordinance granting a thirty-seven-year franchise to the Yakima Water, Light and Power Company was passed.

CRESSON, PA.—The new electric light plant at Cresson has been put in operation and is giving good satisfaction. Prior to this the current was obtained from the power-house at Gallitzin.

NEOSHO, MO.—R. B. Rudy has purchased the Neosho electric light plant from J. E. McDaniel and Paul Kabus, and states that he will make material improvements in order to improve the service.

DANBURY, CT.—The Danbury & Bethel Gas and Electric Light Company is installing some new electric machinery, which, when it is in operation, will make its plant completely modern in its equipment.

TROY, PA.—The plant of the Troy Electric Light and Power Company has been sold to David J. Fanning. It is said that the company will be reorganized and will give very much improved service in the near future.

HOUGHTON, MICH.—The system of street lighting in Hancock has been changed from the old-style open arc lamps to the new type of incandescent enclosed arc lamps and the system thereby is considerably improved.

TERRE HAUTE, IND.—Plans have been completed for the new power-house of the Terre Haute Electric Company, which will cost $200,000. Work will probably be started in the spring and it is hoped to have the plant in operation before next winter.

CONSTANTINE, MICH.—The new power-house for lighting Constantine and Three Rivers has been placed in operation. The power of the St. Joseph river is used to run the plant, the old dam having been raised thirty inches, thereby greatly increasing the power. Over $200,000 has been expended upon the plant.

McRAE, GA.—The matter of building and operating an electric light service and a car line between McRae and Helena is being considered. Civil engineers will begin the survey shortly, and the indications are that both of these enterprises will be established by the close of the year. The car line will doubtless run out to Suomi Springs.

ATLANTIC CITY, N. J.—The Atlantic City Electric Light and Power Company has secured a ten-year contract for lighting the city streets, by which an ostensible saving of $12,340 per annum will be effected. The city's 400 arc lights, under the contract expiring on March 8 next, cost $105.85 annually. The price under the new contract is $75 per light.

TRENTON, N. J.—Electric light improvement bonds were sold by the South River borough council recently to the amount of $6,500. The contract for the construction work for the new electric plant was awarded to the Sayre & Fisher Company, of Sayreville. This company will also furnish power for the lights by a connection with its plant at Sayreville.

INDIANAPOLIS, IND.—The Hammond Illuminating Company has notified the secretary of state of an increase in capital stock from $350,000 to $2,000,000, making it one of the largest corporations of the kind in Indiana. It purposes to greatly enlarge its plant and to furnish light and power for the four Lake County cities—Hammond, Whiting, East Chicago and Indiana Harbor.

BOSTON, MASS.—The harbor and land commissioners have granted to the Holyoke, Mass., Water Power Company permission to erect a power-house for the generating of electric energy from surplus water just below the dam in the angle formed by the abutment and the canal wall. It is now so late that the company will not be able to begin any construction work this fall, but plans will be drawn during the next few months so that all will be ready to begin in the spring. It is likely that the generating capacity of the plant will in the beginning not exceed 4,000 or 5,000 horse-power. Room will probably be left in the new structure for additional generative capacity.

NEW INCORPORATIONS.

RICHMOND, VA.—Henry County Telephone Company. $5,000.

MADISON, WIS.—Great Northern Power Company. $100,000.

CONCORD, N. H.—The Milford Electric Light Company. $50,000.

OWENSBORO, KY.—The Rural Home Telephone Company. $25,000.

INDIANAPOLIS, IND.—The Libertyville Telephone Association. $500.

ELKHART, IND.—Elkhart Power Company. $500,000. Directors: Winfield T. Durbin, Walter Brown and V. W. Vanfleet.

VIRGINIA, ILL.—Home Telephone Company. $10,000. Incorporators: Henry Goebel, C. E. Rexroat and C. D. Bayliss.

MT. CARMEL, IND.—Union Telephone Company. $10,000. Directors: J. R. Collins, W. B. Hood, Albert Kruger and others.

CHILLICOTHE, MO.—Livingston County Telephone Company. $2,000. Incorporators: J. Miller, M. Miller, A. M. Shelton and others.

MADISON, WIS.—Stoughton Independent Telephone Company. $45,000. Incorporators: Robert Freeman, Clarence S. Pierce and Will G. Whitehead.

ALBANY, N. Y.—Wayne-Monroe Telephone Company. $30,000. Directors: J. A. Driscoll, Rochester; L. T. Yeomans, Walworth; J. Selden Brandt, Ontario.

NEWPORT, NEB.—Newport, Hammond & Southern Telephone Company. $3,000. Directors: C. M. Thompson, L. F. Brown, M. E. Smith and Robert Good.

MOUNTAIN GROVE, MO.—The Mountain Grove Telephone Company. $10,000. Directors: E. H. Farmsworth, W. S. Cangler, L. H. Slaughter, of this city, L. M. Fenner, of Buckhart, and B. V. Morris, of Rockbridge, Mo.

GUTHRIE, OKLA.—Blue Island, Riverside & Hammond Street Railway Company. $1,500,000. Directors: William F. Owen, August W. Miller, John F. Noel, Ira J. Owens, W. S. McCaully and Frank E. White, of Chicago; W. F. Harn, J. F. McMechan and John Throadgill, of Oklahoma City.

HARRISBURG, PA.—The Heimebach Railroad Company; $140,000; directors: Frank Jacobs, Allentown; A. N. Brown, H. A. Thompson, John H. Euenfstueck, Bethlehem; H. F. Weaver, South Bethlehem; George H. Kressler, West Bethlehem. The Northampton Central Railroad Company; $20,000. The Bath & Chapman Street Railway Company; $12,000. The Alliance & Bath Street Railway Company; $75,000. The Township Line Street Railway Company; $65,000. The Alliance & Cherryville Street Railway; $50,000. The Donora & Carroll Street Railway Company; $30,000. The Kane Electric Street Railway Company; $24,000.

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ELECTRIC RAILWAYS.

BELLAIRE, OHIO—The county commissioners have granted a franchise for a trolley line from this place to Shadyside.

GRAND RAPIDS, MICH.—The Kalamazoo Valley Electric Company has sent men to Plainwell to estimate the cost of an electric road from Kalamazoo to Grand Rapids by way of Allegan.

NEW LONDON, CT.—The Croton & Stonington Street Railway Company, which is about to build an important trolley line from New London to the Rhode Island state boundary at Westerly, has purchased of the Standard Machine Company the so-called Randall Wharf property as the site for a power station.

BARABOO, WIS.—The Wisconsin Central Traction Company, of Chicago, has assumed all rights, privileges and franchise of the Sauk County Traction and Power Company and purposes to build the projected electric road between Devil's Lake and Kilbourn. The Central company is composed of Chicago capitalists.

BOSTON, MASS.—It is said that within sixty days, if no untoward circumstances intervene, the Newton Lower Falls branch of the Boston & Albany division of the New York Central will be electrically installed. Contracts for the overhead equipment have been let and the work of changing the motive power of the line from steam to electricity will be started at once.

EBENSBURG, PA.—The supervisors of Summerhill Township have granted the Conemaugh Valley Street Railway Company rights of way along certain public highways in the township for a distance of four miles. It is said that this is the last link in the line between Ebensburg and Johnstown, and that the company is now in a position to go ahead with the building of the line.

BOSTON, MASS.—The town of Burlington has instructed the board of selectmen to grant a location to the Middlesex Street Railway Company. The company purposes to construct a line between Arlington and Lowell, with rails in Arlington, Lexington, Bedford, Burlington and Billerica. The route, so far as possible, will be over private land and a double track will be laid.

LANSING, MICH.—It is announced here that the Lansing street railway has been sold to Nelson Mills and M. W. Mills, of Mayville, Mich., and James R. Elliott and George G. Moore, of Port Huron. The price paid is said to be about $175,000. The new owners will improve the system and have signified their intention to build a new line from Lansing to Pine Lake, the right of way having been secured by the previous owners.

WALTHAM, MASS.—The Waltham Street Railway Company opened last week its new line between Waltham and Belmont. Work of constructing this line was begun last Saturday and pushed forward until completed. Wednesday night and Thursday cars were put in operation, as called for in the franchise. The new line starts from Main street in Waltham and passes through Linden street and from Quincy street extension to Tarpelo road.

MARYVILLE, MO.—Surveys are now being made for the proposed electric railway from Parnell through Maryville to St. Joseph, and work will now be pushed as rapidly as possible. The Maryville & St. Joseph Electric Railway Company has been chartered for this purpose, the incorporators being Richard Kuchs, Richard M. Bradbury, Stephen H. Kemp, Clarence E. Bartlette, Adolph Lippmann, Charles E. Gonnell and John W. Thompson.

WORCESTER, MASS.—The Worcester Street Railway Company reports as follows: Earned $17,700 in July and $19,950 in August, with September promising more. The railroad commissioners recently approved an issue of bonds by the Boston & Worcester Street Railway Company to the amount of $250,000, payable in twenty years, with interest at four and one-half per cent, to be used in paying floating indebtedness and in the purchase of property.

CHAMBERSBURG, PA.—Residents of this place, St. Thomas and Fort Loudon have organized the Chambersburg, St. Thomas & Fort Loudon Electric Railway Company. John R. Eberly was made president; Frisby Miller, secretary, and Dr. F. G. Strock, treasurer, all of St. Thomas. An application for a charter has been filed at Harrisburg. The capital stock will be $300,000. The road will run from here to St. Thomas and thence to Fort Loudon, with probably a spur to Mt. Parnell.

RUSHVILLE, IND.—Work on the excavation for the power building of the Indianapolis & Cincinnati Traction Company has been begun. The power plant of the traction company will consist of three large buildings—the main power-house, car barns and repair shop and loop building. The buildings will represent a cost exceeding $50,000, and $200,000 will be expended in equipping the power-house. Work on the grading of the line is progressing rapidly, and this work will probably be completed by December 1.

WOONSOCKET, PROVIDENCE, R. I.—A second survey has been completed by the engineer corps of the Woonsocket Street Railway Company for the double-track Woonsocket-Providence electric passenger and freight short line to be built under the Providence & Burrillville Street Railway Company's charter. The General Electric Company, of New York, is preparing estimates for electric equipment for the line and for the rolling stock for the new road. The line, which will pass through North Smithfield, Lincoln, Smithfield and Centredale, will require about thirteen miles of trackage exclusive of the terminal trackage over existing roads. Mr. E. K. Ray, president of the Woonsocket Street Railway, is the principal promoter of the new line. Construction will likely begin soon and equipment will be delivered as the work progresses.

LEGAL NOTES.

CAR HEATING COMPANY LITIGATION—The Gold Car Heating and Lighting Company, of New York, has announced that the privy council of England has decided that the Gold steam hose coupler does not infringe the Sewall patent, as alleged by the Consolidated Car Heating Company. The Consolidated Car Heating Company appealed to his Majesty the King of England in his privy council from the unanimous decision rendered by the Court of King's Bench for the Province of Quebec (appeal side), Dominion of Canada. The final appeal was argued in July last before the privy council, at London, England. The concluding paragraph in the decision by the lords of the privy council is as follows: "Their lordships therefore have come to the conclusion that the appellants have failed to prove that the respondent has infringed their patent."

MARCONI COMPANY SUED—Suit has been commenced in the United States Circuit Court, at Trenton, N. J., to test the patent rights of the Marconi Wireless Telegraph Company of America. The action is based on the testimony of Emerson Dolbear, of Somerville, Middlesex County, Mass., who claims that he is the original inventor of wireless telegraphy and asks a preliminary injunction restraining the Marconi company from making further use of the invention, and an accounting from the corporation for alleged infringement of his patent rights, which were granted on October 5, 1886. He sold his patent rights to the International Wireless Telegraph Company on March 14, 1903, and this latter company has brought the suit. A similar case has been brought by Reginald A. Fessenden, a citizen of Virginia, who is now living at Bayonne, N. J., and who is a recognized inventor of wireless electrical communication.

WESTERN UNION WINS SUIT AGAINST TELEPHONE COMPANY—The United States Circuit Court of Appeals has rendered a decision reversing the findings of the United States Circuit Court of Boston, Mass., in the case of the Western Union Telegraph Company and others *vs.* the American Bell Telephone Company. A Master's report in the case, which held that the plaintiff could not recover in the suit seeking an accounting for certain shares of stock in companies licensed by the Bell company, under a contract made November, 1879, was confirmed by the United States Circuit Court. Appeal was taken, and the Court of Appeals holds that the plaintiff can recover. When the Western Union Company abandoned the telephone field to the American Bell Company, its patents on telephonic apparatus were turned over, and it appears that its compensation was the contractual twenty per cent of the American Bell's rentals and royalties for seventeen years. The issue turned on the question whether rentals or royalties are not money rentals received as such, or all compensation received by the Bell company for the use of its instruments. The appellate court in its opinion does not recognize the Bell company's claim that the value of the patents could be differentiated into a value for the instruments alone and a value for the use of the instruments.

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INDUSTRIAL ITEMS.

THE NATIONAL ELECTRIC COIL COMPANY, Lansing, Mich., has been incorporated. The company is capitalized at $20,000, and will manufacture electric spark coils.

THE GENERAL ELECTRIC COMPANY, Schenectady, N. Y., has received an order for electric equipment for the Insein shops of the Burmah Railway, in India. The equipment includes power, lighting and fans to replace the old punkahs.

THE ELECTRIC APPLIANCE COMPANY, Chicago, Ill., selling agent for McBride "Arkless" fuses, states that these fuses are now made for voltages up to 500 volts. They are furnished in any capacity up to and including thirty amperes. These are made to fit any style fuse connection in all styles of fuse blocks.

THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, Rochester, N. Y., and Chicago, Ill., has recently closed a contract with the Benson Telephone Company, Benson, Minn., and the Red River Valley Telephone Company, of North Dakota, for 400-line generator-call visual-signal switchboards.

THE MOORE ELECTRICAL COMPANY, Newark, N. J., is introducing the Moore portable artificial daylight apparatus for photographic purposes. This is a system of vacuum tube lighting which was given its first public demonstration for use in photography at the Old Guard Fair, recently held at Madison Square Garden, New York.

THE WESTERN ELECTRIC COMPANY, 22 Thames street, New York city, has recently arranged a novel display of electrical fixtures. A whole room is devoted to this exhibit, and it is festooned profusely with the same. Those interested in this line of electrical supplies will, no doubt, find that a visit to this display will be interesting.

THE BALLOU-HUTCHINS ELECTRIC COMPANY, Providence, R. I., is introducing a new automatic time switch which is a considerable departure from the ordinary apparatus of this nature. The switch-operating mechanism is mechanically insulated from the clock movement, ensuring accurate time and successful operation, as well as unlimited capacity.

THE STANLEY ELECTRIC MANUFACTURING COMPANY, Pittsfield, Mass., has sold a 2,000-kilowatt revolving-field generator to the Memphis Consolidated Gas and Electric Company, of Memphis, Tenn. The motor department of the Stanley company will henceforth be in charge of Mr. A. W. Henshaw, formerly with the General Electric Company, Schenectady, N. Y.

THE F. BISSELL COMPANY, Toledo, Ohio, is sending out an attractive circular, listing a number of electrical supplies, including automatic portable hand-lamps, distributing panels, pole platforms, pole seats, pole ladders, cable trolleys, cable messenger cars, marine cable hangers, double arming braces, duplex wire, doubled galvanized steel and iron wire and National telephone cables.

THE SHELBY ELECTRIC COMPANY, Shelby, Ohio, manufacturer of the Shelby useful light incandescent lamp, has made an important change in its New York office. While the office is still in the Parker Building, 225 Fourth avenue, Mr. W. G. McKennan, who has been with the company for a number of years, will hereafter have charge of the sales department in place of Mr. J. C. Wormley, who has resigned.

THE PEERLESS ELECTRIC COMPANY, Warren, Ohio, is shipping a number of fan motor orders to various parts of India and South America. Export shipments of Peerless transformers are reported, and a lively domestic demand for these and small direct-current power motors. An attractive addition to the company's trade literature, entitled "Long Service," tells concisely of the efficiency and durability of Peerless transformers.

THE AMERICAN ELECTRICAL HEATER COMPANY, Detroit, Mich., has issued a very attractive circular, descriptive of electric air heaters, which it manufactures. The efficiency of these stoves, the manufacturer claims to be, is two watts for minimum and three watts for maximum per cubic foot of air, depending to a great extent on the construction of the building, as well as location of room in which heater is to be placed. Circular will be sent on request.

THE WHITE SEWING MACHINE COMPANY, Cleveland, Ohio, is issuing a handsome bulletin in the interest of the White steam touring car. The first edition, dated Cleveland, Ohio, October, 1903, contains a number of half-tone reproductions of White touring cars and a surface map showing the route of the tour of Mr. James B. Dill, of East Orange, through the Maine woods in a White steam touring car. Mr. Ray D. Lillibridge is the editor of the White bulletin, and the production shows the characteristic excellent treatment which he gives to business literature of this kind.

THOS. E. CLARK WIRELESS TELEPHONE AND TELEGRAPH COMPANY, Detroit and Pontiac, Mich., announces that its business for this fall and winter looks exceedingly encouraging. At the present time, the company is moving into its new factory at Pontiac. Instruments are being prepared for use at the Universal Exposition at St. Louis, where it will have three stations in constant operation. The company is also getting out instruments for two stations for the government work at Washington and Baltimore and numerous orders for colleges, universities, nigh schools, and individual sets for short distances.

THE JEFFREY MANUFACTURING COMPANY, Columbus, Ohio, has just issued its booklet, "Jeffrey Power Drills for Rock or Coal." Contained therein is a complete line of drills (electric, steam, air and hand power), special steel augurs, "Jeffrey" drill truck, "Jeffrey" standard reel with cable, "Jeffrey" portable electric mine plunger pumps, "Jeffrey" electric hoists, "Jeffrey" standard electric coal cutters, "Jeffrey" electric locomotives, "Jeffrey" all-iron bevel gear jacks, "Jeffrey" water elevators, "Jeffrey" conveyors, "Jeffrey" mortar and concrete mixer and miscellaneous labor-saving appliances. Booklet will be sent on request.

THE CHASE-SHAWMUT COMPANY, 390 Atlantic avenue, Boston, Mass., manufacturer of electric specialties, has purchased and equipped a new and model factory at Newburyport, Mass. Its main office and factory will be moved there about the middle of October, where will be provided increased facilities for handling the work and increasing the output very largely. The company has had a very successful season with its theatrical specialties, and has completed and now has under way switchboards for the following theatres: New York Theatre, Hudson Theatre, New Amsterdam Theatre, New Amsterdam Roof Garden, Metropolitan Opera House, Lyric Theatre, Empire Theatre, New York city; Auditorium Theatre, Baltimore, Md., and Globe Theatre, Boston, Mass.

THE AMERICAN ELECTRIC TELEPHONE COMPANY, Chicago, Ill., reports that it has just shipped several carloads of central energy switchboard equipment to the Fort Worth Telephone Company, Fort Worth, Tex. The capacity of the Fort Worth exchange is 6,000 lines, and the apparatus is of the American company's best grade. This is one of the first large switchboards for independent service where each cord circuit is equipped for four-party selective signaling service, the American company's high and low-frequency selective apparatus having been adopted. In addition to the Fort Worth equipment, a 3,000-line capacity switchboard has been sold to the Kewanee Telephone Company, Kewanee, Ill. This switchboard also is being equipped complete with four-party selective keys.

THE EUREKA ELECTRIC COMPANY, Genoa and Chicago, Ill., has lately furnished new switchboard and telephone equipment for Brownstown Telephone Company, Brownstown, Ind.; East Valley Telephone Company, New Prospect, Wis.; Sidell Telephone Company, Sidell, Ill.; F. W. Gratz, Atwater, Minn.; Tucker Brothers, Virden, Ill.; H. and J. Meyer, Cleves, Iowa; Bedford County Telephone Company, Bedford, Pa.; Davenport & Tipton Telephone Company, Tipton, Iowa; Rohret & Cotter, Oxford, Iowa; Gainsboro Telephone Company, Carrolltown, Ga.; W. H. Hargis, Granville, Tenn.; Taylor-Jeardeau Construction Company, Fullerton, Neb.; Wilsonville Telephone Company, Stockport, Iowa; Golden Rod Telephone Company, Cedar Bluffs, Neb.; Equality Independent Rural Telephone Company, Equality, Ill.; D. L. Groce, Willow Springs, Mo.; Elston Telephone and Electric Company, Muscoda, Wis.; Jewell Telephone Company, Jewell, Iowa; Independent Telephone Company, Durham, Mo. The Eureka company is now housed in its new plant at Genoa, Ill., with increased capacity and better able to take care of its customers than ever in the past, and is distributing its No. 23 catalogue. New bulletins No. 26 and No. 27 are now in press and it will be pleased to forward these to any companies interested.

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CHARLES W. PRICE . . . . . PRESIDENT AND EDITOR
STEPHEN H. GODDARD . . . . . SECRETARY AND MANAGER
WM. HAND BROWNE, JR. . . . . TECHNICAL EDITOR
AINSLIE A. GRAY . . . . . ASSISTANT EDITOR

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CONTENTS

EDITORIALS:
Selective Wireless Telegraphy . . . 577
Western Union Telegraph Company's Annual Report . . . 577
Relative Value of Illuminants . . . 578
The Department of Machinery and the Power Plant at the St. Louis Exposition, by Thomas M. Moore . . . 579
Shop Testing for Commercial Service—III, by Bertrand B. Abry . . . 580
Foundry Exhibit at St. Louis Exposition . . . 581
The Home Telephone Company, Dayton, Ohio . . . 582
The Production of Rubber . . . 586
A Prony Brake Controller, by James H. Taylor . . . 587
The World's Production of Petroleum in 1902 . . . 587
The Electric Tramways of Kalgoorlie, Western Australia, by S. W. Childs . . . 588
The Telephone Exhibit at Cincinnati Fall Festival . . . 589
Air Friction . . . 589
National Electric Light Association; Fourth Progress Report of Committee on Photometric Value of Illuminants . . . 590
Portrait of Mr. John W. Mackay . . . 593
The Stone System of Wireless Telegraphy . . . 594
The Ohio Electric Light Association . . . 597
REVIEWS OF CURRENT ENGINEERING AND SCIENTIFIC LITERATURE . . . 600
INDUSTRIAL SECTION:
Slow and Medium Speed Direct-Current Motors . . . 602
Motor-Driven Machine Tool . . . 603
New Designs in Desk Lamps . . . 604
Steam Turbines for Factory Driving . . . 604
Electric Fan for Lamp Socket . . . 604
Free Lectures Under the Department of Education . . . 604
Annual Report of the Western Union Telegraph Company . . . 605
Refuse Destructors . . . 605
Regular Meeting of the A. I. E. E. . . . 606
Electric Car Equipment . . . 605
Experiments for Lessening Noise on Elevated Railways . . . 605
CURRENT ELECTRICAL NEWS . . . 606

How many persons who use electricity in any form appreciate the character of the apparatus which is installed to keep a record of the power which they consume? The electric meter is usually put in by the supply company, and it is generally tucked away out of sight, and, except when the bills come in, it is out of mind. The quality which it must possess is accuracy under all conditions, whether one lamp or fifty is burning, and it must remain accurate without requiring attention. It is doubtful whether there is any other commercial device of which so much is expected. Delicate mechanisms are usually under the care of some one whose business it is to see that they are properly cared for and that they remain in adjustment, but the electric meter must take care of itself. It is sealed up and no one sees it but the man who reads it. In the construction of its parts it is not sufficient to work within the thousandth of an inch, but, when once installed, it must not expect any further attention.

SELECTIVE WIRELESS TELEGRAPHY.

On another page of this issue will be found a description of the wireless telegraph system devised by Mr. John Stone Stone, which is now being operated experimentally from a sending station at Cambridge, Mass., to a receiving station at Lynn.

Selectivity by Simple Harmonic Electrical Oscillations.

The feature of the Stone system is that it is an attempt to secure selective signaling by the use of simple harmonic electrical oscillations. The method employed is described in the Stone patents, which were abstracted in the ELECTRICAL REVIEW for December 20, 1902. The practical application of this method was not easy, but the work of Mr. Stone has resulted in the construction of apparatus by which he is able to signal selectively across a difficult piece of country between Cambridge and Lynn, Mass., without being interfered with at all by other electrical disturbances. The selectivity of the system can at present be controlled within ten per cent, but this will no doubt be improved by further work. At present Mr. Stone is working upon selectivity alone, but when a selective system has been brought to a commercial point, it will not be difficult to secure secrecy also. While Mr. Stone's work is not yet completed, he has already made a noteworthy contribution to the art of wireless telegraphy.

WESTERN UNION TELEGRAPH COMPANY'S ANNUAL REPORT.

In his annual report to the stockholders of the Western Union Telegraph Company, at the meeting held on October 14, 1903, Colonel Robert C. Clowry, the president, contributed some remarkable figures to the literature of electrical finances. The telegraph is one of the pioneer adaptations of electricity to commercial service, and beyond improvements in the transmitting devices, the method of operation is the same to-day as it was when the first key was closed. The telephone and all the other forms of commercial adaptations of electricity have had a most remarkable growth, but notwithstanding the facility which the telephone has brought about in the transmission of business communication, it is hard to see wherein it has usurped any part of the telegraph field when we look at such figures as Colonel Clowry has presented in this report. The revenues for the year ended June 30, 1903, were $29,167,686.80, an increase of $1,094,591.70. There was an increase in expense of only $172,448.86, as against an increase in expenses last year, over 1901, of $1,111,863.53. This business was transmitted over 196,517 miles of poles and cables, carrying 1,089,212 miles of wires. The reorganization of the service has also been completed, and the system of thorough inspection, including the Atlantic and Cuba cable terminals, has been continued; and a further reduction of expenses has also been effected. Colonel Clowry is to be congratulated upon his successful administration.

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RELATIVE VALUE OF ILLUMINANTS.

In this issue appears an abstract of the Fourth Progress Report of the Committee for Investigating the Photometric Values of Arc Lamps of the National Electric Light Association. The report in its entirety is especially valuable and voluminous, and copies of it should be sought by all persons who are interested in the subject of illumination.

Since the advent of illumination by electricity, the contest between the electric and the gas lighting interests for supremacy has been unrelenting. By force of circumstances, an amount of information has been accumulated bearing upon the photometric values of arc and incandescent lamps which has placed this branch of electrical application practically on a par with others. The power required, the characteristics and the peculiarities of electric illuminants are so well understood that, by comparison with what is known of other sources of illumination, electrophotometry may be considered an exact science.

The opportunities for variations, inefficient service, and what amounts to failure, in gas lighting are so numerous and so hard to check up as to make it well-nigh impossible to standardize any of the numerous accessories for the utilization of gas as an illuminant, and this is true to such an extent that gas lighting, judged by exact standards, may still be said to be beyond the control of the operator.

Investigations on the Nernst Lamp.

Returning to the report, we find it contains a great deal of interesting information bearing upon the Nernst lamp. A review of the findings of the committee brings out the following points: The variations in candle-power of the Nernst lamp for slight variations in voltage are particularly marked. Variations in voltage necessarily involve variations in the current taken by the lamp. The report gives a value of 0.4 ampere per glower as the most satisfactory current to be used from a photometric standpoint.

The report emphasizes the fact that the maximum candle-power emitted by the Nernst lamp occurs directly beneath the lamp and that, when considered in connection with many of the uses to which the illuminant may be put, this distribution is very good, since it provides sufficient upward light for the purposes of general illumination, while the light thrown downward is very strong. For reading tables, counters, machine shop practice, drafting rooms, etc., such a distribution is often valuable.

Economy of the Nernst Lamp.

The economy of the Nernst lamp, as given by the committee report, and as based on the mean spherical candle-power of the lamp, does not show this lamp to be much superior to the incandescent bulb.

The tests upon the one-glower lamp show a variation with a clear globe and with an opal globe from 4.11 watts per mean spherical candle-power to 4.91 watts per mean spherical candle-power. In the six-glower lamp an improvement is noted, the consumption being, with clear globe, but 3.3 watts per mean spherical candle-power, and with the opal globe four watts per mean spherical candle-power.

With the Nernst lamp, as with all other lamps, the manner in which the light is equipped has, of course, much to do with the volume of light which is distributed. The committee report shows that, in the case of a three-glower lamp consuming approximately constant power and fitted with nine different commercial equipments, a maximum variation of eighty-four per cent in mean hemispherical candle-power is produced. This is greater than one would believe possible.

The report contains much interesting matter bearing upon the effect of varying the number and arrangement of the glowers in a holder. The whole matter may be summed up by saying that increasing the number of glowers augments the efficiency of the lamp in candle-power per watt, notwithstanding the screening action of the glowers upon one another, owing to the fact that, through mutual radiation, the temperature of the glowers increases with the number of glowers used.

Comparison of Arc and Nernst Lamps.

The comparisons which are given between the six-glower Nernst lamp, the 6.6-ampere direct-current series arc, and the 7.5-ampere alternating-current series arc are particularly instructive. Apparently, the arc lamp is superior to the Nernst lamp when considered as a source of illumination for street lighting. The arc lamps give a surface illumination over twice that of the Nernst lamp at a distance of 150 feet from the lamp. This, of course, is owing to the fact, as brought out in Fig. 7, that the maximum candle-power of the Nernst lamp occurs immediately under the lamp, while that of the alternating-current arc lamp occurs at about thirty-eight degrees below the horizontal, and that of the direct-current arc lamp at about twenty-four degrees below the horizontal. The economy for street illumination is therefore greater when the arc lamp is used than it would be if the Nernst lamp were employed; the Nernst lamp always having the advantage over the arc lamp of greater steadiness, or at least of less sharp variations in candle-power under the conditions of ordinary service.

The Welsbach Mantle.

Through the information which the report gives of the relative value of the Welsbach mantle and of the flat gas flame, we are given a better insight than we have ever before had of the real value of gas as an illuminant. The committee's report may be taken as the entering wedge which will finally break asunder the vast accumulation of ignorance with which we are dominated at the present time concerning gas lighting. An enormous amount of work must be done before the situation is thoroughly cleared up and before this illuminant can be discussed on its merits in its relation to other illuminants; but progress has been made. We are on a firmer foundation. We are better equipped to attack the problem in the light of truth, and we are sure that this record of performance will greatly stimulate and aid the development of electric lighting.

The report should receive high recommendation from all authoritative sources, and Dr. Matthews and his associates again deserve the thanks of the electrical fraternity for the masterly manner in which the present report treats of the matter presented.

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THE DEPARTMENT OF MACHINERY AND THE POWER PLANT OF THE ST. LOUIS EXPOSITION.

BY THOMAS M. MOORE, CHIEF, DEPARTMENT OF MACHINERY.

Radical departures in all of the great classes of machinery will be illustrated by distinct novelties in Machinery Hall at the Universal Exposition of 1904. Gas engines of great power, steam turbines, enormous machine tools, automatic machinery, practical elimination of the line shaft and pulleys and the substitution of directly connected motor in machine shop practice, high pressures and superheated steam in engine and boiler practice, the generation of gas for distinctly power purposes will perhaps constitute the newest and to the engineer the most interesting and instructive features; but the great standards and the standbys which have been evolved by the master minds of the engineering world will not be lost sight of or ignored. The machinery department has been fortunate enough to engage the cooperation and active, cordial and hearty support of the machinery industries both at home and abroad.

It has been possible to arrange for the collection here of the greatest power plant that the world has ever seen, and further, to assemble a collection of machinery for making machinery which will adequately picture the condition of that most important industry. The offerings have been so many and so notable as to necessitate a very careful selection of the exhibits for which space will be allotted. There is a motive, a harmony, a picture present in exposition work quite as much as in the art of the musician or painter or sculptor, and he who merely collects a heterogeneous mass of exhibits, however worthy individually, yet without relation or sequence or logic, fails. And so, in the machinery department the effort has been not so much to gather together a collection, as to gather together a collection of masterpieces, each representing the best thought in each particular line of endeavor, yet each having its relation to the other elements and the total making a complete, coherent, effective and instructive picture. It is hoped that this motive will live in history in contradistinction to the remembrances of the machinery departments in former expositions, where the recollection of only one or two great items has survived.

In the foreground and centrally located, the great power plant of the exposition will properly claim the first attention. This remarkable collection will include a total of about 50,000 horsepower in steam and gas engines and will occupy the entire westerly half of Machinery Hall, or an area of something over 200,000 square feet, about the size of an ordinary city block. There will be installed on this space three great lines of prime movers. The northern line will consist of steam engines exhibited by the foremost builders in England, France, Sweden and Germany, as well as by the great establishments of this country. The southern line will consist of gas and oil engines. The central line between these two will be made up of mammoth steam and gas engines. It would be erroneous to consider any one of these lines as more important than either of the other two, but the character of Machinery Hall renders it necessary to install the highest and most massive engine units in the central bay of the building. Each line is 100 feet wide and about 600 feet long and each will be full of engines in operation.

The great gas engine from the works of John Cockerill, of Seraing, Belgium, will cover an area eighty-two feet long by forty-three feet wide. This engine with its electric generator weighs over 400 tons; it has five times the power of any gas engine ever exhibited in any exposition; it has three times the power of any gas engine on the Western Hemisphere, and twice the power of any gas engine operating in Europe, and it is fifty per cent greater than any gas engine ever designed and now in process of construction. It will exemplify the highest type and the greatest might yet seen, or likely for many years to be seen, in the development of the gas engine. It introduces a new factor for consideration in the planning of great railway and lighting power plants.

Another new factor is the steam turbine or steam turbo-generator. This illustrates the long-sought but until very recently never realized, the rotary steam engine. The largest engine of this type will be one of 3,000 horse-power, from the General Electric Company, of Schenectady. It has the advantage of being extremely economical in the space required for its installation and operation, very inexpensive foundations and remarkable efficiency. It is stated that orders for engines to a total of over 500,000 horse-power are now held in abeyance, pending the determination of the practical success of the steam turbine. From this it should not be understood that turbo-generating sets are still in the experimental stage, for nothing of unproven worth or efficiency will be shown in our exposition power plant, but investors like to see what they are to pay for —to see is to believe—and not one person in half a million has ever seen a high-power steam turbine in operation.

In reciprocating steam engines the most powerful shown will be from the Allis-Chalmers Company, of Milwaukee and Chicago. This is a vertical and horizontal compound engine of the type which furnishes power for the Manhattan Elevated Railway, in New York. The engine to be exhibited here towers over thirty-five feet above the floor level, it covers about 1,700 square feet of floor space, and with its generator (built by the Bullock Electric Manufacturing Company, of Cincinnati) it weighs over 600 tons, that is, thirty average car loads.

Each of the engines in the power plant will be directly connected to its electric generator; for the distribution of energy throughout the entire exposition will be electrical and all artificial light, all cascade or fountain work, and all motion wherever found in the exposition will have its source in the power plant in Machinery Hall and the Steam, Gas and Fuels Building which is an annex to Machinery Hall.

A noteworthy feature of the power plant installation will be the illustration of the elimination of space by the exactness of method and expression which now obtains among engineers the world over. Taking one installation for example, one element is being built in San Francisco, Cal., another in Jeanesville, Pa., another in Ampere, N. J., another in Providence, R. I., and still another in Boston, Mass. Still the five will be assembled here and, without question, they will all fit the one to the other and operate as if built in one shop. The same is true of another installation; one element of which is being constructed in Seraing, Belgium, another in Manchester, England, a third in Schenectady, N. Y., and a fourth in Milwaukee, Wis. For the most part it is improbable that any one of these engineers has ever seen any one of the others. Certainly, no builder of one part has seen the progress of the work on the other parts, yet engineering has become such an exact science both in itself and in its expression that the perfect operation of the complete machine when assembled can not be reasonably questioned.

The Steam, Gas and Fuels Building, which covers an area of about 100,000 square feet, is in effect an annex to Machinery Hall. In this building will be found great hoppers for storing the 4,000 tons reserve supply of coal and mechanical means for automatically conveying this coal from the cars to the bunkers and from the bunkers to the furnaces and gas plants. The daily consumption of coal will exceed 400 tons, and the total length of the automatic conveyor lines will be about three-quarters of a mile. Boilers, gas producers, briquette machines, various types of mechanical stokers, forced draft apparatus, water purifiers, and exhibits of items directly germane to the subject of steam generation and control will be installed in this building.

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SHOP TESTING FOR COMMERCIAL SERVICE—III.

BY BERTRAND B. ABRY.

THE DIRECT-CURRENT SHUNT AND COMPOUND MOTOR.

The usual tests made on shunt and compound motors are practically the same and the results obtained and the curves plotted therefrom are in general similar, with one exception, namely, the speed curve of the two motors. The shunt motor is essentially a constant-speed motor, whereas the speed of the compound motor varies with the load.

In this article the shunt motor will be considered in particular, and the compound motor noted where the difference in the calculations and the curves are marked.

The following are the usual tests and calculations made:

1. Speed test.
2. Iron loss and saturation, and friction tests.
3. Brake test.
4. Efficiency calculated from the losses.
5. Temperature test.
6. Insulation test.

1. Speed Test—In making a speed test on a shunt motor, a convenient method is to belt-connect the motor to a generator of a slightly greater capacity. This allows overload speeds to be obtained if desired. Another method sometimes used is to rig the motor with a Prony brake and vary the load and the speed in that way. Using a generator as load, the observations made on the motor are as follows:

Speed.	Voltage.	Armature Amperes.	Field Amperes.	Total Amperes.

It is usual to begin the test at full load or a slight overload according to the test requirements. When the test is started adjust the generator field and load until the motor is giving its full load, or the desired overload output. Hold the voltage and motor field current constant, and begin taking observations. Note the speed and observe the reading of the instruments at the same time. The total amperes are of course the sum of the motor armature amperes and field amperes, and are simply calculated for each set of readings. After taking the first set of readings, cut down the load; that is, the motor armature amperes. This is done by changing the load on the generator. Continue these readings until no load conditions are reached. Throw the belt off, remove the pulley, and take a final set of readings, being careful, however, that the motor field current is not reduced.

Together with the speed curve of the shunt motor, the field ampere curve is usually plotted. In these tests this will naturally be a straight line.

Plot the speed and field ampere curves on a total or external ampere base; that is, the sum of the armature amperes and field current. Fig. 7[1] shows the general shape of such curves for both shunt and compound motors.

Although a shunt motor is considered a constant-speed motor, there is always this slight variation in speed from no load to full load, as shown by the curve. This gradual decrease in the speed may be accounted for as follows:

In varying the load over the range desired for making a speed test, the drop in the armature increases from a minimum at no load to a maximum at full load or overload. With a constant field the effect is equivalent to reducing the impressed voltage. By keeping the impressed voltage constant, and gradually decreasing the field as the load is increased, this drop might be entirely compensated for and a constant speed obtained for all loads. But as the drop in speed is not excessive, it is customary to make the speed test with a constant field.

It should be stated in this connection that the position of the brushes also affects the speed. Much depends upon the design of the machine, but in general, with sufficient back lead, an increasing speed with an increasing load may be obtained. On the other hand, a decreasing speed with an increasing load results, even to a more marked degree than shown on the curve, when the brushes are given a forward lead.

It may also be noted that it is possible to get an increasing speed with an increasing load due to armature reaction alone, which may be sufficiently great to weaken the field.

2. Iron Loss and Saturation and Friction Tests—The method of making these tests has already been explained under the direct-current generator. In this case the motor is run as a generator, belt-connected to another motor. The same observations are made and the curve plotted in a similar manner.

3. Brake Test—This test provides a convenient method for determining the efficiency of any machine by measuring the torque and the kilowatt input and output. Any convenient form of brake, such as the Prony brake, may be used.

The following data are observed and calculated:

Volts.	Arm. Amps.	Field Amps.	Total Amps.	Speed.	Observed Torque.	Torque at One-Foot Radius.

From these results the total amperes are calculated and the observed torque reduced to pounds torque at one foot radius after first making allowance for the tare. In a test of this kind it is usually quite difficult to obtain accurate speed readings. If a satisfactory speed test has been made previous to the brake test, it is not necessary to note the speed during this test, since it may be obtained from Fig. 7 for the several corresponding total amperes. From the above observed data plot accurately in pencil a preliminary curve of speed and torque, using total amperes as abscissæ as shown in Fig. 8. In motor calculations we use total amperes because the efficiency varies with the total energy put into the machine. That is to say, a certain amount of power is delivered to the motor from the line, part to the armature and part to the field, and we obtain a certain torque at the pulley after supplying the losses. From the ratio of output and input we obtain the efficiency, as will be shown later.

From this preliminary plot of the speed and torque select even values (for convenience only) of the amperes and note the corresponding values of the torque and speed. Tabulate as follows:

Volts.	Amperes.	Speed.	Torque.	B. H.-P.	E. H.-P.	Efficiency.

Knowing the speed and torque, the brake-horse-power may be computed from the following formula:

Brake horse-power = speed × torque × $\frac{2\pi}{33000}$ where torque equals pounds pull at one-foot radius. For convenience the above equation may be written

[1] These curves, Figs. 7, 8 and 9, are not plotted from the performance of any particular motor but are merely intended to show the general shape and relation of such curves.

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Brake horse-power = speed × torque × 0.0001904.

The electrical-horse-power equals of course total amperes multiplied by volts and divided by 746; that is,

$$\text{Electrical horse-power} = \frac{\text{watts input}}{746.}$$

The electrical horse-power represents the input to the motor and the brake-horse-power the output, hence the ratio of the output to the input gives the efficiency.

The characteristic curves of a shunt or compound motor are plotted from these results. They take the general form shown in Fig. 9.

4. Efficiency Calculated from the Losses—This method of obtaining the efficiency is sometimes used to check the efficiency obtained from the brake test.

The cold resistance should be measured and then increased such an amount as will correspond to the average temperature at which the motor will probably run in service. This was explained fully under the direct-current generator. When this

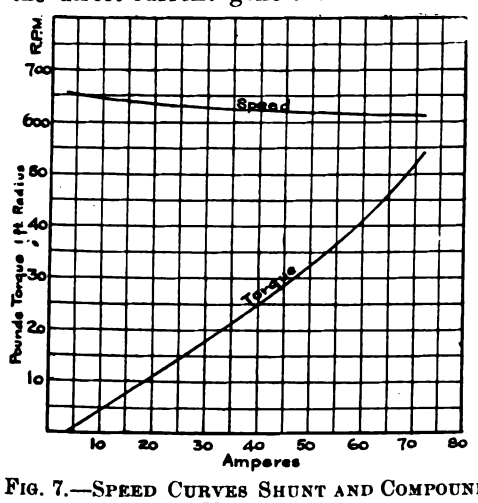

FIG. 7.—SPEED CURVES SHUNT AND COMPOUND MOTORS.

has been done a speed curve should be taken noting the following:

Speed.	Volts.	Armature Amperes.	Field Amperes.	Total Amperes.

Observe also no load readings on the neutral point. The column of total amperes is calculated. Make a preliminary plot of speed and field current with total amperes as base. Then as before, take even values of amperes and read off corresponding values of the speed and field current. Tabulate as follows:

Calculate the different columns beginning with "armature amperes" which is equal to total amperes minus field amperes.

The C^2R armature loss = (armature amperes)^2 × corrected armature resistance.

If a compound motor, the corrected series field resistance must be included.

The C^2R shunt field and rheostat loss = volts × field amperes.

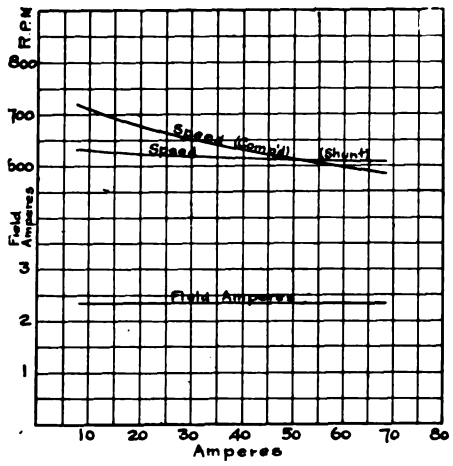

FIG. 8.—PRELIMINARY PLOT OF SPEED AND TORQUE.

As in the case of generators the C^2R brush loss is calculated from the brush cross-section and the total amperes flowing. That is, for a certain number of amperes per square inch, there will be a certain average drop, as explained under direct-current generators. The product

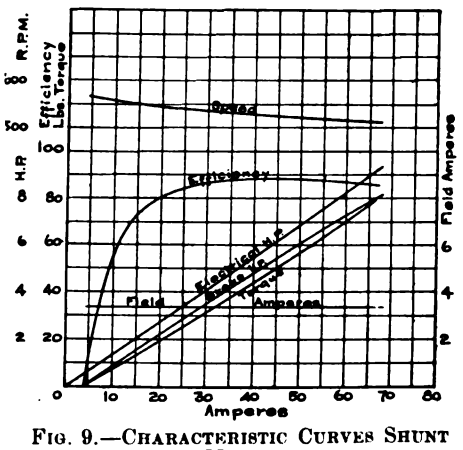

FIG. 9.—CHARACTERISTIC CURVES SHUNT MOTOR.

of the drop and the total amperes gives the watts lost in the brushes.

The iron loss, brush friction loss, and the friction and windage loss may be computed from the no load readings as observed in the speed test. That is, these losses will equal the total no load watts (watts in armature and field) minus no load field loss.

Adding all these losses gives the total loss in the machine, which should be noted in the "total loss" column.

Watts input = total amperes × volts at terminals of machine.

Watts output = watts input — losses.

And as before, the efficiency = output/input.

The torque for different loads may be calculated from the brake-horse-power formula, where

$$\text{Torque} = \text{B. H.-P.} \times 33{,}000/2\pi \times \text{R.P.M.}$$
$$= \text{B. H.-P.} \times 5{,}252/\text{R. P. M.}$$
$$= \text{watts output} \times 7.04/\text{R. P. M.}$$

The efficiency calculated in this manner from the losses should check with the efficiency as obtained from the brake test.

5. Temperature Test—The temperature test on a motor is similar to a generator temperature run and is made to determine the temperature rise of various parts after a certain length of run at a predetermined load.

6. Insulating Tests—The insulation tests on these motors are carried out in a manner similar to the generator insulation tests, but varying only between 1,500 to 3,000 volts alternating current.

Volts.	Total Amperes	Field Amperes.	Armature Amperes.	C^2R Armature and Series.	C^2R Shunt and Rheostat.	C^2R Brushes.	Iron Loss, Brush Friction, Friction and Windage.	Total Loss.	Watts Input.	Watts Output.	Efficiency.	Horse-power Input.	Horse-power Output.	Speed.	Torque.

Foundry Exhibit at St. Louis Exposition.

President Engler, of the Worcester Polytechnic Institute, recently had a conference with a number of leading foundrymen from different parts of the country respecting the building and exhibit which the latter purposes to have at the St. Louis Exposition. It is proposed to erect and operate a model foundry, fully equipped with all necessary apparatus and exhibiting in operation all the processes of modern foundry practice. An advisory committee has been appointed to organize the work, and of this committee President Engler is a member. The Worcester Polytechnic Institute has been invited to prepare complete plans for the building, having in mind special reference to ideal conditions as to light, heat, ventilation and sanitation, and to a maximum of economy and efficiency by convenience of arrangement and use of the best modern devices in machinery and methods. Besides furnishing space for all ordinary operations in iron, brass, aluminum, steel and lead, the building is to provide accommodations for a chemical laboratory, an exhibition room, a library and reading room, etc. This foundry exhibit is designed to be primarily educational in its character, and during the entire time while it is in operation at St. Louis it will be under the direction and charge of the Worcester Polytechnic Institute.

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The Home Telephone Company, Dayton, Ohio.

A Description of the Large Automatic Exchange Recently Inaugurated.

THE automatic telephone exchange built for the Home Telephone Company, of Dayton, Ohio, by the Automatic Electric Company, of Chicago, Ill., having a present installation for 6,000 stations and an ultimate capacity of 19,000, began service early in July. The five-story building in which the exchange is located is at the corner of Fourth and Jefferson streets, in the centre of the city, and occupies an area of forty-nine feet by 104 feet. The lower three floors are rented for stores and offices; the fourth floor contains the offices for the Home Telephone Company and of the United States Telephone Company, and the terminal room in which the distributing rack, the power plant, wire chief, and the information and trouble clerks are located. The fifth floor is one big hall without columns and contains the automatic switchboards and a repair room. The equipment is the Strowger automatic system, and the

EXCHANGE BUILDING, HOME TELEPHONE COMPANY.

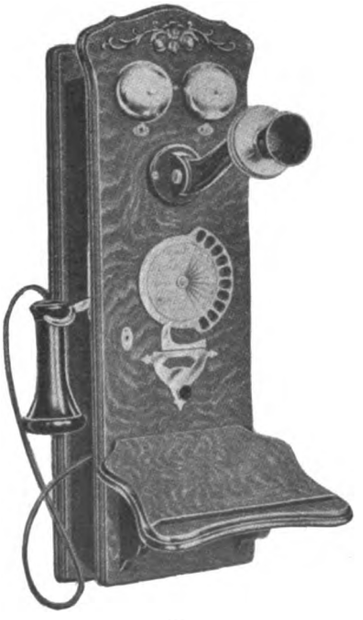

FIG. 1.—WALL SET.

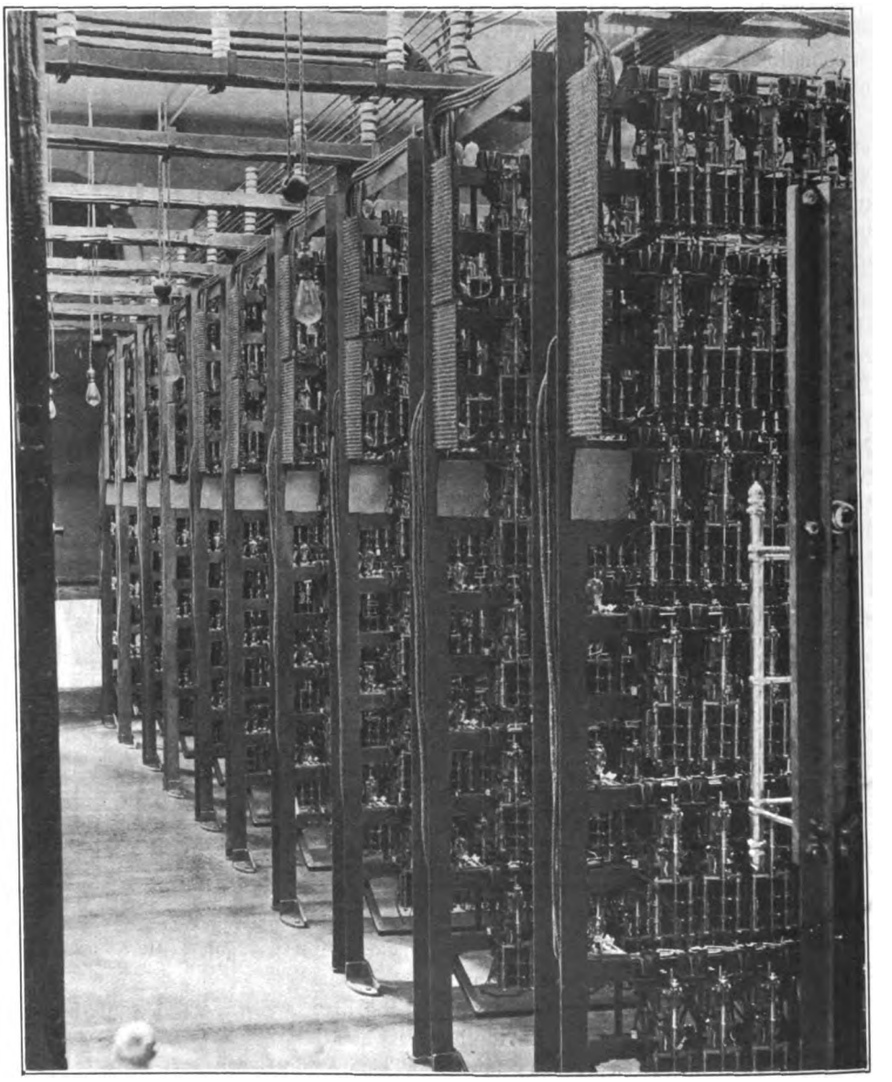

FIG. 4.—GROUP OF TEN SWITCHBOARDS, REPRESENTING 100 SUBSCRIBERS.

same motion, using consecutively the holes 7, 1 and 2, and at last he presses the push-button, thus ringing subscriber No. 5712. If telephone No. 5712 is busy the calling party will hear in the receiver a buzzing sound. When a conversation is ended the hanging up of the receiver restores all connecting apparatus to the normal position.

The subscriber's set is either a wall method of calling may be given in a few words. There are now in operation 2,000 telephones, and the balance are being rapidly connected up.

Suppose subscriber 2378 wants to call 5712, he takes receiver from hook, puts his finger in hole No. 5 on the dial of his telephone, as shown in Fig. 1, pulls it to the finger stop and lets it return to normal position. He then repeats the telephone, Fig. 1, or a desk telephone, Fig. 2. The wall telephone is a well finished box which contains the calling and talking apparatus, the ringer and the local battery, which consists of two dry cells. The desk set contains only the transmitter, induction coil, and the calling device, while the ringer and local battery are placed at any convenient point. The desk set is a nickel-plated, polished apparatus,

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the weight of which is approximately seven pounds complete.

Each subscriber is connected to the exchange by two lines which end in what is called a first selector switch, Fig. 3. This first selector consists of a couple of relays; a vertically and rotatably movable shaft which bears at its lower half three wipers and three contact banks. The contacts in these banks are arranged in three rows, of ten contacts to the row, mounted in semi-circular form. The upper bank is the "busy" bank and the two lower ones the "line" banks. The above-mentioned shaft coincides with the geometrical axis of the banks, and the wipers are adapted to connect to the contacts, one wiper for each bank. The subscriber's operation of rotating the dial with the finger in the fifth hole will lift the shaft, and with it the wipers, to the fifth row of the bank contacts. These contacts are connected by cables to group "five thousand" in the exchange, and the wiper automatically connects with one of these contacts which is not busy. At this point the mechanical part of the first selector switches off. The above-mentioned cable ends in a second selector, an apparatus almost like the first selector. The subscriber's second operation, with the finger in the seventh hole of the dial, raises the shaft of the second selector to the seventh row of the contacts and connects with one of the contacts in that row which is not busy. These bank contacts are connected by another cable to the seventh hundred of the fifth thousand group, and the cable ends in what is called a connector. The connector differs from the selector in being adapted to respond to the last two operations of the calling subscriber, *viz.*, the tens are called by lifting the shaft of the connector, and the units by rotating the same, so that the rotating of the dial with the finger in No. 1 will lift the connector shaft to the first row of bank contacts and the movement using No. 2 rotates the shaft to the second contact of the first row. From these contacts two wires lead to the line of subscriber No. 5712.

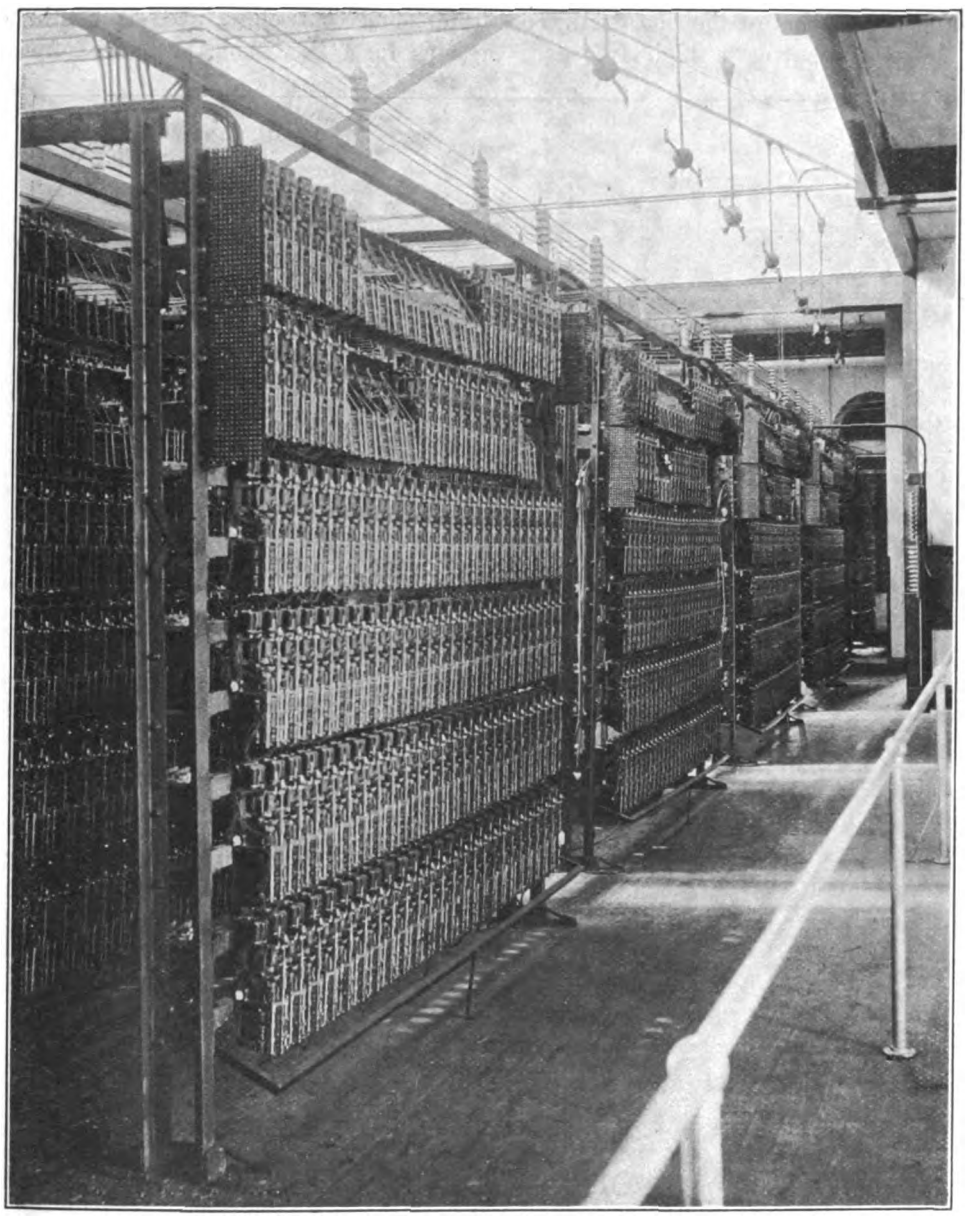

FIG. 5.—VIEW ALONG THE FRONT OF SWITCHBOARDS, SHOWING FIRST SELECTOR, SECOND SELECTOR AND CONNECTOR TERMINALS.

FIG. 2.—DESK SET.

Suppose that subscriber No. 2379 wants to call No. 5713, he can not use the same set of bank contacts and cable wires from first to second selector and connector, since No. 2378 occupies these lines already. He must therefore use lines that are not engaged. The first selector of

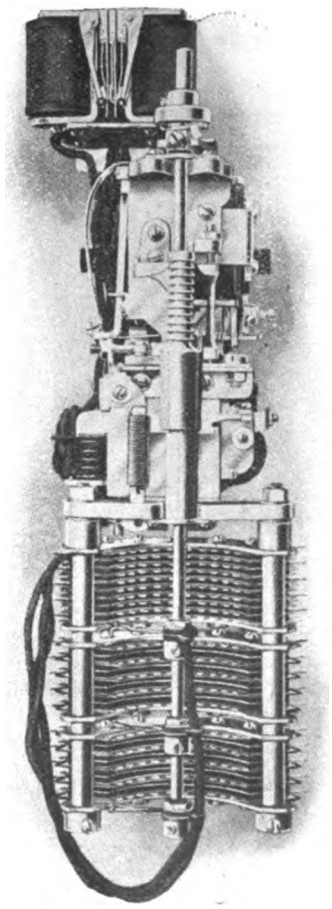

FIG. 3.—FRONT VIEW, SELECTOR SWITCH.

No. 2379 will automatically rotate to the second contact, or the first which is not in service in the fifth row of bank contacts, thus connecting with another second selector and another connector which

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are free. It will be seen that the wipers, banks and connecting cables correspond to the cords in the manual board, and that the selectors select in each case an idle cord. The ringing is done by a ringing relay on the connector. Suppose (in the first case referred to) that subscriber No. 5712 is busy. As soon as the connector wiper worked by No. 2378 strikes the busy connector contact the connector is released even before the dial of 2378 has completed its back motion, and a battery current thrown on the calling subscriber's line gives him the busy signal. It is impossible to cut in on a busy line. As long as the two subscribers talk together nobody can disturb them. If the called subscriber desires to disconnect himself from the calling party he may do so by rotating his dial once and hanging up the receiver; so that nobody can maliciously occupy the line of anybody else. In order to be able to restore each switch to its normal position one part of it must remain connected to the talking lines. In former plants each switch possessed two relays of very low resistance which were cut in series with the lines, *i. e.*, one had to talk through them. Though the transmission of the voice was excellent, the system was changed to a so-called bridging system, in which each switch has two relays of one thousand ohms together, connected across the two lines, so that the talking line is an uninterrupted metallic circuit with no self-induction besides that of the line itself. To voice currents having a high frequence the high-wound relays are entirely impenetrable. In Dayton the bridging system was used for the first time on a large scale.

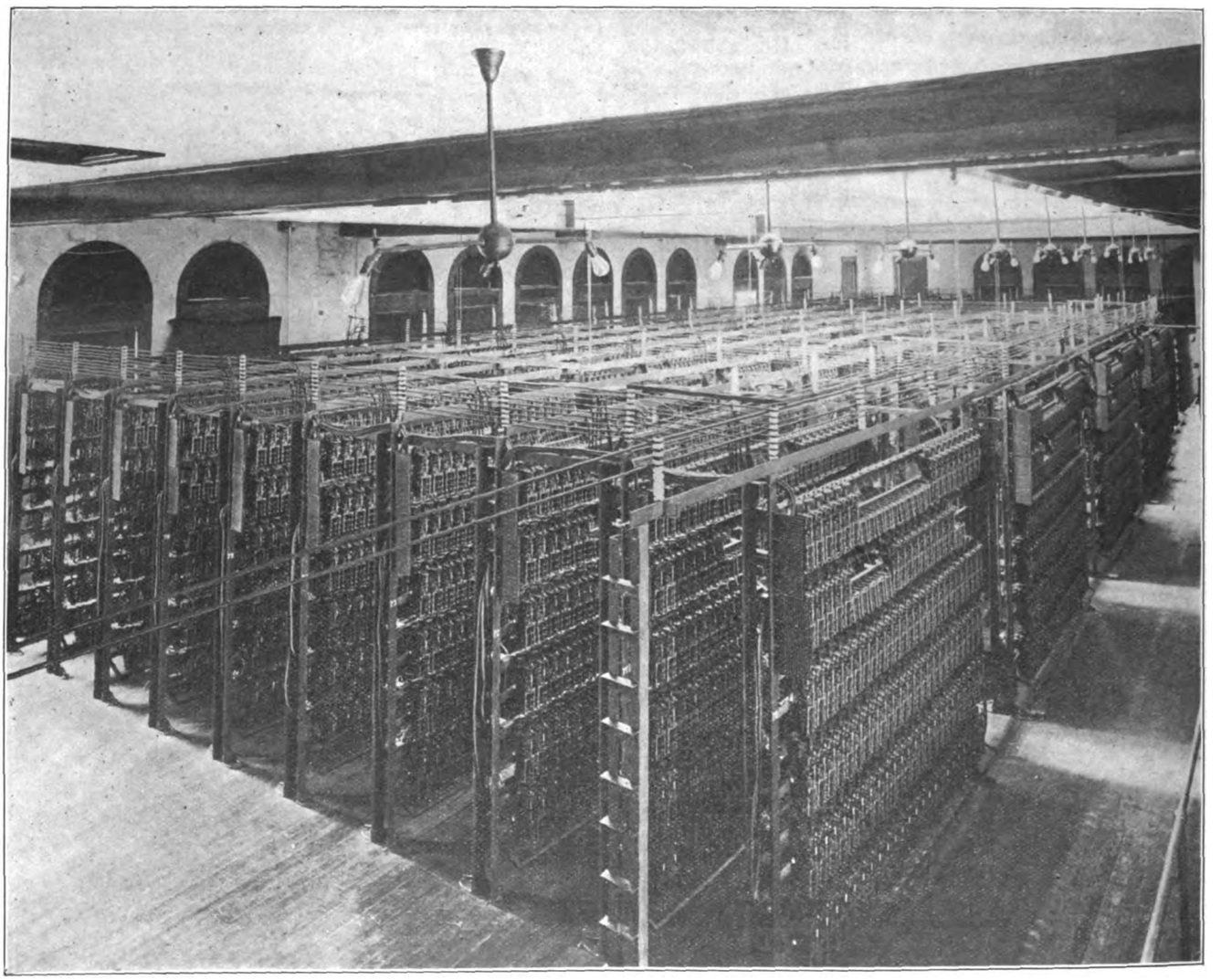

FIG. 6.—GENERAL VIEW OF SWITCHBOARD ROOM.

Looking at the accompanying switchboard illustrations it will be noticed that the switches are mounted on frames made of angle iron. Each frame or so-called switchboard is ten feet five inches long, and eight feet nine inches high. A switchboard consists of six shelves. Each first selector is directly connected to a separate line so that each switchboard represents 100 subscribers. The top shelf has fifteen second selector switches and the second shelf has fifteen connector switches. Any switch can be taken off without disturbing the others and without disconnecting a wire, and if necessary may be replaced by another one. Ten boards are arranged (Fig. 4), the one behind the other forming a group of one thousand first selectors, with requisite second selectors and connectors, and six of these groups form the whole exchange of six thousand lines. It may be mentioned that each thousand group can be completed by itself and be taken into service independently of all other thousand groups. In the Dayton exchange four groups were used while the last two groups were in course of erection. And just as easily extensions to the present equipment may be made without disturbing the service of the working groups. As there are fifteen connectors for each one hundred subscribers, or to each switchboard, it will

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be seen that fifteen calls can be made into a board, and fifteen calls can be sent out at the same time, thus allowing thirty switches of each one hundred to be in use at the same time. This percentage of thirty can easily be increased by simply filling the empty spaces on the second selector and connector shelves, the two shelves at the top of each board (Figs. 5 and 6). The ultimate capacity of the Dayton board is twenty-five calls into each one hundred, and at the same time twenty-five calls out of each one hundred, a percentage which will never be required.

Looking at the illustration, Fig. 5, three cable terminals will be noticed on each board. The one on the right side at the

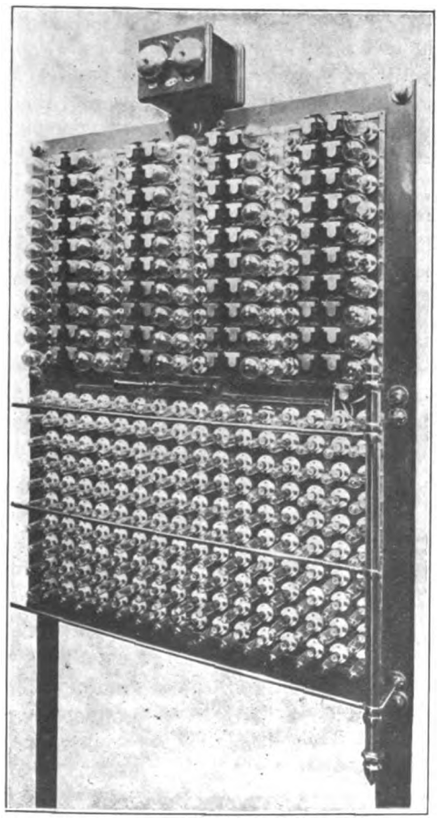

FIG. 7.—TELL-TALE BOARD.

top is the terminal used for the first selectors. The top one on the left side is the second selector terminal and the one underneath is the connector terminal. The cables leading from the first selectors to the connectors run along the side of the board (Fig. 4); the cables from the second selectors to the connectors run from board to board backward at the top of the boards, and the cables from the connectors to the lines are seen inside of the left side post. The lines come to the board through the floor from the distributing rack, located on the fourth floor. The distributing rack does not possess any features differing from those used in manual telephone exchanges. It was built by Frank B. Cook, of Chicago, and is equipped for 6,000 lines.

The outside construction of the plant is as perfect as it can be made. In the business district two hundred pairs of lead-covered cables are laid in fifteen miles of underground conduits. Branches are brought to poles situated in alleys whence every telephone can be reached by an unsupported drop. Outside of the business district aerial cables are strung, the longest being four miles. The lead cover is used as "ground." The lines enter the exchange by passing through a heat coil which is mounted on the switchboard on the back of each switch.

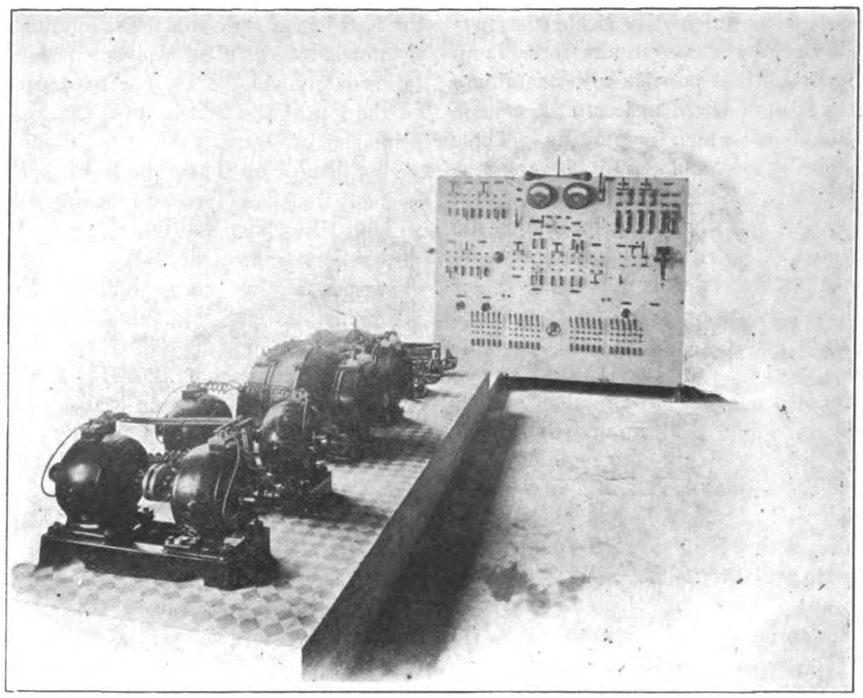

FIG. 8.—POWER BOARD, GENERATOR AND INTERRUPTER MACHINES.

Over each strip of the distributing rack a small lamp is lighted as soon as the heat coil breaks down, indicating immediately where the trouble is located. From each switchboard a so-called tell-tale cir-

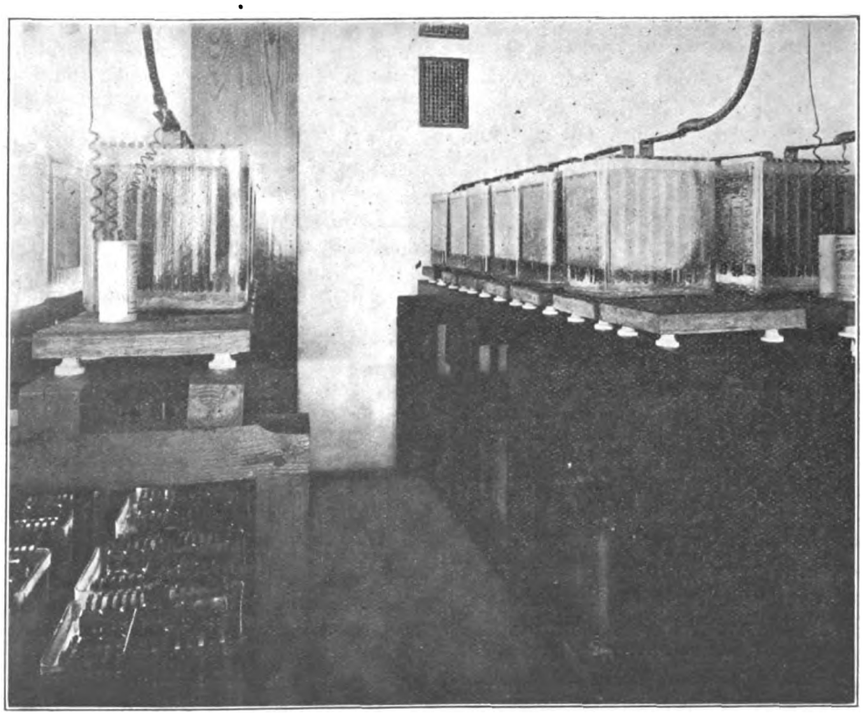

FIG. 9.—STORAGE BATTERY PLANT.

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cuit leads to a relay on the tell-tale board, as shown in Fig. 7. This tell-tale board is made of slate, mounted on an iron frame. Whenever a heat coil blows, instantaneously the relay corresponding to the board on which it is located is energized and closes the circuits for a lamp and a bell. It is possible with one glance at the tell-tale board to locate the trouble by the lamp which is glowing. These tell-tale relays and lamps occupy the upper half of the tell-tale board. On the lower half the generator lamps are mounted. The ringing generator is connected to nickel bus-bars. There is for each switchboard a pair of lamps and a separate pair of wires. Should a call go into a short-circuited line the ringing generator will not be short-circuited, but the generator lamps flash up and indicate to the attendant at once where to look for trouble. A short-circuit in a line will so show up in the exchange. If the subscriber at the end of a short-circuited line tries to make a call he will not get the desired number, but his first selector makes an unusual noise and the attendant can at once find out what has happened. Another trouble which may arise in the outside construction is a ground. That shows up in the exchange by blowing the heat coil on the back of the switchboard and ringing the tell-tale bell. An "open" in one of the lines will indicate itself by the improper working of the first selector in that line. Open lines, crosses, grounds and foreign circuits promptly indicate themselves in the exchanges, and the attendant can generally clear out a trouble before the subscriber knows anything about it. It is sometimes necessary to find out which subscriber has called another subscriber. That is easily done by means of small pilot lamps on the back of the switchboard. As soon as a switch is lifted off its normal position the lamp at the end of the shelf lights up. These lamps are arranged so that they can be seen from any place in the exchange. As a help to follow a call small blue-prints are affixed to the board, which diagrammatically show the circuits.

The power to operate the switches is delivered by two storage batteries of twenty-six cells, built by the American Battery Company, Chicago, having 400 ampere-hour capacity each. The batteries are charged by two motor-generators, which are supplied with current from the electric light circuit at 220 volts. Besides the generators the power platform contains three ringing generators and two interrupter machines.

The power board, Fig. 8, has three panels of marble and holds all the necessary measuring, switching and protecting apparatus. The different kinds of current are brought to the fifth floor in iron conduits, and are distributed on top of the board in a style somewhat similar to the outside work. The leads are fastened to insulators which are supported by pins on the top of the switchboard. It was a principle of construction to have all wiring done as open as possible, so that in case of trouble every wire is accessible without disturbing any other wire. The illustrations show how every cable and every power wire can be followed from beginning to end without lifting any cover.

In the building of the Home Telephone Company the Dayton branch of the United States Telephone Company is located. This company has long-distance lines all over the state of Ohio, and already has connections with Cleveland, St. Louis and other important places. If a subscriber wants long-distance he calls the long-distance operator who has a number like any other subscriber. The long-distance operator makes manually the toll connection, as it is usually done, and plugs the subscriber to the toll line. In the case of incoming calls the operator makes the connection through her toll board, calling and ringing the subscriber with the automatic instrument affixed to the toll board.

The officers of the Dayton Home Telephone are: John T. Barlow, president; H. C. Kiefaber, vice-president; James C. Reber, secretary and treasurer; R. D. Funkhouser, cashier.

The telephone world is watching the installation at Dayton with keenest interest. It was the first automatic exchange of so great a capacity to be built, though it was closely followed by that of the Illinois Telephone and Telegraph Company, of Chicago. The latter company has a ten-thousand station switchboard built by the Automatic Electric Company and is now connecting up subscribers in that city. More than 1,500 stations are already in operation, and a large number are being added each day. The automatic exchange of five thousand stations in Grand Rapids, Mich., is expected to be in complete operation within sixty days, and the exchange which is now being installed for the Northeastern Telephone Company, Portland, Me., with an initial installation of twenty-five hundred stations will be in operation within forty days.

The Production of Rubber.

The importations of india-rubber into the United States last year amounted to more than 50,000,000 pounds, with a value of over $30,000,000. In 1890 the quantity was only 33,000,000 pounds; in 1880, 16,000,000 pounds, and in 1870, 9,000,000 pounds. In 1862, the earliest date at which it was separately shown in the import statements, the quantity was 2,125,561 pounds.

The rapid growth in the demand for india-rubber in manufactures has brought about a new industry which is novel in its extent and in its requirements. This has been the reclaiming of india-rubber scrap. During the past few years there have been from ten to twenty million pounds per year of "old and scrap rubber fit only for remanufacture." The industry of importing and reclaiming india-rubber for use in manufacturing utilizes large quantities of worn-out rubber boots and shoes and other articles of this character. In 1893 the total importation of old and scrap india-rubber was less than a million pounds. In 1896 it was over 3,000,000 pounds; in 1898, more than 9,000,000 pounds; in 1900, 19,000,000 pounds and in 1902, 22,000,000. In 1903, the total was 24,659,394 pounds, valued at $1,516,137. This is outside of the scrap secured in the United States.

A new product has recently been developed which may be utilized in conjunction with india-rubber. This is gutta-joolatong. It is a product of the East Indies, chiefly the island of Borneo, and the following description of it, taken from the report of the Bureau of Statistics of the Department of Commerce and Labor, states that it is "whitish in color, looking something like marshmallow candy, smelling strongly of petroleum and oxidizing on exposure to the air, becoming hard. It is not a substitute for gutta-percha or india-rubber, but is used chiefly as a filler in manufactures of india-rubber gum and gutta-percha." The importation of this material has increased from 6,500,000 pounds in 1899 to 14,000,000 pounds in 1903.

A large proportion of the india-rubber imported into the United States is produced in Brazil, over one-half of the total amount coming from that point. Considerable quantities come from the United Kingdom, presumably the product of her colonies, and from Belgium, principally the product of the Congo Free State, which is under the control of the Belgian Government and its industries of this character controlled by the people of that country. Recent reports received by the Division of Consular Reports of the Bureau of Statistics have shown the entire practicability of producing the best Para rubber in territory immediately adjacent to the Philippines, from trees transplanted from South America, suggesting the possibility that the Philippine Islands may in time supply at least a part of the growing rubber consumption of the United States.

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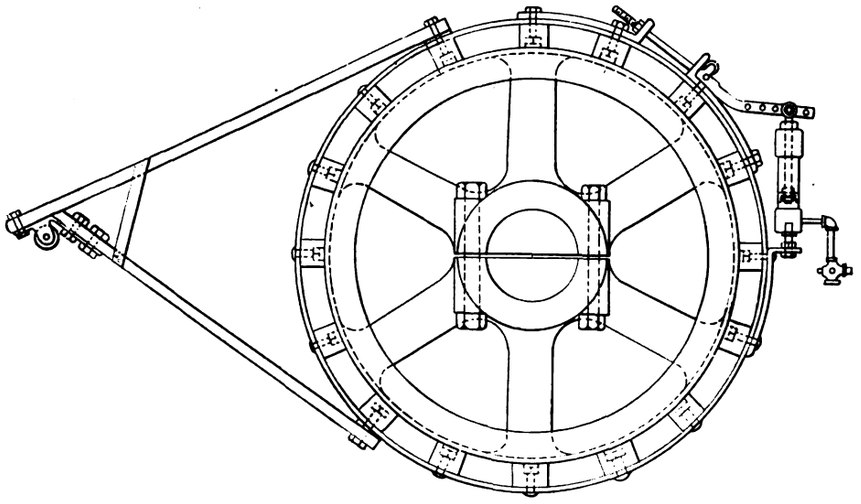
A PRONY BRAKE CONTROLLER.

BY JAMES H. TAYLOR.

When the adjustment of a Prony is made, as is generally the case, by means of a screw turned either by a wrench or a hand wheel, it is difficult to keep the load constant. Variations in temperature or in the amount of lubrication applied to the wheel produce such great changes in the friction between the wheel and the brake as to cause sudden fluctuations in the load.

The accompanying figure illustrates an improved arrangement devised by the author which eliminates, he believes, much of this trouble and maintains a constant load for any period of time desired.

Referring to the sketch, the pulley is surrounded by a strap brake of the usual type and provided with the necessary arms for transmitting the pull to the measuring device. The tension on the brake is regulated by means of a lever which itself is operated by air, steam or water pressure acting upon a piston which moves within the cylinder as shown. This cylinder is made from a piece of three-inch pipe with an ordinary coupling at each end. The bottom is plugged to make it tight, and to the side, near the bottom, is attached a three-eighth-inch pipe through which the operating fluid is admitted. In this pipe, and placed at some point convenient to the man in charge, is the operating valve. This is of the ordinary type, with a five-sixteenth-inch hole drilled at right angles to the port through the plug and side of the case, so as to release the pressure in the cylinder when the valve is given a quarter turn.



PRONY BRAKE CONTROLLER.

The piston of the cylinder is made of leather, and the pressure is transmitted from the piston to the brake band by means of a cam and a short lever of adjustable length. The apparatus allows the load to be applied to the engine instantaneously, or as gradually as may be desired, and the dimensions given are suitable for absorbing from 5 to 350 indicated-horse-power. The controlling valve can be placed near the engine throttle, so that one man has entire charge of the engine. The brake is, of course, suitable for testing any other motor, and it has been used by the author for making engine tests at the Ames Iron Works, Oswego, N. Y., for some time past.

The World's Production of Petroleum in 1902.

In his report to the United States Geological Survey on the production of petroleum in 1902, now in press, Mr. F. H. Oliphant gives the following table showing approximately the production of crude petroleum in all the known countries of the world, together with the percentages of each for 1902, in terms of United States barrels. A small estimated quantity is placed under the head of "all other countries," included in which is the primitive production in several of the South American states, and in Algeria, Persia, the Philippines, and China, from which no returns could be secured.

The total increase in 1902 amounted to almost seven per cent as compared with 1901, and to almost twenty per cent as compared with 1900. The most conspicuous items in the list are the increase in the production of the United States and the decrease in the production of Russia, the result being that the output of these two countries reached nearly the same figures in 1902. In 1902 the United States and Russia produced 91.08 per cent of the total output, as compared with 93.22 per cent in 1901 and with 94.11 per cent in 1900. Of the remaining 8.92 per cent produced by all other countries, Sumatra, Java, Borneo, Galicia, and Roumania, which furnished only 4.65 per cent in 1901, furnished 6.82 per cent in 1902, leaving 2.10 per cent of the total as the output of the other producing countries.

WORLD'S PRODUCTION OF CRUDE PETROLEUM IN 1902.

(BARRELS OF FORTY-TWO UNITED STATES GALLONS.)

Country.	Quantity. (Barrels.)	Percentage of Total.
United States	80,894,590	45.64
Canada	520,000	.29
Peru	60,000	.03
Russia	80,540,045	45.44
Galicia	4,142,160	2.35
Sumatra, Java, Borneo	5,864,000	3 31
Roumania	2,059,980	1.16
India	1,570,500	.89
Japan	1,198,000	.67
Germany	358,675	.20
Italy	12,000	.02
All other Countries	26,000	
Total	177,231,900	100.00

In 1898, 1899, 1900 and 1901 the production in Russia exceeded that in the United States; but in 1902, by its gain of 11,505,396 barrels and by the decrease of 4,628,511 barrels in Russia as compared with 1901, the United States more than made up its deficiency and exceeded Russia's production, for the first time in five years by 354,545 barrels.

Although in the production of crude petroleum the United States and Russia so closely divided the 91.08 per cent of the entire production of the world in 1902, yet when the quality of the crude petroleum is considered, the parallel is by no means so complete, since more than double the quantity of the higher grades of refined products was obtained from the average crude petroleum produced in the United States as compared with that produced in Russia. Out of a gross output of 80,894,590 barrels of crude petroleum, the United States obtained approximately 1,766,737,000 gallons of refined products, or about sixty-seven per cent; Russia, out of a gross production of 80,540,045 barrels, obtained refined products to the extent of 676,536,000 gallons, or about twenty-six per cent; and the remaining countries of the world obtained from their crude production about seven per cent of the total output of refined products. Thus it appears that in 1902 the United States produced a little more than two barrels of refined products for every barrel produced by the rest of the world.

The purest and most valuable grades of crude petroleum in the known world continue to be produced in the northeastern portion of the United States—in the Appalachian and the Lima-Indiana fields. A very fair grade of crude petroleum is also produced, though in comparitively small quantities, in Sumatra, Java, Galicia, Roumania and India.

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THE ELECTRIC TRAMWAYS OF KALGOORLIE, WESTERN AUSTRALIA.

BY S. W. CHILDS.[1]

In many respects, the continent of Australia offers opportunities for the investment of American capital, energy and brains unsurpassed by few other countries in the world. This is particularly true of the state of Western Australia, occupying the western portion of the island continent. This section comprises an area of nearly 1,000,000 square miles, much of which is yet undeveloped, but which has large mining, agricultural and industrial possibilities.

A description of the Kalgoorlie electric tramways will suffice to show, as a single instance, what has been and what can be accomplished in the transportation line alone. Although the city of Kalgoorlie is situated 400 miles inland from Perth, the nearest seacoast town, this city now enjoys the facilities of an electric tramway system, built and operated according to the latest American practice, and not surpassed, as far as engineering features are concerned, by any city of similar size in the old or new world.

Kalgoorlie has a population of about 30,000 people and the tramway lines were laid out to furnish transportation within the city itself and to the gold fields lying in the outskirts of the city. The heaviest business handled by the tramway comes from the miners who flock to the city in large crowds, particularly on Saturdays and Sundays. The tramway system comprises sixteen miles of track, of which ten miles are double-track and six miles are single-track lines. The fares are collected on the "flat" system; that is, the fare is threepence, or six cents, for a ride within the municipal boundaries, and sixpence, or twelve cents, to any point outside the city or into the Roadsboard district, as the suburbs are called. Cash fares are collected and registered as in the United States.

The tracks are laid in a soil which is practically a good natural cement of ironstone composition, which, though hard to work, forms a very good and permanent road-bed. In some cases, excavations for track were made by native laborers with pick and shovel, and in some cases with horse-drawn plows. The rail is a ninety-pound girder, supplied partly by a Belgian house and partly by the Lorain Steel Company, of the United States. For ballast and road-making, residue from the gold mines, known as "blue metal," was used to good advantage. This is harder than granite and, when broken into sizes ranging from one and one-half to two and one-half inches in diameter and laid to a depth of six inches under the ties, forms a very hard and firm, yet elastic road-bed. The rails are laid on ties of "jarrah" wood, a native wood as hard and fine as American mahogany. This wood is practically indestructible and is absolutely proof against the attacks of the white ants and impervious to moisture. This is the wood that is now being used with great success as block paving in the streets of London. The ties are six by eight inches by seven feet six inches, laid two feet centres. The rails are joined with six-bolt fish-plates, with tie rods every six feet. The track is bonded with Mayer & Englund double bonds under the fish-plates. It is interesting to know that during the track excavation work, gold nuggets were frequently turned to the surface by the plow—unfortunately, however, not in paying quantities.

For double-track lines, the double-bracket style of overhead construction was employed with a single line of thirty-five-foot poles of "jarrah" wood between the tracks. The overhead brackets were supplied by the Mayer & Englund Company, of Philadelphia. On single-track lines single-bracket construction was used.

The car house measures 300 by 60 feet, and is equal to anything to be found of similar size in the United States. It is built of steel throughout, covered with galvanized iron. The steel for the building was furnished by the American Bridge Company. The pit arrangement at the car house is novel and is applicable to American conditions. The track rails upon which the cars rest in the car house are carried on cast-iron columns five inches in diameter, resting upon concrete cement piers. There is no flooring, strictly speaking, in the car barn, but all the work is done from the ground level, as will be understood from the illustrations. To expedite repair work, a bogie truck with flat-tired wheels is used, which can be moved about at will over the ground level. At the back of the barn on the lower level is a set of cross tracks so that armatures and truck and motor parts can be dropped to this level and taken under the cars to any part of the workshops on the bogie trucks. The workmen stand on the bogies when doing the truck and motor-repair work.

Owing to the scarcity of fresh water in this locality, there have been constructed at the car barn two concrete cement tanks running the full width of the building into which is drained all the rain water falling upon the roof. These tanks are sixty feet long, eight feet deep and five feet wide, and each year they catch and render available about $5,000 worth of water, which is used for washing the cars and for fire-protection purposes. The car house is equipped with a complete system of automatic sprinklers in the roof, the water for the sprinkling system being drawn from the cement storage tanks by a pump and forced to an elevated tank near the car house by which means adequate pressure is maintained on the sprinkling system.

The company owns ten double-truck cars and fifteen single-truck cars, all of which are of the closed type and were furnished by the J. G. Brill Company, of Philadelphia. The cars are mounted on Brill trucks, and in the case of the single-truck bodies they are equipped with two G. E.-58 motors. The double-truck cars have four G. E.-58 motors to each car, following accepted American practice.

Power is furnished by the Kalgoorlie Electric Power and Lighting Corporation, Limited, which also supplies electric power to the neighboring gold mines. This power plant is capable of producing power economically, using during dry seasons water which is practically a saturated solution of ordinary and other salts. The entire plant was designed by J. G. White & Company, Limited, of London, and this company later secured the contract for its complete construction, and built a plant which is generally recognized as being unusually well built. The power-house contains three vertical units, each consisting of an 800-horse-power Stewart engine, made by D. Stewart & Company, of London and Glasgow, and direct-connected to a 500-kilowatt General Electric alternator. These units supply two-cycle alternating current at 600 volts, which for tramway purposes is changed to 550 direct current in two General Electric rotary converters, located at the power-house. Steam is furnished by a battery of Babcock & Wilcox boilers, using "Australian gum" wood as fuel.

Up to a short time ago practically the only water available for power-house purposes was a brackish water obtained from the low levels of the mines, and to fit this for boiler purposes it was necessary to maintain large evaporating and condensing plants. Lately, however, the Kalgoorlie water system has been completed,

[1] Formerly general manager of the Kalgoorlie Electric Tramways Company.

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which is now pumping fresh river water from the coast, 400 miles away.

The Kalgoorlie electric tramways are owned by a London syndicate, but were built by J. G. White & Company, of New York and London. The tramways were opened to the public on May 20, 1902, and on the opening day souvenir tickets were sold for fifty cents each, at which price over 10,000 tickets were sold to people who were anxious to commemorate the event by riding on the opening day.

One of the difficulties in the way of economical operation is the climate, which is very dry for nine months in the year, these conditions giving rise to severe dust-storms, the dust in the air at times becoming as thick as the proverbial London fog. Under these conditions it is difficult to maintain the exterior and interior finish of the cars in good condition, and the dust also hinders operation by filling in the groove of the rail. The only way of freeing the groove from this accumulation of dust is to force it out by a stream of water, fed under pressure to nozzles attached to the sprinkling cars. As before stated, the water contains a large percentage of salt and this is not conducive to long life of rails or motor equipments. The top soil is also saline and very hard on the rails.

Although the cost of building these tramways was very high, due to the transportation and tariff charges, it is interesting to know that the road was built at a cost of $5,000 per mile less than the original estimate. The cost of living in Australia is high, and labor is able to demand high wages. Ordinary laborers on the track receive one shilling and threepence, or thirty cents, an hour, and conductors and motormen are paid $3 a day, of eight hours.

The grade crossing idea has reached into the centre of Australia, one instance being the "Golden Gate Crossing at Kalgoorlie, where a crossing at grade was overcome by building an overhead bridge, consisting of steel girder floor beams, resting upon concrete cement abutments.

THE TELEPHONE EXHIBIT AT THE CINCINNATI FALL FESTIVAL.

BY J. E. PEAVEY.

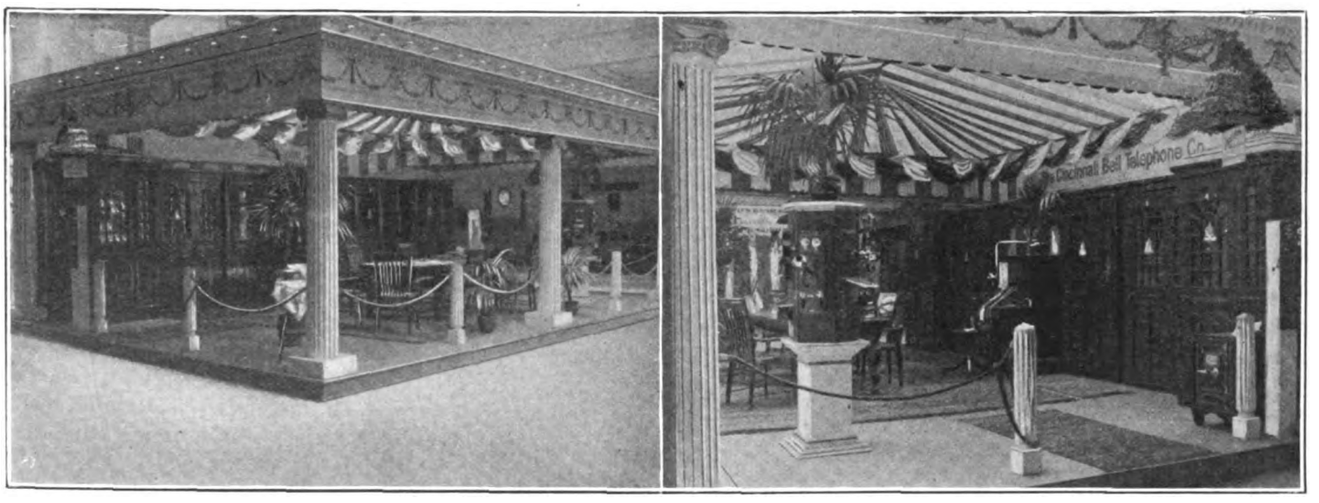
A most interesting exhibit was made by the Cincinnati Bell Telephone Company at the fourth annual fall festival recently held at Cincinnati, Ohio. The accompanying illustrations, Figs. 1 and 2, give a general and interior view, respectively, of the Cincinnati Bell Telephone Company's booth. Here were located the switchboard for handling the various telephone connections throughout the festival grounds, telephone booths for those desiring to call up parties outside of Cincinnati, and a comfortable lounging quarters for visitors and guests.

As an additional feature of attraction there was a neat showboard displaying the various types of instruments furnished to the subscribers, and also a facsimile of the first telephone ever shown to or used by the public at the Philadelphia Centennial in 1876.

On each side of the exhibit booth were two telephones mounted on apparatus so that they could be used by parties standing in the aisles and out of sight of each other. These two instruments were connected together and so arranged that one party could look the other in the eyes while talking to him. This feature furnished considerable amusement to large crowds every day during the show.

Two large blue bells with loud-talking telephone receivers were hung over each aisle. During the band concerts these bells played the music brought over by wire as it was rendered by the band in another part of the exposition.

The Telephone company has always taken a liberal part in these festivals, not only in furnishing a fine display, but by putting telephones in all of the exhibitors' booths, where wanted, and giving free service throughout the grounds. As an adjunct and means to facilitate the handling of large crowds the telephone has no equal, as it connected up the police department, the emergency hospital, the president's offices, the information bureau, the fire department and all of the ticket offices at the entrance gates.



FIGS. 1 AND 2.—THE TELEPHONE EXHIBIT AT THE CINCINNATI FALL FESTIVAL.

Air Friction.

Mr. W. Odell related some interesting experiments at the recent Southport meeting of the British Association for the Advancement of Science, in his paper entitled "Preliminary Experiments on Air Friction." These experiments were begun with the object of finding a convenient method of determining the power wasted by the windage of flywheels and dynamo armatures. The experiments were made with paper discs mounted on the shaft of an electric motor. The excitation was kept constant, so that the torque was proportional to the current. Thus the extra current required to maintain a given speed after the disc had been fixed to the shaft gave the torque absorbed by the disc. There was found to be an angular speed for each decrease above which the torque was proportional to about the 2.5th power of the speed. This critical speed appeared to vary inversely as the square of the diameter. Below it the law followed was of a lower degree. However, owing to the multiplication of errors in measurements, no definite conclusion as to its exact nature was arrived at. As the three discs originally tried gave uncertain results as to the effect of size, a much larger one—nearly four feet in diameter—was tried. As a result of all the experiments it was concluded that the torque varied as about the 5.5th power of the diameter. The author stated that a disc of forty-seven inches required 0.1 horse-power to keep up a constant speed of 500 revolutions per minute, and that if a different law held, a nine-foot disc would absorb ten horse-power at the same speed.

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NATIONAL ELECTRIC LIGHT ASSOCIATION.

THE FOURTH PROGRESS REPORT OF THE COMMITTEE FOR INVESTIGATING THE PHOTOMETRIC VALUES OF ARC LAMPS.

[*Abstract.*]

The committee has received, from time to time, requests for measurements made upon sources other than the arc lamp. Realizing the importance of comparative results, the committee has, during the past year, authorized tests upon several light sources now in common use, these tests to be conducted in the same laboratories, and with the same care and rigor that have characterized its previous work. More particularly, the sources tested during the past year have been the Nernst lamp, the mantle burner of the Welsbach type, and the open gas flame.

The report of Dr. C. P. Matthews and his assistants, Messrs. Paul G. Winter and Terry T. King, who have conducted the work during the past year, is divided as follows:

(1) Tests of the Nernst lamp.

(2) Tests of the mantle gas burner.

(3) Tests of the naked gas flame.

(4) A consideration of the illumination derived from these sources.

The work has been carried on in the electrical and photometric laboratories of Purdue University, as heretofore. For the work on gas sources, a special laboratory has been equipped with the necessary photometric apparatus, meters and pressure regulators.

A careful series of tests has been conducted upon the Nernst lamp, of the one, three and six-glower types, equipped with the various globes, shades and heater cases furnished by the manufacturers.

In making candle-power measurements on the Nernst lamp, constancy of voltage is of the utmost importance. A special test given in the report shows that a change of one per cent in the voltage makes in this particular case a change of more than fourteen per cent in candle-power. It was found that operation of the Nernst lamp under conditions of a constant current of 0.4 ampere per glower gives the most satisfactory result from a photometric standpoint.

Fig. 1 shows the distribution of candle-power from a six-glower lamp in a horizontal plane containing the glowers. It will be seen that the candle-power in this plane varies between wide limits. Normal to the glowers the value is 260 per cent of that parallel to the glowers. This horizontal distribution of candle-power is characteristic of the parallel arrangement of glowers in a horizontal plane. It is interesting to contrast this curve with similar curves obtained from the naked gas flame, the mantle burner and the arc lamp. These last-named sources give candle-power distributions in the horizontal plane that are circular, or nearly so. When the Nernst lamp is equipped with a diffusing globe, its horizontal distribution of candle-power is, of course, considerably rounded out. Because of this peculiar distribution of candle-power, the computation of the mean spherical intensity presents some difficulties not found in the case of the other sources referred to. The difficulties are, in fact, precisely those encountered in spherical measurements on an incandescent lamp. In table 1, the relative errors in the three different methods of computing the mean spherical intensity from candle-power distribution are shown. The methods are: (1) from the mean of six distribution curves in vertical planes fifteen degrees apart; (2) from the mean of two distribution curves, namely, parallel and normal to the glowers; (3) from a single distribution curve in a vertical plane thirty-five degrees to the glowers.

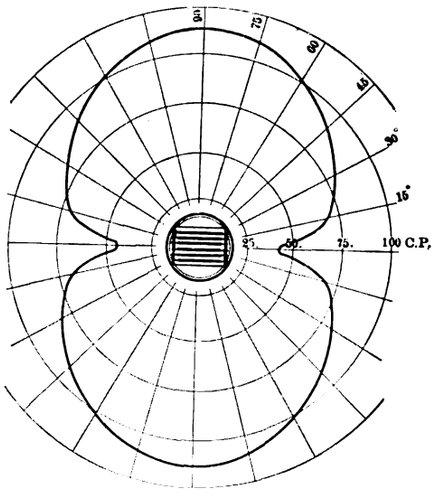

FIG. 1.—HORIZONTAL DISTRIBUTION OF CANDLE-POWER ABOUT SIX-GLOWER LAMP, EQUIPPED WITH CLEAR GLOBE.

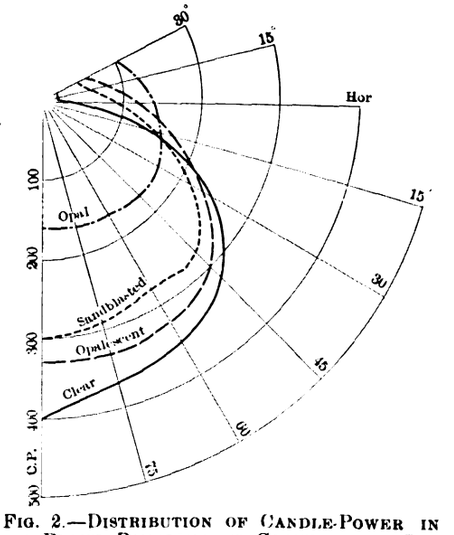

FIG. 2.—DISTRIBUTION OF CANDLE-POWER IN A PLANE PARALLEL TO GLOWERS FOR SIX-GLOWER LAMP, EQUIPPED WITH GLOBES AS INDICATED.

TABLE 1.

ERRORS IN COMPUTATION OF MEAN SPHERICAL AND MEAN HEMISPHERICAL CANDLE-POWER.

Lamp.	Mean of Six Curves Every Fifteen Degrees around Glowers.	Mean of Parallel and Normal.	Thirty-five Degrees to Glowers.
	Per Cent Error.	Per Cent Error.	Per Cent Error.
Six-glower, clear globe, M.H.S	0	−4.3	
Six-glower, clear globe, M.S.	0	−4.0	
Six-glower, pearl opal globe, M.H.S.	0	−0.8	−2
Six-glower, pearl opal globe, M.S.	0	+1.8	−1
Three-glower, pearl opal globe, M.H.S.	0	+0.5	
Three-glower, pearl opal globe, M.S.	0	+0.9	

Considering the first method as correct, the errors in the other two methods are as tabulated. The second method seems to yield a result correct to about one per cent when diffusing globes are used, and about four per cent when clear globes are used. It was found that there is no single plane, in which a candle-power distribution can be taken and integrated for the mean spherical intensity, with correct results for all types of globes and shades. With an integrating photometer, however, the matter becomes simply that of the taking five or six photometer settings, the mean of which yields the value sought.

From the records of the many Nernst lamp tests, contained in the report, those on a six-glower lamp equipped with various globes and shades are reproduced here as being fairly typical. Figs. 2 and 3 show the distribution of candle-power from this lamp in vertical planes, respectively parallel and normal, to the glowers.

Figs. 4 and 5 show candle-power distribution in the same planes from the same lamp when equipped with opal and metal shades. The results show that the Nernst lamp equipped as indicated gives maximum candle-power directly beneath the lamp. It may be said that for many purposes this distribution of light is very satisfactory, there being sufficient upward light for the purposes of general illumination, while the light thrown downward within an angle of forty-five degrees from the vertical is very strong, making a desirable source for the illumination of reading tables, counters, machines, etc. A comparison of Figs. 2 and 3 brings out

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the great difference in the distribution of candle-power in the two vertical planes, respectively parallel and normal, to the glowers, to which reference has already been made. The use of opal and sand-blasted globes alters the distribution of candle-power in such a way as to diminish the downward intensities and increase the outward and upward intensities.

The marked effect of various shades and globes on the downward flux of light is well illustrated in the case of the tests upon the three-glower Nernst lamp. As tested with a constant current of 0.4 ampere per glower, this lamp consumes approximately 260 watts. It yields mean hemispherical candle-power ranging from 64.3 for the pearl opal ball to 118.4 for

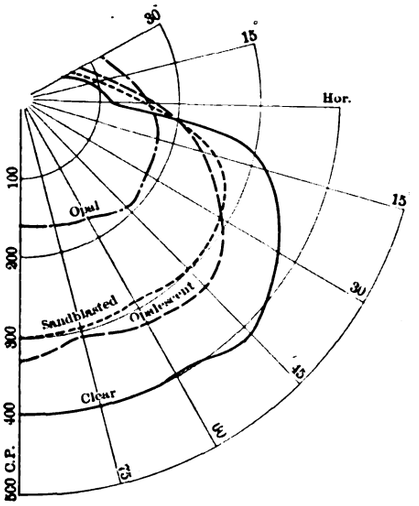

FIG. 3.—DISTRIBUTION OF CANDLE-POWER IN A PLANE NORMAL TO GLOWERS FOR SIX-GLOWER LAMP, EQUIPPED WITH GLOBES AS INDICATED.

the clear heater case. The corresponding values of watts per mean hemispherical candle-power being 4.18 and 2.22.

The wide variation in these values indicates clearly how it is possible to alter the flux of light below the horizontal plane by the use of different globes and shades, and is a strong argument against the rating of lamps on the basis of mean hemispherical candle-power, or, for that matter, on any basis that does not take into account the total volume of light emitted by the source. Coming now to a comparison of the light output, based on the mean spherical candle-power, we find a minimum of 51.9 and a maximum of 68.7, the power consumption being the same as in the previous case. The corresponding variation in specific power consumption or watts per mean spherical candle-power is from 5.09 to 3.84. It is evident that the variation in mean spherical candle-power can be due only to differences in the absorbing power of the globes and shades used. To put the matter in another way, this three-glower lamp, consuming approximately a constant power, is made to yield through the agency of its nine different equipments a maximum variation of eighty-four per

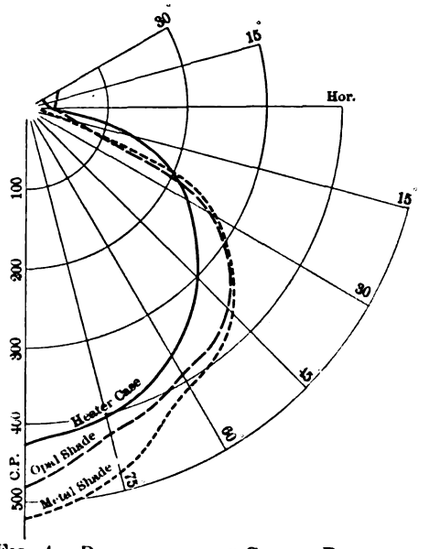

FIG. 4.—DISTRIBUTION OF CANDLE-POWER IN A PLANE PARALLEL TO GLOWERS FOR SIX-GLOWER LAMP, EQUIPPED WITH CLEAR HEATER CASE AND OPAL AND METAL SHADES.

cent in mean hemispherical candle-power, and a maximum variation of thirty-two per cent in mean spherical candle-power.

It is interesting to note the relative candle-power of the one, three and six-glower lamps. In Fig. 6 will be found distribution curves plotted to the same

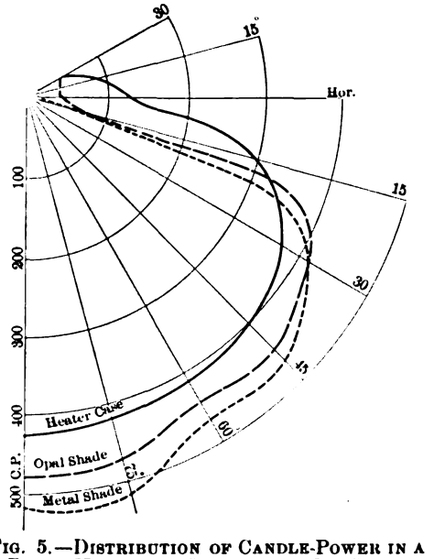

FIG. 5.—DISTRIBUTION OF CANDLE-POWER IN A PLANE NORMAL TO GLOWERS FOR SIX-GLOWER LAMP, EQUIPPED WITH CLEAR HEATER CASE AND OPAL AND METAL SHADES AS INDICATED.

scale for the three lamps, equipped with clear globes. These curves are the mean of parallel and normal distribution.

The relative power consumption per unit of candle-power is shown in table 2, which gives the watts per mean hemispherical and per mean spherical candle-power of each of the three types of lamp.

TABLE 2.

RELATIVE POWER CONSUMPTION PER CANDLE-POWER OF ONE, THREE AND SIX-GLOWER LAMPS WITH VARIOUS GLOBES AND HEATER CASES.

WATTS PER MEAN HEMISPHERICAL CANDLE-POWER.

No. Glowers.	Opal Heater Case.	Clear Heater Case.	Clear Globe.	Opal Globe.	Sand-Blasted Globes.
1	....	....	2 31	4.19	2.78
3	3.09	2.22	2.33	4.18	2.72
6	2.31	1.90	1.88	3.25	2.29
WATTS PER MEAN SPHERICAL CANDLE-POWER.					
1	....	....	4.11	4.95	4.80
3	4 55	....	4 04	4.51	4.28
6	....	....	3.80	4.01	3.64

The table shows clearly that the three-glower lamp is slightly more efficient than

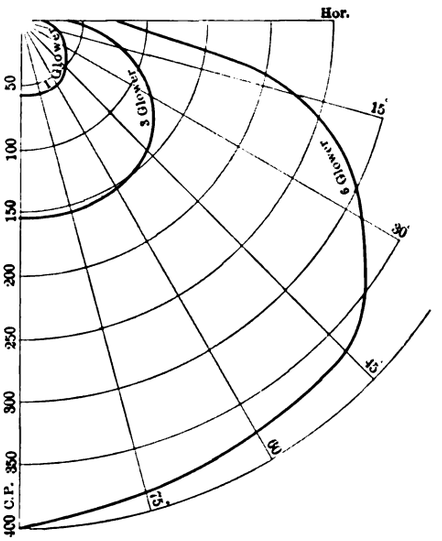

FIG. 6.—MEAN DISTRIBUTION CURVES OF LAMPS EQUIPPED WITH CLEAR GLOBES.

the single-glower lamp, and the six-glower lamp considerably more efficient than the three-glower. This increase in efficiency can be accounted for, if we remember that a number of glowers in close proximity must, through mutual radiation, operate at higher temperature than would an isolated glower. The result is an increase in light output, in spite of the fact that multiple glowers must screen the light from one another in certain directions, dependent upon their arrangement in the holder. Thus, if the number of glowers be increased, in the type of lamp with which we are dealing in these tests, the horizontal intensity will not increase in the same ratio as the downward intensity, because of the screening action of one glower upon another.

The report contains interesting results on the effect of varying the number and arrangement of glowers in the holder. The whole matter may be summed up by saying that increasing the number of glowers augments the efficiency of the

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lamp in candle-power per watt, notwithstanding the screening action of the glowers one upon another.

Although the six-glower Nernst lamp takes about twenty per cent more power than either the direct or alternating-current series arc lamps commonly used in street service, yet it is, as regards maximum candle-power, a light source of the same order of brightness, and hence a comparison of the three sources is justifiable. Fig. 7 shows the mean distribution curve of the six-glower Nernst lamp, equipped with metal shade, plotted on the same sheet with the curve for the 6.6-ampere direct-current series arc and the 7.5-ampere alternating-current series arc (see table 3). These arc curves have

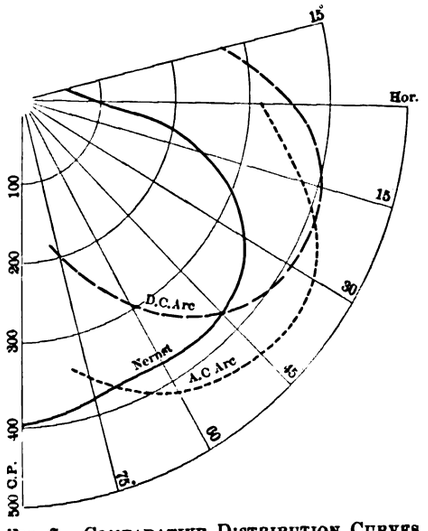

FIG. 7.—COMPARATIVE DISTRIBUTION CURVES OF NERNST AND ARC LAMPS.

been taken from a previous report of the committee. The lamps on which these measurements were made were equipped for street service. The direct-current lamp

TABLE 3.

FOR FIG. 28.

Angle.	Nernst Six-glower.	Candle-Power Series Arc A.C.	Series Arc D.C.
Hor.	87	310	352
15° B.	248	375	404
30° B.	335	440	410
45° B.	373	445	375
60° B.	372	430	295
75° B.	380	355	200

Globes.	Clear.	Opalescent Inner. Street Shade.	Opalescent Inner. Clear Outer.
E. M. F.	226.	73.8	71.
Current	2.4	7.5	6.6
Watts	542.	469.	459.
Mean hemispherical candle-power	289.	394.	360.
Watts per mean hemispherical candle-power	1.87	1.19	1.27

having an opalescent inner globe and a clear outer globe. The alternating-current lamp having an opalescent inner globe and a metal shade. It will be noted that the candle-power distribution of the Nernst lamp is altogether different from that of either arc lamp. The

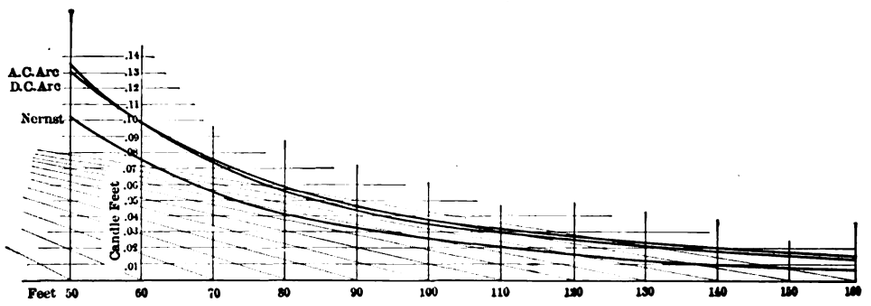

FIG. 8.—NORMAL ILLUMINATION (FROM 50 TO 150 FEET) OF SIX-GLOWER NERNST LAMP, EQUIPPED WITH CLEAR GLOBE.

Nernst lamp is strong where the arc lamps are weak, and vice versa. The points of intersection of the curves form segments which show the superiority in certain zones of each lamp over the other two.

Those who prefer to study curves of illumination, rather than curves of candle-power, will find in Fig. 8 a normal illumination plotted as ordinates against distances from the lamp along the horizontal as abscissæ. All three lamps are suspended at a height of twenty-five feet from the ground. Because of the strong intensity of the Nernst lamp below forty-five degrees from the horizontal, the illumination of points somewhat remote

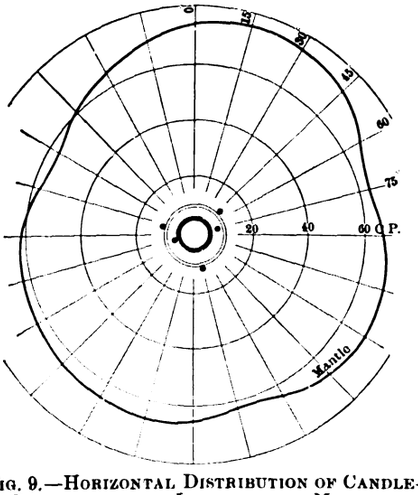

FIG. 9.—HORIZONTAL DISTRIBUTION OF CANDLE-POWER ABOUT AN INCANDESCENT MANTLE.

will, in general, be enhanced as the lamp is raised.

With a view of getting representative results on gas mantles of the Welsbach type, a variety of mantles were purchased in the open market. These mantles were classified according to their retail price, as follows:

Class A, retail price, thirty-five to sixty cents.

Class B, retail price, twenty to thirty cents.

Class C, retail price, below twenty cents.

It was found that the candle-power of a gas mantle is dependent in a marked degree upon the gas pressure. The report contains data on the relations of these two magnitudes. So important is this relation that comparative measurements on mantles become meaningless unless conducted under conditions of constant pressure. Fig. 9 shows the horizontal distribution of candle-power about an ordinary gas mantle mounted in a burner having three side supports for the mantle. It is clear that the distribution would be practically a circle were it not for the screening effects of these supporting rods. It will be noted that there are three depressions in the curve corresponding to the positions of the rods. The minimum horizontal candle-power in this instance is about fifty-seven, the maximum about seventy-six. The position of the supporting rods is indicated in the middle of the figure.

In Fig. 10 is shown the mean vertical distribution of candle-power from each of the three grades of mantles tested. This winged-shaped distribution of candle-power in a vertical plane is characteristic of the ordinary gas mantle. The maximum candle-power is found at about fifteen degrees above the horizontal, because from this point of view the visible area of incandescent surface is probably a maximum. On account of the position of the maximum candle-power in these curves, the mean hemispherical candle-power is uniformly larger above than below the horizontal. The mean gas consumption for class A mantles working under a pressure of two inches of water is 3.79 cubic feet per hour.[1] The values of gas consumption for grades B and C are respectively 3.66, 3.99 cubic feet per

[1] All instruments used in this work were carefully standardized except the gas meters; time and means were not available to test the meters. The figures for gas consumption will, therefore, have to be understood as indications of ordinary commercial meters.

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hour. The mean spherical candle-power for the three grades is tabulated as 55.8, 58.8, 62.2. This means a gas consumption per candle-power of 0.068, 0.062 and 0.064 cubic foot. It is seen that the more expensive mantles give the least candle-power. Whether this is a general conclusion or not can not be said without a larger number of tests than is here described. In point of gas used per mean spherical candle-power, class B leads classes C and A, following in the order named. The real economy of one grade of mantles over another can not be told without a life test. Time was not available for such a test in connection with this work.

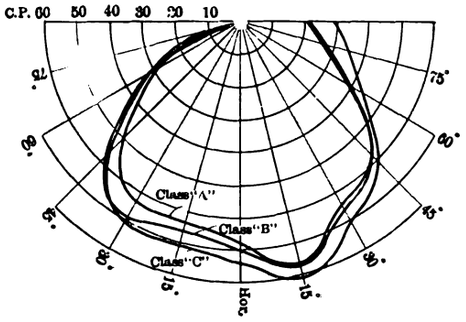

FIG. 10.—MEAN DISTRIBUTION OF CANDLE-POWER ABOUT THE INCANDESCENT GAS MANTLES.

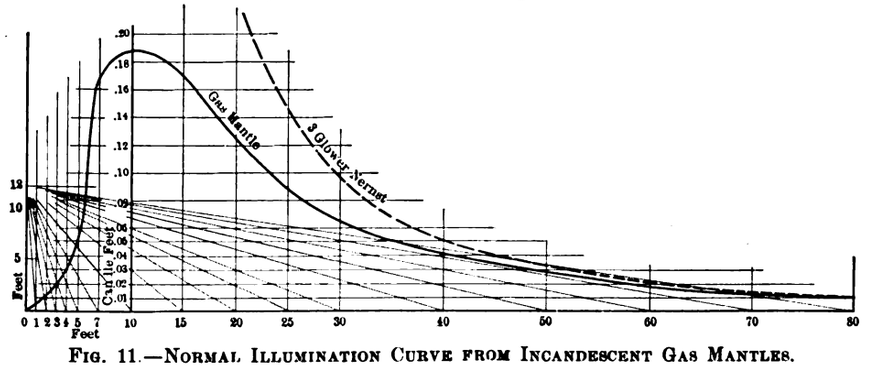

FIG. 11.—NORMAL ILLUMINATION CURVE FROM INCANDESCENT GAS MANTLES.

Fig. 11 exhibits the illumination on a plane normal to the ray produced by the mantle burner, placed at a height of twelve feet above the street. The illumination varies from the maximum of 0.187 candle-foot at a distance of ten feet, to 0.0105 candle-foot at a distance of sixty feet. Changing the height of the burner has but little effect on the illumination at points beyond fifty feet from the lamp, but changes in a marked degree the illumination at points near-by. The illumination at a distance eighty feet from the lamp is practically 0.01 candle-foot for all heights of lamp between eight and twenty feet. However, as the lamp is raised between these limits, the mean normal illumination will fall from 0.039 to 0.029 candle-foot.

The report concludes with a short series of tests of the candle-power and gas consumption of the ordinary open gas flame. An assortment of tips was secured from different dealers conveniently at hand. In seeking to test these, it was soon found that the nominal rating of the tip had scarcely any significance, either as regards the gas consumption or candle-power.

Table 4 and Fig. 12 summarize the tests on the open gas flame. It is evident from these tests that the candle-power of gas as found in ordinary commercial service can be determined only by means of a very large number of tests.

Chemical analyses of the gas used in this work show a very considerable variation in the composition of the gas at different times. An analysis made under the supervision of the department of chemistry of Purdue University, on April 23, 1903, concludes with the statement that "The gas is supposed to be a mixture of coal gas and water gas (enriched), but evidently contains a large quantity of natural gas."

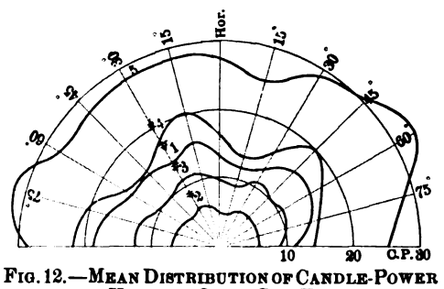

FIG. 12.—MEAN DISTRIBUTION OF CANDLE-POWER FOR VARIOUS OPEN GAS FLAMES.

The complete report of the committee is quite voluminous, containing some nineteen tables of data and forty-one figures.

Portrait of Mr. John W. Mackay.

A portrait of the late John W. Mackay, painted by Miss Cecile de Wentworth, was on exhibition last week at the galleries of William Schaus, New York. Many of the friends of Mr. Mackay called to see the painting, which is to be placed in the directors' room of the Commercial Cable Company, at 253 Broadway, in this city. The portrait, which is full length, is an excellent one, and the artist was highly complimented.

TABLE 4.

FOR FIG. 12.—OPEN GAS FLAME. PRESSURE, 1.2 INCHES OF WATER. CANDLE-POWER.

Angle.	Tip No. 1.			Tip No. 2.			Tip No. 3.			Tip No. 4.			Tip No. 5.		
	0°.	90°.	Mean 0° and 90°.	0°.	90°.	Mean 0° and 90°.	0°.	90°.	Mean 0° and 90°	0°.	90°.	Mean 0° and 90°.	0°.	90°.	Mean 0° and 90°.
75° A.	15.77	19.30	17.54	6.02	6.70	6.36	13.38	10.73	12.06	20.85	20.35	20.60	30.6	33.6	32.1
60° A.	13.38	17.27	15.33	6.90	5.23	6.07	10.40	10.80	10.60	15.12	17.68	16.40	26.2	29.4	27.8
45° A.	15.87	14.40	14.89	6.27	5.07	5.67	9.82	10.52	10.17	14.90	16.48	15.67	26.8	29.4	28.1
30° A.	13.90	14.45	14.18	5.96	6.49	6.23	11.21	10.86	11.04	17.02	19.15	18.09	26.4	29.8	28.1
15° A.	15.00	16.09	15.55	6.16	6.03	6.10	11.01	10.92	10.97	19.10	21.00	20.05	26.3	31.3	28.8
Hor.	12.00	14.85	13.43	5.46	4.99	5.23	9.85	9.55	9.70	15.20	18.00	16.50	25.1	29.7	27.4
15° B.	11.51	12.27	11.89	4.44	4.76	4.60	9.11	8.94	9.03	13.92	13.73	13.48	22.9	27.1	25.0
30° B.	12.82	12.96	12.98	5.99	5.90	5.65	10.20	11.67	10.94	15.15	16.40	15.78	26.6	30.8	28.7
45° B.	13.82	17.46	15.64	5.26	6.33	5.80	9.04	11.22	10.13	18.02	21.73	19.88	29.7	36.3	30.0
60° B.	13.43	17.80	15.62	5.24	6.49	5.87	8.95	11.92	10.44	16.90	18.20	17.55	28.0	38.5	33.3
75° B.	12.42	15.85	14.14	4.41	7.41	5.91	7.59	12.63	10.11	11.80	19.18	15.49	27.4	29.2	28.6
Cubic feet gas used per hour	....	5.75	....	....	3.64	....	....	4.45	....	....	6.20	....	....	9.7	....
Mean hemispherical candle-power—upper..	....	15.00	....	....	6.00	....	....	10.67	....	....	17.96	....	....	28.60	....
Lower	....	13.88	....	....	5.42	....	....	9.93	....	....	16.38	....	....	29.20	....
Mean spherical candle-power	....	14.44	....	....	5.71	....	....	10.30	....	....	17.17	....	....	28.90	....
Cubic feet gas used per mean hemispherical candle-power—upper..	....	.384	....	....	.607	....	....	.417	....	....	.345	....	....	.339	....
Lower	....	.414	....	....	.672	....	....	.449	....	....	.378	....	....	.332	....
Cubic feet gas used per mean spherical candle-power	....	.399	....	....	....	....	....	.432	....	....	.362	....	....	.336	....

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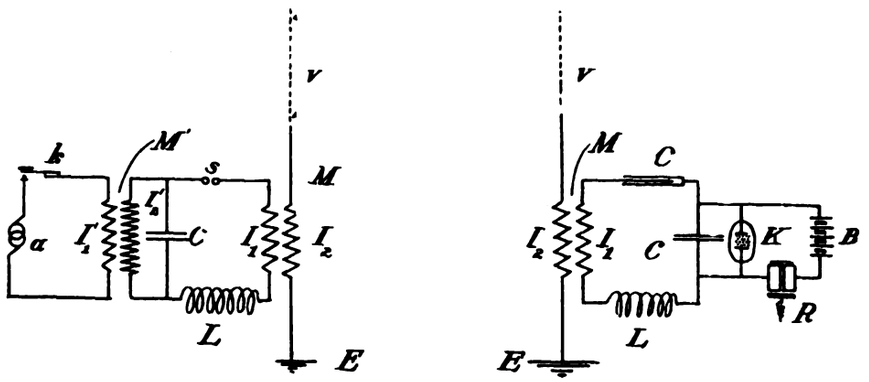
The Stone Wireless Telegraph System.

NOW that it has been shown to be feasible to send messages by wireless telegraphy over considerable distances, and that when there is no outside interference reliable transmission can be secured, the practical application of this means of transmitting messages seems to depend upon the development of a system which will not be affected by accidental electrical disturbances in the neighborhood of the stations, and by which the simultaneous transmission of several messages from one or more stations will not cause interference and confusion. In other words, what is needed before wireless telegraphy can be put to general use is a selective system.

This need for a selective system was recognized as soon as it became evident that signals could be sent an appreciable distance without wires, and on this problem not a little ingenuity and labor have been expended by men more or less eminent in this field of investigation. One of these, Mr. John Stone Stone, of Boston, Mass., has accomplished some noteworthy results which apparently indicate that selective signaling is feasible, not only in a scientific experiment, but in actual commercial use. These results have been obtained by a long and exhaustive theoretic study and an experimental investigation. Believing that selectivity could only be secured by devising a system which would respond to but one period of oscillation, Mr. Stone has devoted his time to a study of the conditions which this requirement makes necessary and to the construction of apparatus which will set up and respond to oscillations of but one period. The selection of the best type of coherer is secondary to that of setting up simple harmonic oscillations in the aerial conductor so that he has been content to use whatever type of coherer happened to be most convenient. Various kinds were tried, but that with which the greater part of the work was carried out is a small tripod made of three steel needles attached together at their upper ends and resting on a plate of aluminum. Great sensitiveness was not sought for—indeed, rather the reverse; and the same idea was adhered to in selecting a place for conducting the experiments, the inventor believing that for a system to be of any value it must be able to operate under adverse conditions.



FIGS. 1 AND 2.—DIAGRAM OF CIRCUITS FOR SENDING AND RECEIVING STATIONS.

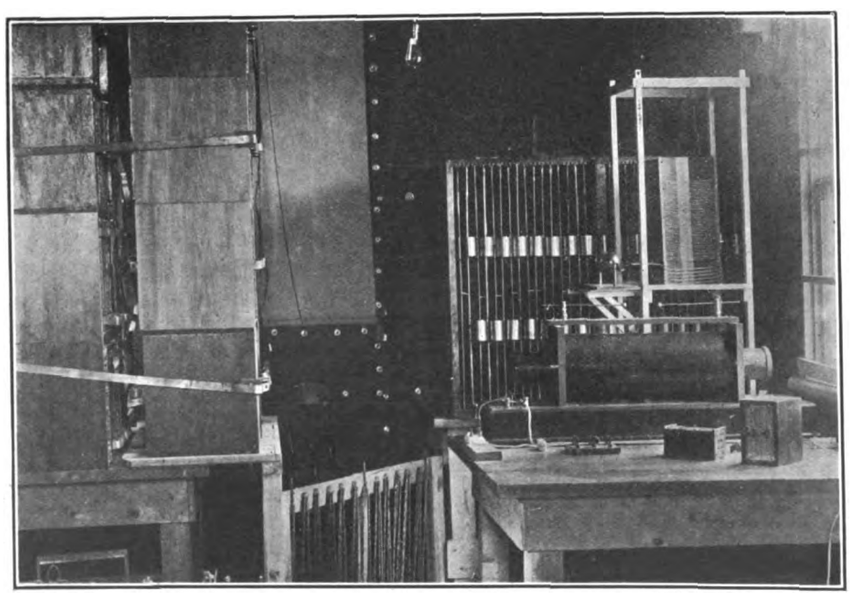


FIG. 3.—ONE SET OF SENDING APPARATUS AT CAMBRIDGE, MASS.

The problem which Mr. Stone then set himself was to devise a sending circuit which would develop electrical oscillations of a simple harmonic character and sufficiently sustained to set into vibration a suitable receiving system that would not respond to oscillations more violent but not simple harmonics. It is also necessary that the receiving apparatus at one station should respond only to its own particular frequency, and must not be affected by sustained harmonic oscillations of a different period. The accompanying diagrams show the system of circuits which was adopted by Mr. Stone. These are reproduced from an abstract of the Stone patents which appeared in the ELECTRICAL REVIEW of December 20, 1902. The general idea of these circuits is this: a is a source of alternating current; k is a controlling key; M is a transformer for charging the condenser C; s is a discharge gap, and L a variable inductance for tuning. I_1 is the primary of a transformer, the secondary of which I_2 is connected in the aerial wire. When the key is closed the condenser is charged and discharges across the spark-gap through the oscillating circuit s I_1LC. This circuit is so constructed that these oscillations are harmonic and, by means of the transformer M, they impress forced harmonic vibrations on the aerial wire. These are radiated through space and received by a similar arrangement of circuits, as shown in Fig. 2. It will be noticed that in this system the aerial wire plays no part in fixing the frequency of the oscillations set up, as this is entirely determined by the constants of the oscillating circuit. It was found that simple harmonic vibrations could not be obtained when the vertical wire formed part of the resonant circuit, because of the distributed capacity of the wire, as this distorted the wave-form and introduced harmonics. Moreover, by placing

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the electrical oscillations set up in this the discharging air-gap in the resonant circuit, and not in the vertical wire, the

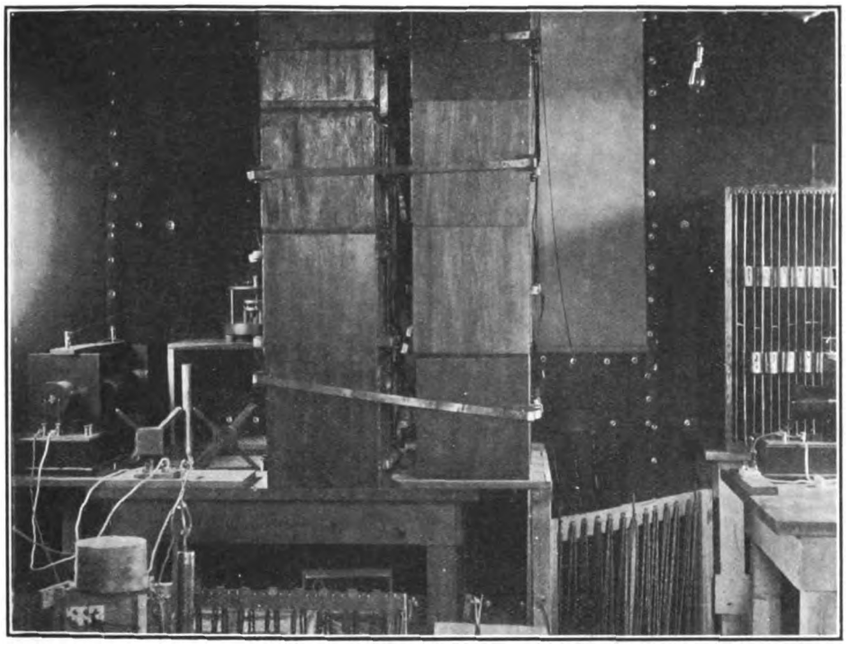

FIG. 4.—ANOTHER SET OF SENDING APPARATUS AT CAMBRIDGE, MASS.

resistance of this is removed from a point where it would greatly interfere with

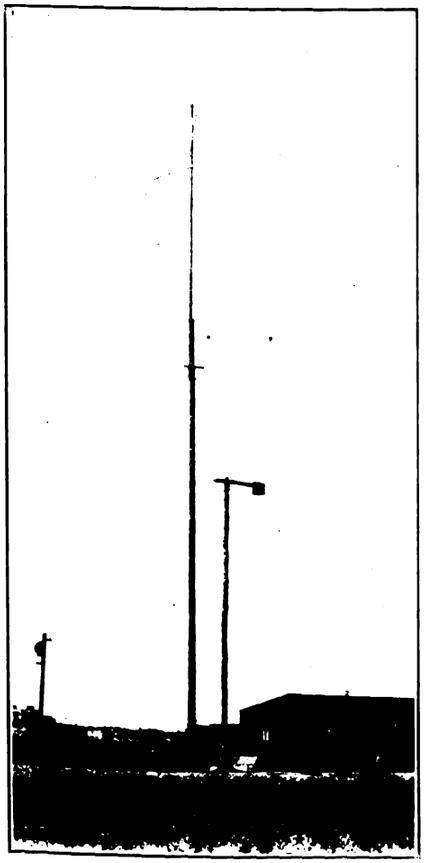

FIG. 5.—SENDING STATION AT CAMBRIDGE, MASS.

the wire by the waves radiated from the sending wire.

This arrangement of circuits having been adopted, the problem was reduced to that of constructing a resonant circuit, the oscillations of which would follow the sine law. To do this all reactions which would distort the oscillations must be eliminated. Thus it was found that the ordinary condensers could not be used, because distortion was produced by the dielectric hysteresis which, although inappreciable at commercial frequencies, becomes serious at the high frequencies used in wireless telegraphy. Mr. Stone has accomplished this by constructing condensers the dielectric of which is air. These condensers are built up of glass plates covered on both sides with tin-foil. In using these condensers at high voltages ionization of the air took place at first at the edge of the tin-foil, but this trouble has been entirely done away with by coating the edges of the tin-foil with beeswax.

Another difficulty encountered in designing circuits is that of reducing the reaction of one coil upon another. If two circuits are tuned independently to a definite period and are then brought near together, the mutual induction of the two upsets the previous adjustment. To get around this it is necessary that the mutual induction be kept small; but if the mutual induction is small, the electromotive force generated in the coil which is acting as the secondary is also reduced. A study of this problem indicated that if two coils, in one of which oscillations are being set up and by it impressed upon the second, are placed close together and then moved apart, the oscillations in the second will die away gradually as the distance between the coils increases, until a point is reached where they begin to increase. Moving the coils further apart, these oscillations very rapidly rise to a maximum, and as rapidly die out. Moving the coils still further apart, a second maximum point may be found. This effect is due, of course, to the decrease in the mutual induction, which at some point allows the coil to oscillate in its natural period. In this way, although the mutual induction between the coils is small, the necessary high potential is obtained by the resonant rise in the coil, and yet distortion of the wave-form is prevented. Experimental study of this gave results entirely confirming the theory. Another advantage of these simple vibrations is that they persist for a longer time, another essential in selective transmission. It has been estimated by Mr. Stone that he obtains as many as 200 oscillations for each discharge of the condenser. With this construction of the resonant circuit, in which hysteretic loss is avoided and the disturbance due to mutual inductance reduced to a minimum, two or more coils may be used in series, each succeeding coil weeding out any distortions which may have passed through the preceding one, and thus impressing upon the aerial a pure harmonic oscillation.

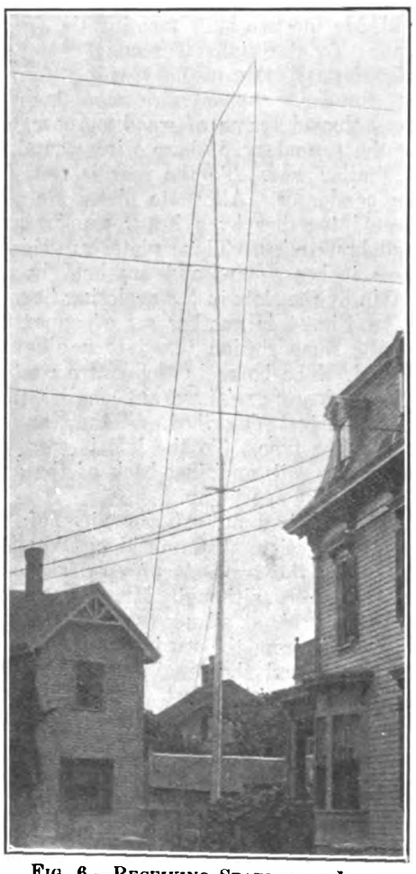

FIG. 6.—RECEIVING STATION AT LYNN, MASS.

The same general plan is adopted for

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the receiving circuits. The aerial is connected to the ground through one coil, which forms the primary of a transformer, the secondary of which forms part of a resonant circuit. This arrangement was shown in Fig. 2, where M is a transformer; CC condensers, and L an adjustable inductance; *k* is the coherer connected around one of the condensers where the greatest rise of potential takes place; B is a battery, and R is a sounder for indicating when the coherer has been affected.

In this system, as the constants of the vertical wire play no part in determining the period and character of the oscillations, the length of this wire is immaterial. Thus, at the sending station, located at Cambridge, Mass., this wire is about 100 feet long, while at the receiving station at Lynn it is about ninety-four feet. In Fig. 3 is shown one set of apparatus tuned to a definite frequency at the sending station at Cambridge. In front is seen the step-up transformer or induction coil. In the present work a clockwork mechanism, not shown, makes connection with this coil every five seconds by closing a mercury switch. The mercury is at the bottom of the water column, and the hydrostatic pressure of the water forms a very effective brake. Back of this, and just above the coil, are the two balls forming the spark-gap. To the right is seen the step-up transformer, the primary being formed of standard copper wire wound on a cross-shaped frame of wood. Above this is the secondary of bare wire wound in a similar way. To the rear is seen the air condenser. Alternate plates are connected together by a heavy copper band and brass clips. These plates are thirty-four inches square and are held in position by the slots in the enclosing box.

In Fig. 4 is another set of apparatus at the same station tuned to a different period. The boxes in the centre contain the condensers. These are smaller than the one just described, as they are of an earlier type. To the left is seen the induction coil, and just back of the condensers, the spark-gap.

Fig. 5 gives an exterior view of the sending station at Cambridge. Vertical wires for the two sets of apparatus are in duplicate, although Mr. Stone does not think this at all necessary. They are suspended from the yard near the top of the mast, and the length, as mentioned before, is about 100 feet. The aerial current is carefully grounded under the house.

The small pole shown between the house and the larger mast is the mast which was used in earlier work for signaling to the old receiving station, which is about a quarter of a mile north of the house seen here. Between these two stations runs a trolley line, but this in no way interfered with the operation of the system.

Fig. 6 shows the receiving mast at Lynn. Lynn was selected as the point for establishing a receiving station because of the disadvantages presented to wireless transmission from this point to Cambridge. The distance is about ten miles, and the air line passes over Cambridge, part of Boston, part of Lynn, and a number of trolley lines, one of these running just outside of the station at Lynn.

In Fig. 7 is shown one set of the receiving apparatus at the Lynn station. On the central cross-shaped frame is the primary of the transformer which is connected in series with the vertical wire. On each side of this is a coil which forms part of the resonant circuit in connection with the air condensers shown below. In front is seen a telegraphic sounder which acts as an indicator, and a decoherer. The decoherer is a simple tripod of steel needles resting on the aluminum plate just to the right of the sounder. To the right is the relay, which is a modified lines, although when the coherer is connected directly in the aerial its behavior is very erratic, and the passage of a car along the neighboring trolley line seldom fails to operate it.

The behavior of the apparatus can be clearly shown by changing the capacity of the condenser in the receiving circuit when in operation. If while the signals are being received the condenser plates are shifted slightly, the signals at once cease. Moving the plates back to the original position causes the signals to commence again. When signals are sent by one set of apparatus, tuned to one frequency, they do not affect at all the receiving apparatus tuned to the other frequency; but, by moving the plates of the condenser in the receiving circuit, this can be tuned to the frequency of the signals, and the sounder at once responds.

To sum up, in this system Mr. Stone has constructed an oscillating circuit which gives simple harmonic vibrations

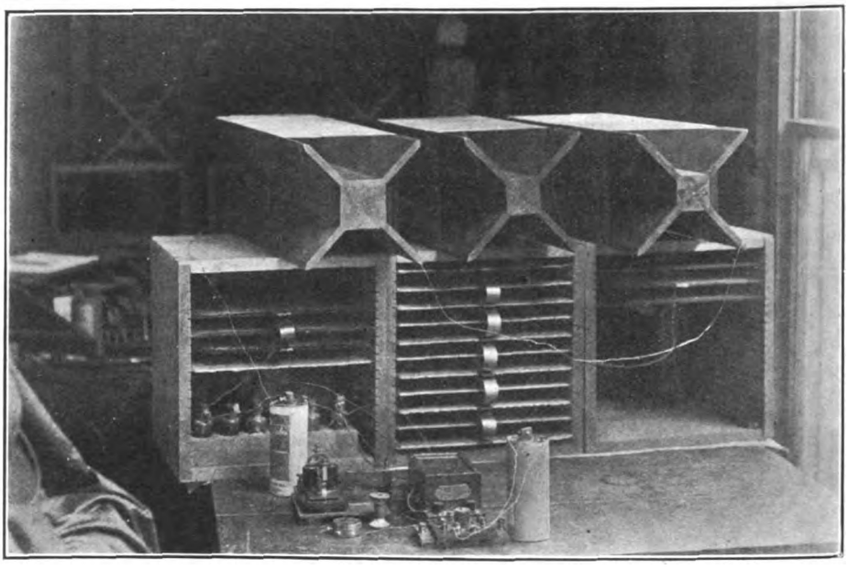

FIG. 7.—RECEIVING APPARATUS AT LYNN, MASS.

Weston-d'Arsonval galvanometer. To the front of this relay is a battery and a potentiometer for obtaining a suitable potential across the coherer. Across the relay is connected a condenser which thus practically short-circuits it for the high-frequency oscillations set up in the resonant circuit, thus eliminating the relay resistance. Back of the sounder is the battery for operating it, and back of that, an electrolytic condenser which, in connection with a resistance, is used to prevent sparking at the relay terminals.

This apparatus is in tune with one set of sending apparatus at Cambridge. There is a second set at this station in tune with the other sending apparatus. The two are adjusted to a difference in frequency of about twenty per cent. Signals can be sent by either set of sending apparatus, and are then received by the corresponding receiving apparatus, without at all affecting the other set. Neither is the work of this apparatus interfered with by the various trolley by eliminating the effects of hysteresis and mutual induction. He secures a high potential by taking advantage of the resonant rise of potential in his two circuits. To actuate the receiving device he depends upon a carefully tuned resonant circuit which responds to the comparitively long series of waves sent out from the sending station, but is not affected by sudden oscillations of a short duration. By using a resonant circuit entirely independent of the aerial, the deleterious effect of the distributed capacity of the latter and the high resistance of a spark-gap in this circuit are eliminated, and the frequency of the electrical oscillations taking place in the apparatus is independent of the height and electrical constants of the vertical wire. While all the experimental work has not yet been done, enough has been accomplished to indicate the practicability of selective wireless telegraphy by means of properly constructed and properly adjusted sending and receiving apparatus.

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The Ohio Electric Light Association.

The Ninth Annual Meeting of the Ohio Electric Light Association Was Held at Hotel Chittenden, Columbus, Ohio, on October 13-15, 1903.

THIS association, comprising as it does in its membership all of the principal central stations of Ohio, always holds interesting meetings, and this was no exception. The programme was a departure from the ordinary in that it gave considerable attention to the boiler and engine-room economy and equipment. The attendance, however, was not what it ought to have been, and it is thought by some members that the dates are set too late in the fall, when the busy season keeps many from attending.

The following active members were in attendance:

Geo. Hayler, the Gas L. & P. Company, Van Wert; W. F. Hubbell, of H. H. Williams & Company, Wauseon; E. H. McKnight, of the L. E. B. G. & N. Ry. Company, Bowling Green, and the Middleton E. L. & P. Company; Geo. Matt, Lancaster El. Lt. Company, Lancaster; H. Smith, Mansfield Ry. L. & P. Company, Mansfield; S. M. Rust, Piqua Elec. Company, Piqua; L. G. White, J. M. Plaisted, V. S. Kohler, the Columbus Railways & L. & P. Company, Columbus; M. E. Turner, Cleveland Elect. Ill'g Company, Cleveland; E. F. Gwynn, Delaware Elec. L. & P. Company, Delaware; E. J. Bechtel, Toledo Railways Company, Toledo; J. H. Perkins, E. H. Bell, the Youngstown Consolidated Gas & Elec. Company, Youngstown; A. C. Blinn, Sandusky Gas & Elec. Company, Sandusky; D. L. Gaskill, John Riddle, Greenville Elc. Company, Greenville; C. R. Lutz, Citizens' Elec. Lt. Company, Logan; F. E. Valentine, Urbana Elect. L. & P. Company, Urbana; E. W. Plaisted, Frank Espy, Kenton Gas & Elec. Company, Kenton; A. W. Field, Columbus Edison Company, Columbus.

SUPPLY MEN IN ATTENDANCE.

Adams-Bagnall Electric Company—W. V. Orr, Cincinnati; F. L. Druliner, Cleveland.

American District Steam Company—H. B. Kimbrough, Chicago.

Bryan-Marsh Company—F. H. Haughton, F. W. Godfrey, Cincinnati, Ohio.

Buckeye Electric Company—R. M. Barwise, Cleveland; R. M. Hemming, E. E., Columbus.

Babcock & Wilcox Company—W. D. Chester, Pittsburg, Pa.

F. Bissell Company—C. M. Hamilton, Toledo.

Crocker-Wheeler Company—H. A. Brown, E. E., Chicago.

Hart Manufacturing Company—William Crichton.

Doubleday-Hill Electric Company—C. P. Hill, Pittsburg; Elliott Reynolds.

Electric Appliance Company—O. T. Kimmel, Columbus, Ohio; Perry R. Boole, Chicago.

Erner-Hopkins Company—W. A. Hopkins, Jr., Columbus.

Fort Wayne Electric Works—T. J. Ryan, Cincinnati; George B. Edgar, Cincinnati.

G. I. Arc Light Company—W. F. Geddes, 3d, Cleveland, Ohio; H. B. Coles, Cincinnati.

General Electric Company—W. M. Demming, manager; W. J. Hanley, H. C. Houck, S. D. Gilbert, Cincinnati; Matthew O. Troy, Schenectady, N. Y.

Kuhlman Electric Company, Elkhart, Ind.

W. G. Nagel Electric Company—W. G. Nagel, E. J. Paradis, J. M. Wood, Toledo, Ohio.

Post-Glover Electric Company—Charles S. Kuntz, Cincinnati.

Nernst Lamp Company—D. D. Strite, Pittsburg.

National Electric Company—Charles G. Burton, Chicago.

National Carbon Company—F. H. McDowell, Cleveland.

Otis Elevator Company—A. H. Wright, Cleveland.

J. A. Roebling's Sons Company—W. P. Bowman, I. W. Brooks, Cleveland, Ohio; W. W. Affleck, Cleveland, Ohio.

Standard Electric Company—P. J. Williams, Cincinnati.

Stanley Instrument Company—F. J. Alderson, Great Barrington, Mass.

Stanley Electric Manufacturing Company—O. H. P. Fant, Cincinnati.

Sprague Electric Company—O. P. Fant, Cincinnati.

Westinghouse Traction Brake Company—Wm. D. Ray, Cleveland.

Western Electric Company—Charles W. Cobb, Cleveland.

Westinghouse Electric and Manufacturing Company—Nathaniel Paige, Jr., Leon Goldsmith, Columbus, Ohio; J. W. Schrantz, Cincinnati; K. C. Randall, E. E., Pittsburg.

Lehman B. Holt, C. E., Cleveland, Ohio.

It will be seen by the above list that the meeting was well attended by representatives of companies dealing in electrical supplies and materials.

The General Incandescent Arc Light Company exhibited its multiple alternating-current and direct-current lamps in operation, and series alternating-current arc lamps in both shunt and differential types; showing the knife-switch, automatic switch, remote control; also Wright-demand meter.

Roeblings made no display, but distributed souvenir wire gauges. These were in great demand.

The W. C. Nagel Electric Company, of Toledo, exhibited the Nernst lamp in operation in various sizes.

The General Electric Company had a special display of its new Meridian lamp and its concentric light diffuser.

The Stanley Electric Manufacturing Company exhibited a line of meters in operation.

The Bryan-Marsh Company had on exhibition its new type lamp, burning out at the eighty per cent line of initial candle-power.

The exhibit of arc lamps by the Adams-Bagnall Electric Company, of Cleveland, handled by the Electric Appliance Company, of Chicago, was very complete. Here were also shown the Gutmann wattmeter and the Packard incandescent lamp and transformer.

The National Electric Company, of Milwaukee, showed a line of enlargements representing its various types of direct-current and alternating-current generators and motors, belt-driven and engine type. The company also gave away steel tape-measures to all callers.

The above were all the regular exhibits, but the traveling men from the other houses represented were attentive and ever present and made up in personal attractiveness what they lacked in material exhibits.

A theatre party was given Tuesday night by courtesy of the Erner-Hopkins Company, the Columbus Railways and Light Company and the General Electric Company.

The Engineers Club, of Columbus, offered the use of its rooms, and the president and faculty of the Ohio State University received the members of the association as guests on Wednesday evening.

Officers elected during the session for the ensuing year are as follows:

President, S. M. Rust, Piqua.

Vice-president, J. H. Perkins, Youngstown.

Secretary-treasurer, D. L. Gaskill, Greenville.

Advisory committee: D. L. Gaskill, Greenville; Samuel Scovil, Cleveland; L. G. White, Columbus.

Executive committee: A. W. Field, Columbus, Ohio; W. F. Hubbell, Wauseon; A. C. Blinn, Sandusky; J. F. Bendure, Lima; C. Johnson, Akron.

Finance committee: E. H. McKnight, Middletown; Edward Plaisted, Kenton; E. F. Gwynn, Delaware.

President A. W. Field, of Columbus, in his annual address briefly reviewed the objects of the association, the fostering of the common interests of its members, the advancement of scientific and practical knowledge in matters relating to electric light and power companies, and the establishment of cordial and beneficial relations with kindred associations.

Mr. W. D. Chester, of Babcock & Wilcox Company, Pittsburg, read a paper on "Steam Boilers for Power Plants," in which, after commenting on fuel values, he passed to a consideration of various types of boilers, and after referring to the advantages of superheated steam, predicted that in the near future results would be obtained with superheated steam of one pound of coal per indicated horse-power on daily average running.

Mr. D. S. Kohler, of the Columbus

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Railways and Light Company, opened the discussion, and asked if the essayist had any data as to amount of saving from use of superheaters and as to how the superheaters made by his company compared with those known as independent superheaters.

Mr. Chester stated that his company made both kinds, but the separately fired had not met with much success. A test of a McIntire compound steam engine in Columbus, after running the same battery two days not superheated, and then two days superheated, showed a saving of ten or eleven per cent in pounds of water evaporated per kilowatt generated.

Professor Hitchcock declared in favor of a fire brick arch or Dutch oven Turner furnace, especially with use of bituminous coal, as a means of protecting the heating surface and tending to distribute the heat better.

Upon again assembling on Wednesday, the first paper read was by Mr. E. J. Bechtel, of the Toledo Railways Company, on "Engine Economy and Equipment." Mr. Bechtel seems to regard with some favor the possibilities of the steam turbine for central station requirements, their capacity at present being limited to 500 kilowatts per unit for direct-current work; gas engines were a doubtful factor; it is necessary to carefully weigh all conditions in deciding upon equipment, and after all the economy of the plant depends largely upon the personal equation of the operating force which it is peculiarly desirable to carefully select. Men should be treated so as to ensure their feeling that no favors would be shown, but their advancement would depend upon merit strictly.

Professor Magruder, of the Ohio State University, being invited to speak upon the subject, came to the rescue of the gas engine; he thought unfavorable opinions had come from gentlemen who were unfamiliar with the gas engine's capabilities. He instanced a plant in Lancaster, which had been using gas engines for five years for electric lighting work satisfactorily. Gas engines of 150 horse-power had worked on about ten cubic feet per brake horse-power-hour, which he considered was equivalent to something under twelve pounds of steam per brake horse-power-hour; so that when it came to the question of heat units the gas engine can deliver the goods. One of his German friends had written that he had designed a 5,000-horse-power unit, and one of his own students had designed a forty-five by fifty-four, crank-pin twenty inches in diameter, that is being built by the Allis-Chalmers Company. The foreign makers were guaranteeing regulation of their gas engines, and in America there is a great future for the gas engine.

The paper by Mr. J. H. Perkins, of the Youngstown Consolidated Gas and Electric Company, illustrated the advantages to be derived in a plant of average size by combining all classes of service in increasing the load-factor, and showing how the plant has developed from one of small capacity operating many kinds of service from as many types of machines to one of comparatively large capacity operating all classes of service from only one type of machine. Within the past three years the Youngstown plant has discarded all belt machines and all generators of any kind other than the two-phase alternating-current type. Their commercial series arc light machines have been thrown out in favor of constant-potential alternating-current arc lamps on meter; while the direct-current series open arcs for street lighting have been replaced by constant-current alternating-current apparatus. All possible direct-current power service has been changed by the use of single and two-phase motors, the remaining 500-volt direct-current service being furnished by rotary transformers, so that the prime movers may all be of the same type.

Questions were asked by Messrs. Bechtel, Hayler, Bailey, Professor Caldwell, and Mr. McKnight, which were replied to at some length and in elaboration of the facts stated in the paper. He stated that they had to-day practically no trouble with their rotaries, although they had at first experienced some by reason of their not operating on the vertical engines. Some of his substations are not inspected once in three months because not found necessary. They were understood to be the pioneers in the operations of sixty-cycle rotaries, and had now found how to operate them without any trouble, the commutator being the principal thing that requires watching.

The paper by Mr. George Hayler, Jr., of the Van Wert Gas, Electric and Power Company, on "Steam Records" was listened to with close attention. The writer believed that it is altogether due to the intelligent study of proper records and the application of the knowledge derived therefrom that the cost of producing electrical energy has reached the low figure quoted by some of the larger companies. The smaller companies would do well to look after this question of records more thoroughly. Mr. Hayler gave many suggestions of a practical character looking toward the detection and remedying of waste, and summarized the details which, in his judgment, the average central station throughout the country should make a matter of record.

Mr. A. C. Blinn, of the Sandusky Gas and Electric Company, read a paper on "Value of Station Records." He contended that this was as essential to the proper operation of a small as of a large plant, that complete records be kept and carefully studied daily. This is the only way in which to work intelligently toward broadening the peak, and stopping little leaks in consumption which at the end of the year have a very material effect upon the balance-sheet; where records are lacking a prospective buyer instead of being hoodwinked is rather all the more apt to depreciate the true value of the plant upon the assumption that there is something wrong where no records have been kept. As a means of discipline close attention to the matter of keeping a record has a salutary effect upon employés; it is also valuable in convincing employés of their own derelictions or shortcomings which otherwise they would charge up elsewhere. The cost of installing a complete system of records is trifling in comparison to the advantages derived, provided the information compiled is intelligently studied and availed of.

The paper by the Hon. D. L. Gaskill, on the "Municipal Code of Ohio," as affecting electric light plants of the state, was a comprehensive résumé of the subject. The writer said that in many ways the new code had proved a disappointment.

These papers rounded out the morning session of Wednesday, and recess was taken until 2 P. M.

The first paper of the afternoon session was that by Mr. K. C. Randall, of the Westinghouse Electric and Manufacturing Company, Pittsburg, Pa., on "Some Practical Considerations and Applications of Transformers." The writer took up four points as of especial interest to the station operator: (1) the first cost; (2) amount of power consumed in losses; (3) the continuous and overload capacity; (4) the life of the transformer. These were considered with reference to different classes of service, attention being paid to the time of heavy load and light load; also to the requirements where overload might exist. By means of definite examples the relative value of two transformers was illustrated; also the su-

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periority of a transformer which normally operates at a low temperature rise, and, therefore, having large overload capacity, over one with a high temperature rise, and, therefore, little or no overload capacity. As a summary, durability, life and low temperature were shown to be practically synonymous and the result of low losses in a good design.

The paper further stated the importance of replacing many small transformers by a single larger one, and illustrated this by a definite example showing the actual monetary gain by such a change, as well as the gain due to putting several transformers in reserve which were replaced by the single larger transformer.

In the discussion Mr. Troy, of the General Electric Company, Schenectady, asked if the other qualities of a transformer, such as regulation, C^2R loss, etc., might not be limiting features just as much as heating? Most central station men are equally concerned with the matter of regulation and copper loss. The overload capacity of a transformer is just as much a function of the regulation and C^2R loss as it is of the heating. Mr. Troy urged the necessity and desirability of a fixed standard of temperature on which to base regulation and efficiency of transformers under discussion. If such a universal standard was accepted he thought the standard set by the American Institute of Electrical Engineers, namely, fifty degrees centigrade maximum rise, is the logical one to accept.

Mr. Troy thought that in operating a line containing transformers of various ratios the lamps on the line would be subjected to dangerous voltages under light load conditions, and it might well be asked, how much would this voltage vary during different parts of the day in the example cited by Mr. Randall, where transformers of three different ratios, nine, nine and one-half and ten to one were used on the same line? Would not the saving in line construction be more than offset by the poor all-day efficiency of the transformer, etc.?

Mr. Randall replied that as to using a nine to one ratio all over a community instead of just at different places, if used all over the iron losses which are pointed out as being very prominent would be increased, but would even then be quite low, while the gain in regulation and gain in reduced copper loss would perceptibly offset the iron loss, and there would be better regulation, which would be a substantial gain. In reply to a question by Mr. Hoit, regarding the relative efficiency of a fifty per cent and a 150 per cent load, that Mr. Randall said would depend upon the proportions of iron and copper loss. Assuming a transformer with an iron loss of say one and one-half per cent, and a copper loss of say two per cent, at one-half load the iron loss would come down about sixty-six per cent or just about to one per cent, and the copper loss would go up to about four and one-half per cent.

Mr. Turner thought that regulation was one of the most vital points in the distributing system; if you can not maintain a uniform voltage on your distributing system, you lose one of the great advantage that electric light has in competition with other illuminants. If at light load the lamps will receive a very high voltage and are burning at standard voltage only at the time of maximum load, it not only means that the lamps' life is shortened, but that those customers who have their maximum current at an earlier period than others will notice the difference between the candle-power of their lamps at one time of the day and what it is at another time. The question of candle-power is mostly one of comparison. The best way to maintain a distributing system is by the use of feeders and subfeeders; otherwise uniform voltage can not be maintained.

In the absence of Mr. Mosman, of the General Electric Company, Schenectady, Mr. Troy read his paper, "Notes on Certain Three-Wire Systems."

Mr. Bechtel stated that in Toledo they used a three-wire direct-current system for downtown lighting business districts, and a single-phase alternating-current in the residence portion. Have three-phase four-wire generators; balance, single-phase. Feeder lines are arranged with main feeders and subfeeders on the primary mains so as to give as nearly equal distribution over the whole territory as possible. The three-wire direct-current system is entirely underground; it is an interconnected network, mains fed at different points from the station by three-wire feeders. Have a rotary converter as a tie in between the two systems. It will convert alternating current to direct-current, or vice versa, making a flexible system and requiring somewhat less machinery for peak load; peak on the direct-current is at 5.30 in winter time, and on alternating current about 8 o'clock. That in a measure does away with duplicate machinery.

The session closed with the reading of a paper by Mr. Lehman B. Hoit, C. E., of Cleveland.

The Thursday morning session opened with routine reports, that of the secretary-treasurer, Mr. Perkins, showing a healthy balance in the treasury, and was referred to the finance committee.

The executive committee asked that the matter of fixing time and place of next annual meeting be referred to the incoming executive committee, which was concurred in.

In the absence of Mr. W. F. Raber, of Mansfield Electric Light and Power Company, his paper entitled "Electrical Distribution in the Engine Room" was read by title and authorized to be included in the regular minutes.

Professor F. C. Caldwell, of the Ohio State University, read his paper entitled "The Combined Use of Alternating and Direct Current for Central Station Work." The paper was a comprehensive one, and listened to with interest which was heightened from the fact that both on the occasion of this and former meetings Professor Caldwell has entertained the members of the association at the University in conjunction with other members of the faculty. The following members of Professor Caldwell's senior class in electrical engineering took part in the discussion: J. G. Campbell, G. M. Cameron, C. F. Kettering, H. S. Bostater, W. A. Schertz, J. S. Riddle, E. W. Benedict, A. S. Stewart, L. S. McGarey, T. Crocker, W. Kalb, Edward Sill, J. W. Gwynne, Fred Nesbit, H. L. Beach, J. E. Powell, F. B. Pelton and W. Kempton.

Mr. M. C. Hull, of the Columbus Railways and Light Company, read a paper entitled "Methods and Means of Securing New Business." His suggestions were practical, especially that in reference to cultivating the architect, and looking after the electric wiring of all new houses, many of which but for such precaution being taken would be finished without wiring.

In discussing the paper Professor Caldwell said that the great convenience from the use of electric current was a point that could never be overdrawn when approaching a customer, especially in a natural gas territory where there was so much to contend with; the case of turning on an electric light in a cellar or any remote part of the house without striking a light was a great inducement as a matter of convenience.

The convention adjourned to meet at such time and place as may be hereafter determined by the executive committee.

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Reviews of Current Engineering and Scientific Literature.

A Double-Frequency Generator.

In the issue of the ELECTRICAL REVIEW of October 10, a review is given of a serial by Mr. E. J. Brunswick on the application of polyphase motors to driving centrifugal drying machines in the sugar refinery at Cambrai, France. These motors are started by connecting them successively to circuits which are supplied at frequencies of twenty-one, thirty-five and fifty cycles per second. The latter frequency is the standard for the refinery, and the two lower frequencies, used for starting only, are given by a single double-frequency generator. This is a machine of the inductor type, having two stationary armatures and a revolving inductor with two sets of poles. The machine is excited by a single fixed field winding, current for this purpose being drawn from an exciter mounted on an extension of the generator shaft. The generator is rated at 300 amperes at 150 volts, twenty-one cycles, and 300 amperes, at 250 volts and thirty-five cycles, in each case with a power-factor of 0.6. One end of the rotor has three poles and the other five. The interior diameter of the armatures is 1.10 metres. The twenty-one-cycle armature has seventy-two slots, with a six-pole winding connected in star. The thirty-five-cycle armature has 120 slots, with a ten-pole winding connected in star. This size of generator was decided upon in order that it might furnish power to more than one motor at a time. The machine is used for starting twelve motors rated at thirty-five horse-power each, and which are designed to bring the centrifugal machines up to full speed within one minute. —*Translated and abstracted from l'Electricien (Paris), September 26.*

Chemical Valency, Electrical Conductivity and Hardness of Metals.

This is a theoretical consideration by Mr. John G. A. Rhodin, of the molecular structure of matter, the aim being to connect in some way the chemical, electrical and mechanical properties of various substances. The author assumes metallic induction to consist in a harmonic vibration of the molecules. As the adjacent ones come in contact, the electrons are passed from one to the other under the influence of the electrical stress. The author deduces equations from this assumption, and reaches the conclusion that the hard metal has more complicated molecules than the soft one, and will therefore have a higher resistance, since the mobility of the molecules must be less. Non-conductors, as a general rule, have molecules of unusual magnitude. To elucidate the difference between metallic conductors and all other substances; the following criteria are suggested: All metallic conductors are composed of ultimate particles which can act as cathions without the intervention of other elements. The ultimate particles are thus electrically uniform. All electrolytic conductors are composed of ultimate particles of two kinds—one or more cathions and one or more anions, which readily dissociate by the influence of a solvent or fusion. They are thus electrically binary. All dielectrics are characterized by an exceptional resistance offered by their ultimate particles against molecular motion, depending upon either the exceptional size and mass of its molecular combinations, if solid, or internal friction if liquid. They are electrochemically uniform. The electrical behavior of any substance is a function of the absolute temperature.—*Abstracted from the Electrochemist and Metallurgist (London), September.*

Electricity Supply in Milan.

The hydroelectric station at Paderno, Italy, transmits the greater part of its output to Milan. This is conducted to the station at Porta Volta, where there is an auxiliary steam plant. The rated output of this steam equipment is 13,000 horse-power. The most recent additions to this are a Parsons turbine of 3,000 horse-power, coupled to a Brown alternator and a Parsons-Brown turbo-alternator of 4,-500 horse-power. These are run condensing, jet condensers being used, the pumps being driven by geared induction motors. Power is received from Paderno at a pressure of 12,600 volts, and is transformed down to 3,700 volts, there being twenty 400-kilowatt transformers grouped in parallel and connected to the station bus-bars. Power from this station is supplied to 3,000 three-phase motors, representing over 10,000 horse-power, compared with which the 77,000 incandescent lamps and 725 arc lamps are of secondary importance. The Santa Radegonda station supplies direct current by means of motor-generators to the amount of 2,500 kilowatts for traction and 1,870 kilowatts for lighting, supplemented by Tudor batteries of nearly 2,000 kilowatts for traction and 2,500 kilowatts for lighting. This station supplies 80,000 incandescent lamps and 1,000 arc lamps, as well as 300 cars. Besides the supply to Milan proper there is a large demand from the surrounding districts. The principal tramway line outside of the city is that which runs to Monza. This is supplied through the substation of Sesto San Giovanni, which is equipped with synchronous converters and a large storage battery. The whole undertaking has a maximum load of 16,000 kilowatts.—*Abstracted from the Electrical Review (London), September 25.*

Motor Car Reliability Tests in England.

The object of the Automobile Club, under whose auspices a series of reliability tests was conducted recently in England, is to give the public an opportunity of ascertaining which is the best and most reliable car obtainable. Brake, noise, vibration and dust trials were held at the Crystal Palace grounds, and these were followed by reliability tests extending over several days. The first day's journey was to Margate and return, a distance of 150.5 miles, and was performed in fine weather. One hundred and four cars started. Several were in difficulties toward the end of the day, and the official summary showed that thirty-five cars made non-stop runs, twenty-six had trifling stops, and twenty-eight longer delays not of a protracted character. On Friday ninety-three of the original 104 started on the second day's journey, which was to Osbourne and back, 121 miles. Twenty-three cars returned to the palace within the specified time, fifty returned with trifling delays, and fifteen returned later. On Monday eighty-six cars started for Worthing, 118.75 miles, and it was during this journey that the most difficult hill-climbing test took place. After leaving Dorking the hill rises toward Bury 338 feet in three-quarters of a mile, with an average grading of 1 in 11.74, but with some sections as steep as 1 in 8.75. This hill showed that some of the less expensive lighter and less powerful vehicles could do just as good work as the more expensive, and that much depended upon the skill of the driver. The results at night-time showed that thirty-eight cars made non-stop records, and forty-two were delayed by a few minutes. On Tuesday the course was laid to Folke-

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stone and back, and eighty-four cars started. This route has many sharp turns, so that the skill of the drivers was put to test. Thirty-nine cars made the trip without stopping, and thirty-two had delays of a few minutes. On Wednesday the route was to Southsea. On Thursday seventy-seven cars started on the run to Bexhiel and back. During this run a straight course for 880 yards allowed speed tests to be made. The cars had a flying start and some traveled at the rate of over forty miles an hour. The day's results showed that forty-six cars made non-stop records, and twenty-seven suffered slight delays. The results of this series of severe tests would seem to show that a marked advance has been made in mechanical efficiency and reliability.—*Abstracted from the Railway News (London), September 26.*

Preventing Disturbances to Telegraph and Telephone Systems Caused by Using the Earth as a Return.

In this article on electric trolley vehicles without rails, M. Emile Guarini describes a system which he has devised for the purpose of preventing disturbances to feeble electrical systems such as the telephone and telegraph, caused by other more powerful systems using the earth as a return. The means he has tested is analogous to the three-wire distribution system. It consists in dividing the current between two circuits, both earthed at each pole, the earth connections of the respective circuits at each pole having opposite polarities. The intensity of the current is substantially equal in the two circuits. A very sensitive galvanometer placed in circuit will not indicate any current. In other words, what is needed is to neutralize by a charge of contrary sign the charge which each ground of the galvanometer circuit receives from the current from the earth plate connected to the dynamo. The author does not think that it will be impracticable to use the ground return for a vehicle which does not run on rails, if the power is supplied at a high voltage. A bad ground connection will be immaterial when the pressure is thousands of volts. He has personally made experiments in wireless telegraphy from a moving vehicle, using a telephone receiver, and, as a return, the wheels of a truck resting on the street pavement. The potential was 30,000 volts, and no difference in the intensity of the sound given by the telephone receiver could be detected, whether the grounding was through the wheels resting on the pavement or through a rod sunk deep in moist ground.—*Abstracted from the Engineering Magazine (New York), October.*

Electrical Wiring Fire Risk.

The proper precautions to be observed when installing and for the care of electric wiring are here discussed by Mr. E. C. de Segundo. Experience has shown that a building lighted by electricity enjoys complete immunity from risk of fire, provided, always, that the erection of the wires and fittings has been carried out in a sound and workmanlike manner. If satisfactory work is to be done, attention must be paid to the following points—the means adopted for insulating wires, the means adopted to prevent mechanical injury to the insulation of the wires, the subdivision of the main circuit and the proportionate size of the conductor to the work it is to do, the means adopted to guard against accidental overloading of the conductor, the nature of the joints made in the conductors, the design of the fittings, with special reference to ease in wiring without injury to the conductor, the method of manufacture and erection of fittings and accessory apparatus, and the general scheme of wiring and method of fixing in place all of the wiring fittings, so as to avoid danger from the proximity of gas and water pipes and ironwork of all kinds. All these points are covered by the statement that the essential condition of a properly erected wiring installation consists in providing that the electric current be kept within its prescribed bounds, and that if by any contingency a way should be opened for the current to travel in an unauthorized direction, the supply should be cut off automatically and instantly. The conductor wires should be of copper and should carry the maximum current without any perceptible heating of the conductors to the touch. In addition to adopting a safe current density, a maximum fall of potential should be specified for any one circuit. Dampness must be guarded against, as it is most insidious in its action. It may arise from a variety of causes and, particularly in the case of new buildings, is apt to be of an acid nature. The author would like to see every wire in a house treated as if it were a submarine cable. Unfortunately, gutta-percha is useless for wiring houses, because it is extremely sensitive to the oxidizing action of the atmosphere and becomes plastic at a temperature only slightly elevated above the normal. The ideal method of wiring a building is to use nothing but the highest class vulcanized rubber insulation covered with a braid and enclosed in a continuous system of cold-drawn steel tubes, especially selected for smoothness of bore, with joint boxes inserted at all points necessary, so that the wires may be drawn in without injury and may be easily inspected. This system is somewhat costly, but according to certain estimates made by the author the increase in cost over the wooden moulding system was not more than twenty-five per cent.—*Abstracted from Insurance Engineering (New York), September.*

Electrical Towing on Canals.

Mechanical towing of boats on canals is not new. It has been tried on several well-known waterways with more or less favorable results, but little has been published beyond a mere description of the installation. M. Georges Petit describes the researches of M. Léon Gérard, who has made a careful study of the problem. Two systems of haulage are investigated—that in which the tractive motor runs over an ordinary towpath, and that in which rails are laid down for the motor. To determine the relative advantages possessed by the two systems it was necessary to compute the starting effort required and the average pull necessary to maintain the desired speed. The effort required to overcome the inertia of the boat is easily computed from its known weight. That required to overcome the friction of running water could only be determined experimentally. This was done by bringing certain boats up to a convenient speed, then cutting off the driving force, and allowing them to drift, the rate of retardation being noted. From the retardation curves the water friction was easily determined, and combining the results obtained in this way with the effort required to overcome the inertia of the boat, acceleration curves were obtained. This was done for empty and loaded boats, and the dimensions of the particular section of canal to which these results apply were given. From this study it was shown that it was theoretically impossible to obtain the necessary starting effort on rails without slipping, even with damp rails. It was found that a motor traveling on rails would be more economical than one running on an ordinary towpath, although the latter would give a greater tractive effort for a given weight without slipping. The system using rails will, of course, be more expensive to install, but will cost less to keep up, and, in the end, it is thought would be more economical. This study, it is believed, demonstrates the practicability of mechanical traction for canals, and seems to indicate that this will be the motive power of the future. An electrical system will be adopted, because this is reliable, efficient, and the most satisfactory method of supplying power to the motors.—*Translated and abstracted from the Revue Technique (Paris), September 25.*

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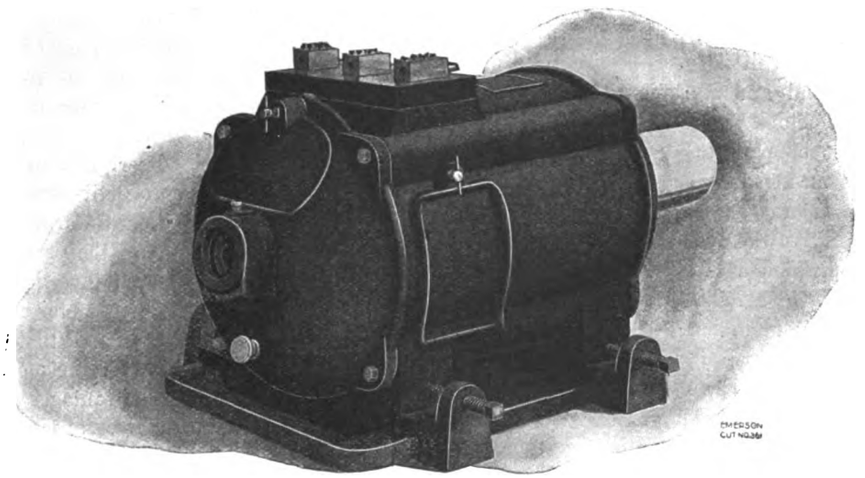
INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Slow and Medium-Speed Direct-Current Motors.

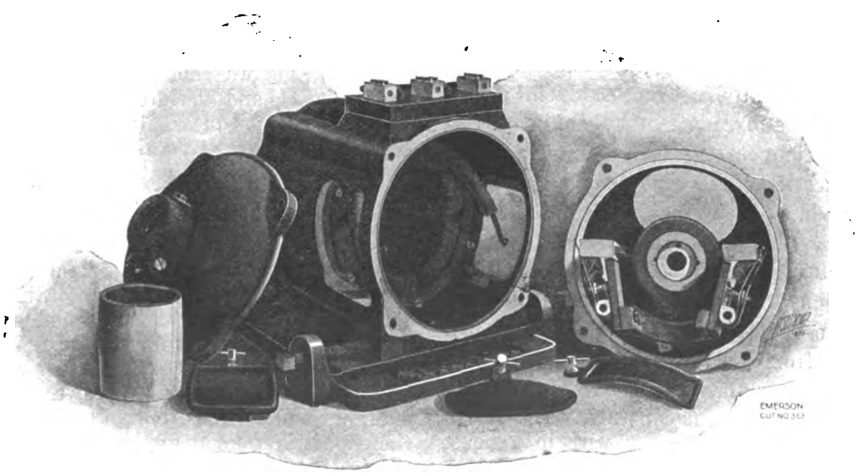
The accompanying illustrations show a typical direct-current motor for slow and medium speeds, which the Emerson Electric Manufacturing Company, St. Louis, Mo., is building for capacities from one-quarter to two horse-power. These motors are built in four sizes of frames, for both shunt and series or shunt and compound winding, and run on all standard voltages. They are the outgrowth of a line of smaller multipolar motors, a large number of which are now in service under severe and varied conditions.



SIX-POLE ENCLOSED MOTOR.

The design of these machines adapts them to any form of machine tool driving and where economy of space is a first consideration. One of the difficulties of direct-connection of motors to shop and other tools is solved by the design of the armature and commutator, which are mounted on a cast-iron sleeve, self-contained, instead of being assembled directly on the shaft. The shaft is pinned into this sleeve and may be readily removed and replaced by an extended shaft of the driven machine when desired. This arrangement eliminates all couplings and is accomplished without disturbing the relative positions of the armature and commutator.

The motors may be reversed by simply changing the connections of the armature on the binding-post plate, without removing the covers of the motor. Each plate is stamped "shunt" or "series" to indicate the winding of the motor, and also bears the word "reverse" close to the armature lead.



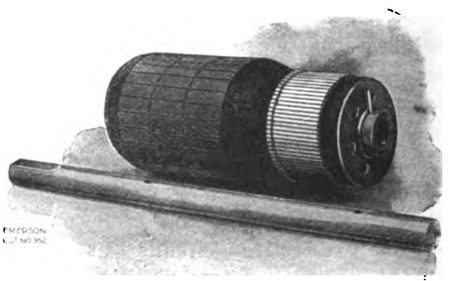
SIX-POLE ENCLOSED MOTOR, DISASSEMBLED.

The illustration shows a six-pole entirely enclosed motor. When ventilation is advisable the machine may be operated without covers as a semi-enclosed type. The field is composed of mild steel laminations having high magnetic qualities, and which are treated before being placed in the motor frame. The field coils are form-wound and heavily taped to prevent mechanical injury.

The armature is of the small engine type, having closed slots and no band wires. It is built of toothed laminations of mild steel, with coils dipped and baked and well insulated from each other and from the armature core.

The commutator is unusually large and is made from hard-drawn copper bars, with mica insulation.

Motors of one-quarter and one-third horse-power are fitted with three-quarter-inch steel shafts running in self-aligning phosphor-bronze bearings of the wick oil type. Larger motors are equipped with self-aligning oil-ring bearings and proportionately larger shafts. The end housings of the machines are concentric and may be moved one-quarter or one-half way round, keeping the oil wells upright if it is desired to operate the motor in an inverted or semi-inverted position.



ARMATURE FOR SIX-POLE MOTOR.

Carbon brushes of the radial type are supplied. The brush-holders are mounted on paper-insulating plates which give a long break for possible grounds likely to be caused by oil and dirt in the small enclosed motor. Owing to the design of the brush-holders, the motor may be reversed without readjusting the brushes. The rocker arm is set to the point of best commutation after test, but, if necessary, the brushes may be readjusted by loosening the thumb nut outside the cover. The brush-holder springs are of tempered steel wire, giving an even tension throughout the entire range of the brush, and are fastened directly on the fibre insulating plates holding the brush-holders. They carry no current and can not become heated from that cause.

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These motors, in sizes up to one-half horse-power, are furnished with three-inch iron flanged paper pulleys for two-inch flat belt. Frames larger than one-half horse-power are equipped with crowned face iron pulleys of four-inch diameter, four-inch face.

Each motor is thoroughly tested under full rated load before shipment, and is guaranteed to operate continuously under normal load without undue temperature rise. The motors are also guaranteed to carry an overload of fifty per cent for one hour without dangerous heating.

Motor-Driven Machine Tools.

The machine tool industry has witnessed a decided tendency toward the motor-drive within recent years, and the anxiety to keep abreast of improvements in this line has, no doubt, done considerable to induce the machine tool manufacturers to either make a line of motor-driven tools, or arrange their tools so that a motor can be attached, if the purchaser desires. The electric motor has come into the machine tool field to stay, and its application in this direction will increase with time. For example, take the shops power for operating all the tools in every shop. The accompanying illustrations are typical of recent practice in adapting the motor to machine tools.

Fig. 1 shows a No. 2 combination cold saw cutting-off machine, motor-driven, the machine being belted from the driving shaft to the armature shaft of motor.

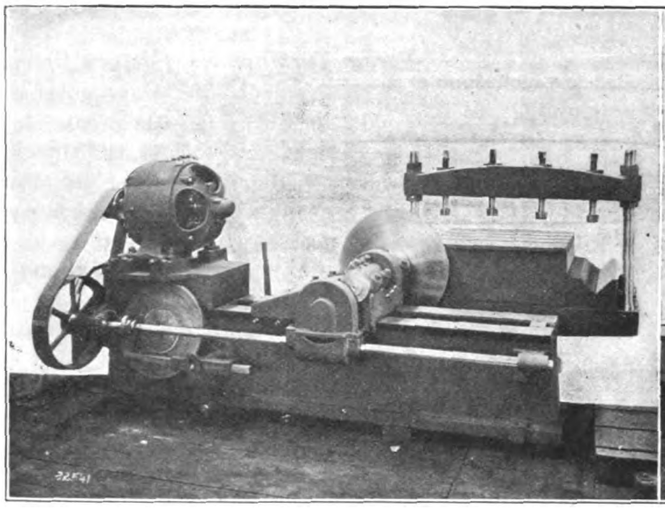

FIG. 1.—COMBINATION COLD SAW CUTTING-OFF MACHINE, MOTOR-DRIVEN.

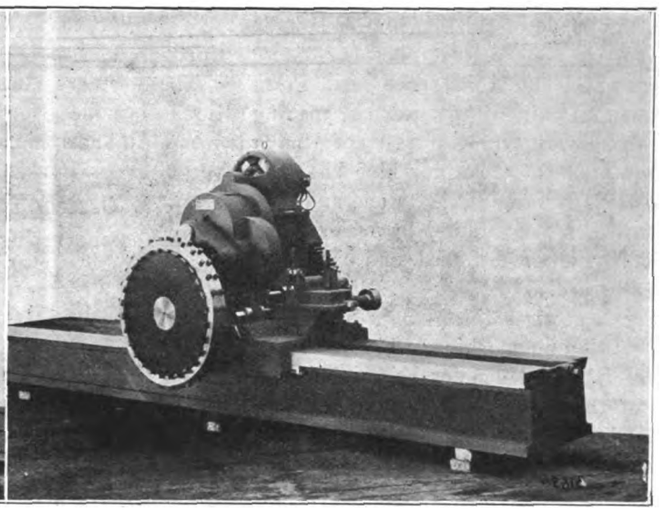

FIG. 2.—PORTABLE ROTARY PLANING MACHINE, MOTOR-DRIVEN.

This is a five-horse-power General Electric C. E. type, 250 volts, clamped to a base and has an adjustable movement which acts as a belt tightener. This machine is designed to accommodate a wide range of work, including round and square stock, to be held in V-block which clamps to the bottom table, I-beams, channel bars, etc. The machine has a capacity for I-beams and channel bars up to fifteen inches on a square or mitre cut, on bottom table up to an angle of forty-five degrees. By using the top or auxiliary table, as shown in the illustration, the machine can be used for cutting

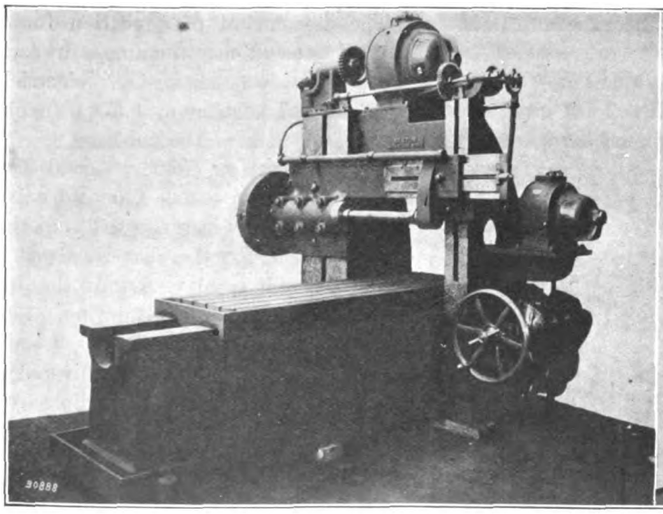

FIG. 3.—PLANE MOTOR-DRIVEN MILLING MACHINE

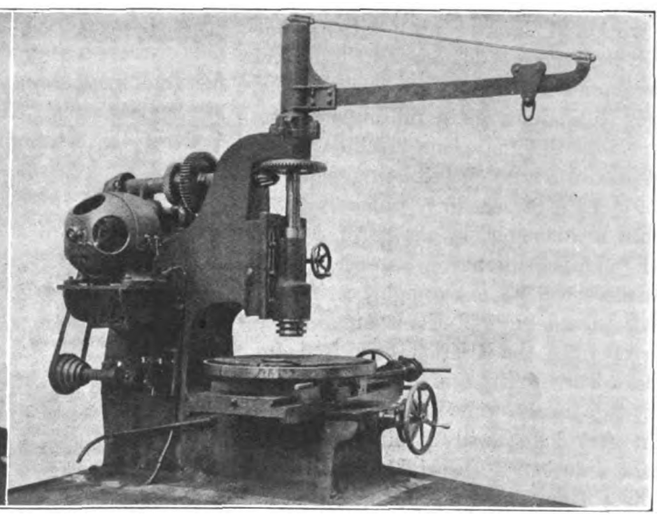

FIG. 4.—VERTICAL MOTOR-DRIVEN MILLING MACHINE.

New Revolving Electric Flash Light for the Lizard.

A revolving electric flash light of 1,000,000 candle-power is to be substituted for the two present fixed lights at the famous Lizard head lighthouse, at a cost of over $15,000. It is reported from London that the new light will be visible at sea for forty to fifty miles.

which the government is having erected at New Orleans, La. According to the plans and specifications prepared under the auspices of the Bureau of Yards and Docks, Washington, D. C., the only steam that will be employed for running various machines, no matter how intricate or cumbersome, will be produced for the sole and exclusive use of generating electric

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plates seven inches thick by twenty-four inches long, or an aggregate number of tee rails up to the capacity of the machine can be cut by clamping them on the top table. By removing the top or auxiliary table, the machine can be used for sawing a number of irregular pieces of work, such as gates or risers on steel castings, up to the capacity of the machine. The saw blade of this machine is spindle driven, by a steep lead, phosphor-bronze worm-wheel and a hardened steel worm through a train of cut gearing, making the drive very powerful and ensuring a steady even cut. The machine has suitable feeds from one inch to one and one-half inches per minute, by means of a variable friction disc feed, and has power quick return.

Fig. 2 shows a thirty-six-inch portable rotary planing machine, which is direct motor-driven, the motor being placed on top of the machine, as shown in the illustration, and driving a spindle through a train of cut gearing. The cutter-head, which is thirty-six inches in diameter over tools, has an in-and-out adjustment of four and one-quarter inches. The length of feed of the standard machine is eight feet. This type of machine is used principally on the housings of marine and stationary engines and for a similar class of work, where there are plain surfaces to be milled off, the work being clamped to a large floor plate and the different portable tools being brought forward to the work and clamped into position. The head has suitable changes of feed and power quick movement in both directions.

Fig. 3 shows a plain milling machine of modern design. This machine is direct motor-driven, power being supplied to a spindle of machine, which is seven inches in diameter, by means of a steep lead, phosphor-bronze worm-wheel and hardened steel worm through gearing, by motor placed on top of machine, which also operates the friction disc feed for table. The carriage of the machine is forty-two inches wide and made to mill eight feet long; will admit work fifty inches wide between uprights; maximum distance from centre of spindle to carriage of fifty inches. The small motor shown on side of machine is used for raising or lowering the cross-head by power, and also power quick movements to carriage.

Fig. 4 shows a vertical milling machine, motor-driven. The motor sets at right angles to the driving shaft, to which it is geared by means of a spiral gear and pinion which supplies the power to the spindle. When the machine is driven by a constant-speed motor the changes of speed of spindle are made mechanically, and by field control when a variable speed motor is used. The machine has a compound work table which has automatic feed in all directions. The circular carriage is forty-eight inches over tee slots, fifty-four inches over all, has an in-and-out adjustment of thirty-six inches and a cross adjustment of thirty-six inches.

The machines illustrated are manufactured by the Newton Machine Tool Works, Philadelphia, Pa.

New Designs in Desk Lamps.

The accompanying illustrations show two new designs of desk lamps manufactured by McLeod, Ward & Company, 27 Thames street, New York city. Fig. 1 shows the Kinsman bookkeeper's desk lamp, which is arranged so as to clamp on the gallery of a bookkeeper's desk. This lamp is adjustable in every way, keeps the light out of the eyes, throwing it on the work. The lamp and stand are finished in nickel-plate, polished brass, old brass or oxidized copper. Fig. 2 shows the Ward typewriter's desk lamp. This stands on the desk, as shown, and can be adjusted to throw its light wherever desired. This lamp and stand are finished in nickel-plate, polished brass, old brass, or oxidized copper.

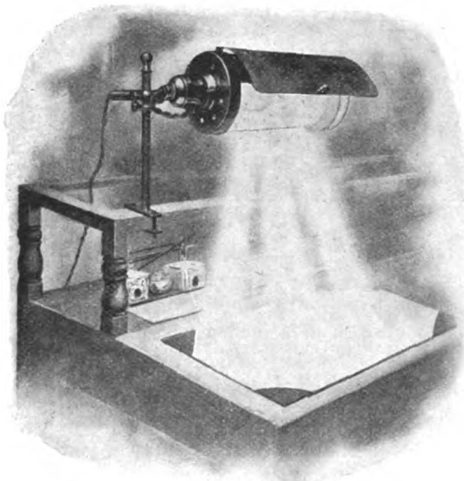

FIG. 1.—ADJUSTABLE BOOKKEEPER'S DESK LAMP.

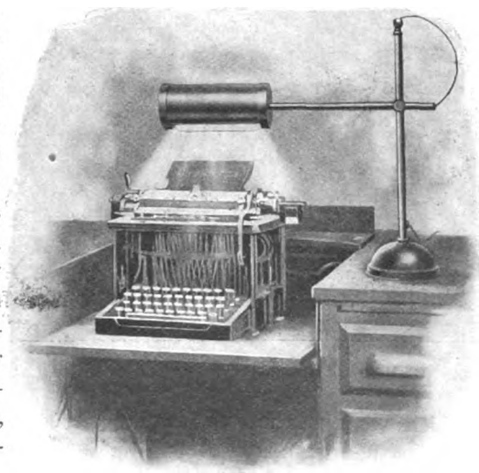

FIG. 2.—ADJUSTABLE TYPEWRITER'S DESK LAMP.

Steam Turbines for Factory Driving.

The Westinghouse steam turbine is rapidly increasing its field of usefulness. The Eaton, Cole & Burnham Company, of Bridgeport, Ct., is preparing plans for a turbine plant which will furnish power to its works. Large extensions to the present work are now under way and the entire plant will then be operated by polyphase motors from the new power station. A 400-kilowatt Westinghouse turbine unit will be immediately installed to provide additional power during the construction work. It will temporarily be installed in the present power-house and will operate under 200 pounds steam pressure and twenty-eight-inch vacuum without superheat. The unit will furnish three-phase current at 440 volts. The installation is in charge of Mr. George Hooper, engineer, 11 Broadway, New York city.

Free Lectures Under the Department of Education for the City of New York.

The department of education for the city of New York announces a course of lectures on chemistry, electricity, physics and astronomy for October, November and December, at the Y. M. H. A. Hall, Ninety-second street and Lexington avenue, New York city. A course of ten lectures will be given by Professor E. R. von Nardroff on Wednesdays, at eight P. M. At the John M. Toucey Memorial Building, 150th street, near Mott avenue, Bronx, a course of eleven lectures will be delivered by Mr. W. W. Kerr, on "Principles and Practice in Electrical Engineering."

An Electric Fan to Be Attached to a Lamp Socket.

A German firm, Messrs. Reiss & Klemm, of No. 18 Stallschriber Strasse, Berlin, has introduced a novel electric fan which is operated from the ordinary 110-volt incandescent lamp socket. The fan is eighteen centimetres in diameter. The apparatus, with the fan cord and fan, which are all adjustable, is packed in a small carton 75 by 65 by 188 millimetres in dimension.

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The Annual Report of the Western Union Telegraph Company.

The annual report of the president of the Western Union Telegraph Company, Colonel Robert C. Clowry, made at the meeting of the stockholders, October 14, 1903, shows an excellent condition. The capital stock outstanding remains unchanged, namely, $97,370,000, of which $29,495.86 belongs to and is in the treasury of the company.

The revenues for the year ended June 30, 1903, were $29,167,686.80, making an increase of $1,094,591.70. The expenses for the year were $20,953,215.07, an increase of $172,448.86, making the net increase $922,142.84. After interest on bonds and appropriations for dividends have been figured, this leaves a surplus for the year of $2,268,721.73. This surplus, together with the surplus on July 1, 1902, makes a total surplus on June 30, 1903, of $13,019,724.55.

There were added to the company's system during the year 402 miles of poles and 59,228 miles of wires.

Of the newly constructed wires 47,000 miles were of copper.

The number of messages transmitted by the employés of the company was 69,790,866, being 415,983 more than for the previous year. These figures do not include the messages transmitted by the lessees of wire, nor do they include the messages of the various railroad companies that are sent between their local stations under its contracts. The uses of the leased wires were probably the equivalent of 10,000,000 messages for the year.

There was an increase of $1,094,591.70 in the revenues for the year. Of this amount the transmission of regular commercial messages contributed $321,759.90, and leased wires $282,774.28, the remainder coming from sundry other sources.

The increase in the operating and general expenses, including taxes, was $250,598.55, and for equipment of offices and wires $81,921.69. Reductions of $159,242.96 in the cost of maintenance and reconstruction, and $828.42 in rentals of leased lines, made the net increase in expenses $172,448.86.

$1,077,700 was disbursed for interest on bonds, leaving $7,136,771.73 as the profits for the year.

After paying $4,868,050 for dividends on the capital stock, $2,268,721.73 was added to the surplus account.

The average receipts per message transmitted by the company were 31.4 cents, and the average cost was 25.6 cents.

The cost of construction for the year was $3,351,644.94.

Since Colonel Clowry's last report the reorganization of the service has been completed. The system of thorough inspection, including the Atlantic and Cuba cable terminals, has been continued, and a further reduction of expenses has been effected, bringing the total saving up to $612,000 per annum.

Refuse Destructors.

At the recent meeting of the British Association for the Advancement of Science, held at Southport, England, Mr. W. F. Goodrich contributed a discussion entitled "Twenty-five Years' Progress in Final and Sanitary Refuse Disposal." The author especially emphasized the necessity for high temperature of furnace in order to destroy the refuse effectively and without nuisance. The older types of destructors were practically useless by reason of the low working temperature. Figures were given showing that in 1887 the old beehive destructor at Nelson had a temperature of 705 degrees Fahrenheit, while last year the destructor installed at Walker-on-Tyne had a temperature of 3,000 degrees Fahrenheit. To-day there is at Nelson a destructor working at a temperature of 2,693 degrees Fahrenheit, and the result is that power is available for electric light and traction, about forty Board of Trade units being obtained by the burning of each ton of refuse.

At present there are 180 towns which destroy their refuse by cremation. In sixty-three of these the destructors are combined with electricity works. In forty towns they are operated in conjunction with sewage works. Five years ago there were but two destructors operated in combination with electricity works. In Liverpool destructors are being erected which are arranged to supply power for electric traction. Other instances of this arrangement are Nottingham, Wolverhampton and Preston.

Regular Meeting of the American Institute of Electrical Engineers.

The following programme was announced for the regular meeting of the American Institute of Electrical Engineers, October 23, held at Carnegie Hall, 154 West Fifty-seventh street, New York city: "The Conditions Governing the Rise of Temperature of Electric Railway Motors in Service," Dr. Cary T. Hutchinson; "A Graphic Recording Ammeter and Voltmeter," by A. H. Armstrong.

Electric Car Equipment.

TO THE EDITOR OF THE ELECTRICAL REVIEW:

I write to express my appreciation of the editorial in your issue of September 26 upon "The Equipment of an Electric Car." Articles of this character, explaining to the public just what may be dangerous, and what is not dangerous in the equipment of an electric car, are of great and positive value at this time. In my opinion, there is more to be feared from panic that may be caused from misinformation based upon sensational statements of newspapers than from any actual danger in the operation of properly equipped cars.

L. B. STILLWELL, Electrical Director, Interborough Rapid Transit Company.

New York, October 13, 1903.

Experiments for Lessening Noise on Elevated Railways.

Some interesting experiments are in course of prosecution on the Berlin (Germany) elevated electric railway. Complaints have been frequent concerning the noise made by the cars on the elevated structure. The first experiment consisted of inserting three layers of felt between the rails and the wooden crossties on which they were laid. This was inadequate, however, although it gave some improvement. Hollow iron girders filled with loose sand were then substituted for the wooden sleepers. This was also partially effective, but not entirely so. The rails were then laid on long longitudinal sleepers with cushions of lead under them. Finally, the car wheels have been lined with wood, so as to break the continuity of the path for vibrations through the metal. The experimental remedies are still on trial, and no definite conclusions have been announced.

McCaghey & Linehan, of Little Falls, N. Y., who have the contract for erecting the dam for the Greenfield, Mass., Electric Light and Power Company at the Gardner falls, a short distance below Shelburne Falls, are making good progress. The dam, which is about 350 feet in length, is of concrete, and rests on a rock foundation, much of the way the solid rock being cut out to make room for the dam. A canal some 1,100 or 1,200 feet in length is being built, part of the way through the rock. At the power station 1,100 horse-power will be developed. The contractors hope to finish the work by the first of November.

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CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

INDIANA TOLL LINE—Work has begun on the new telephone toll line which is to connect Abilene, Kan., with Indianapolis, Ind. The company building the line is composed of the owners of the exchanges at Abilene, Manhattan, Junction City, Concordia and Indianapolis, and, it is stated, has a capital of $150,000. Work has been begun at several points on the line.

RUSSIAN ELECTRIC RAILWAY—The announcement is made that a syndicate of American capitalists has under way a proposition to construct an electric line between Warsaw, the capital of Poland, and Lodz, the principal commercial centre. The length of the road will be about seventy-five miles, and it is to run in as nearly a straight line as practicable between the two points. High-speed cars will be employed, and at all points where the new line will cross other railroads viaducts will be constructed.

ANOTHER LONG-DISTANCE TROLLEY SYSTEM FOR THE PACIFIC COAST—Articles of incorporation have been filed by the Fresno Traction Company, with a capital stock of $5,000,000, to construct four electric roads from Fresno to the adjacent country with a view to opening up that territory. The total length, it is stated, will be 196 miles. The incorporators are given as W. G. Kerkoff, A. C. Balch, H. P. Baumgartner and W. D. Durfey, of Los Angeles, and A. G. Wishon, of Fresno, Cal. Mr. H. E. Huntington, who has already been prominently identified with electric railway and power enterprises in California, is said to be interested in the proposition.

A NEW ELECTRIC RAILWAY PROJECT FOR RUSSIA—An electric railway is to be constructed between the city of Kief and the borough of Brovari, the province of Thshernigof, with a branch at the village of Darnitza. A syndicate has been formed to build and operate the road, which will be of standard gauge. The principal man interested in the scheme is N. U. Matvieisf, the Kief capitalist. In order to supply current for the line, generating stations will be built at Kief and Brovari. The length of the main line will be about eighteen miles. The branch line will be five miles long. According to the agreement entered into with the Russian Government, the road is to be in operation within two years.

WATER POWER PLANT AT SHERBROOKE, QUEBEC—The city council of Sherbrooke, Quebec, has appointed a commission to report upon the development of water power at Westbury basin, situated about eighteen miles from the city. The minimum flow of water is 40,000 cubic feet per minute, and the available head is thirty-seven feet. The council recommends dividing the power plant into three units, providing room for a fourth unit, to be installed when the minimum flow is increased. Each power unit is to consist of a three-phase sixty-cycle 500-kilowatt generator running at about 425 revolutions per minute and driven by two pair of turbines on a horizontal shaft direct-coupled to the generator. Reports show that for a development of 2,500 horse-power the cost is placed at $207,226, made up of $19,000 for hydraulic machinery, $42,800 for power station electrical equipment, $18,000 for substation, $87,550 for dams and work apart from machinery and lines, and the balance for contingencies, engineering and superintendence. A second estimate is $188,526, and covers power-house and other works for four units, only three of which are to be installed at present. The power developed in this case would be 1,875 horse-power.

EXTENDING ELECTRIC TRAFFIC ARRANGEMENTS IN NEW JERSEY—Traffic agreements between various electric railway companies operating in New Jersey have made possible the running of through cars from Camden to Jersey City. This service, it is stated, will be introduced on November 15, on a schedule of six hours for the entire trip. The Trenton & New Brunswick Railway Company will inaugurate the new service, operating over the Camden & Trenton Railway to Trenton, over its own line from Trenton to New Brunswick, and from New Brunswick by way of the Middlesex & Somerset Traction Company's and Public Service Corporation's tracks to Jersey City. Since the tracks of the Public Service Corporation were connected with those of the Middlesex & Somerset Traction Company at Dunellen, the only gap in the electric railway chain between New York and Philadelphia is four miles of track yet to be constructed on the Camden & Trenton Railway. It is announced that this will be completed in time to establish through service before the middle of November. Although the officers of the Trenton & New Brunswick Railway Company have entered into a temporary agreement with other companies, it is expected that it will complete its own line from Trenton to Elizabeth and reduce the time to four hours between Philadelphia and New York within a year.

THE CANADIAN WESTINGHOUSE COMPANY—As announced last week, the Canadian Westinghouse Company, Limited, was organized at Hamilton, Ontario, October 8, 1903. The capital is $2,500,000. The new company is a consolidation of all the Westinghouse interests in Canada, which heretofore have been conducted individually. It will take over all the property, patents and other interests of the succeeded companies, including the sales organization and business of Ahearn & Soper, of Ottawa. The organization committee elected the following board of directors: Mr. George Westinghouse, Pittsburg; C. F. Size, of Montreal; H. H. Westinghouse, George C. Smith, Frank H. Taylor, L. A. Osborne, all of Pittsburg; Thomas Ahearn, of Ottawa; the Hon. J. M. Gibson, of Hamilton, W. Y. Soper, of Ottawa; Paul J. Myler, of Hamilton. The executive committee will consist of the following gentlemen: Mr. H. H. Westinghouse, Mr. F. H. Taylor, Mr. L. A. Osborne, Mr. George C. Smith and Mr. W. Y. Soper. The officers are as follows: Mr. George Westinghouse, president; Mr. H. H. Westinghouse, vice-president; Mr. F. H. Taylor, vice-president; Mr. Paul J. Myler, general manager and treasurer; Mr. John H. Kerr, secretary. While only ten directors were elected, the board, when complete, will consist of fifteen members, the remaining five to be named from among the Canadian gentlemen interested. Ground is to be broken for the new works at Hamilton within a week, and the erection of the new buildings will follow as fast as possible. It is expected that at least 1,000 employés will be serving the company within a year.

ELECTRICAL INDUSTRIES OF GERMANY—Mr. S. W. Hanauer, deputy consul-general at Frankfort, Germany, writes, under date of August 25, that Dr. Bürner, the syndic of the Association for Guarding the Interest of German Electrotechnics, makes several valuable statements in a brochure recently published by him. In 1900 about $595,000,000 was invested in the electrical industries of Germany. The severe crisis which it has undergone, and from which it still suffers, is, in the main, due to the following causes: The electrical companies, instead of confining their activity to manufacturing, engaged in promoting ventures and obtaining concessions, and carried on the building of electric roads, lighting plants, etc., in towns and rural districts, instead of leaving these enterprises to the municipalities, financial promoters and private companies. A great mistake was committed in erecting and conducting branch electrical factories in other countries, which caused numerous competitors to spring up in those countries and led other German companies to enter the foreign business, thereby producing a sharp struggle to obtain profitable orders. A third error was the practice inaugurated by the electrical companies of establishing installation shops in all the cities and large towns of Germany, instead of leaving that part of the business to the resident plumbers and installation concerns. Dr. Bürner does not favor the plan of uniting the German electrical companies into one common concern. He urges the formation of syndicates to regulate and protect prices and limit production where such is unprofitable. The main recommendation is to extend and increase the export trade. During 1902 Germany exported 13,499 tons of electrical machinery, 8,481 tons of electric cable, 2,295 tons of carbon burners, and 2,206 tons of accumulators.

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PERSONAL MENTION.

PROFESSOR ARTHUR E. KENNELLY, professor of electrical engineering in Harvard University, and president of the Society for the Promotion of the Metric System, was recently in Canada spending a holiday.

MR. HERBERT F. MOORE has tendered his resignation as instructor in machine design at Cornell University to accept a position as mechanical engineer at Riehle Brothers Testing Machine Company, Philadelphia, Pa.

MR. JOHN GRAHAM MILLAR, manager of the roofing department of the H. W. Johns-Manville Company, died at St. Luke's Hospital, New York city, on October 15. Mr. Millar was forty-two years of age and was well known throughout the electrical and allied industries.

MR. R. S. KELSCH, E. E., of Montreal, has submitted to the city council of Ottawa a report on the establishment of an electric plant for street lighting, the present contract with the Ottawa Electric Company expiring May next. The complete plant could be secured for $40,000. The cost of operating is estimated at $19,900 a year.

MR. HERBERT LLOYD, president of the Electric Storage Battery Company, Philadelphia, Pa., has returned from a two months' tour of London, Berlin, Paris and other European capitals. Mr. Lloyd spent some time in London, where his company has large interests, and where it is associated with the Chloride Electrical Storage Syndicate, Limited.

MR. DERMOT McEVOY, late engineer for the Gutta-Percha and Rubber Manufacturing Company, of Toronto, and recently with the Fairbanks Company, has been appointed engineer and mechanical superintendent of the Canadian Rubber Company, Montreal, whose works are now being remodeled and equipped with new machinery at a cost of about $150,000.

SIR CHARLES METCALFE, the builder of the section of railroad that will touch on Victoria Falls and Bulawayo, Africa, and Mr. I. F. Jones, manager of the South African Charter Company, which has the concession for opening up that part of Africa, arrived last week on the Campania. They will spend a month, it is said, visiting Niagara Falls and the various centres of industry, to learn whatever may be of advantage in the construction of the power-house at Victoria Falls.

PROFESSOR E. W. RUTHERFORD, whose investigations into the properties of radium have been so much discussed, and who was recently elected a fellow of the Royal Society, has returned from Great Britain to take up his duties at McGill University. Mr. F. Soddy, of McGill University, who was a coinvestigator into radium with Professor Rutherford, and who went to England this summer, will not return to Canada, having accepted a post in Owen's College, Manchester, England.

PROFESSOR W. J. SWEETSER, B. S., of Newton, Mass., has recently been appointed to the chair of engineering in Mt. Allison University, Sackville, New Brunswick. Professor Sweetser graduated from the Massachusetts Institute of Technology in 1901, and was considered such a brilliant student that he was offered an assistant professorship in that institution. Since graduation he has been employed in engineering work. Professor Sweetser will have charge of the McClellan School of Industrial Arts, and will organize a manual training course in connection with the Sackville High School.

MR. LOUIS SIMPSON, consulting engineer, of Ottawa, Ontario, has recently visited the United States for the purpose of investigating the merits of the different electrical furnaces. He is confident that the electrical reduction of iron ores, and their conversion into steel, is a commercial possibility under the conditions which exist in the Ottawa valley and near the city of Ottawa. The difficulty seems to be only in the collection of sufficient data in order to decide which of the several different furnaces and processes are the best to adopt. Mr. Simpson is continuing his investigations with a view of utilizing some of the water power at the Chats falls, within twenty miles of the city of Ottawa, for the purpose of producing iron and steel.

DR. LEE DE FOREST sailed October 14 on the White Star steamer Majestic for England, taking with him his chief assistant, H. M. Horton, and two outfits of the De Forest wireless telegraph apparatus, at the request of prominent men connected with the British Post Office, the Admiralty and others. A demonstration is to be made between Holyhead and Dublin, and all the facilities of the Post Office have been put at Dr. De Forest's disposal toward this end. Sir William Preece is especially interested in the enterprise. The matter of speed of transmission of the De Forest system will be especially observed. It is the intention of those interested in Great Britain to incorporate the British Empire De Forest Company upon the completion of these tests.

S. W. CHILDS.

MR. S. W. CHILDS has just returned to this country after an absence of several years in West Australia, where he was until his departure general manager of the Kalgoorlie electric tramways. Mr. Childs started in the electric railway business on the old Watervliet Turnpike Railway, at Albany, N. Y. In 1890 he went to Boston, remaining in the employ of the old West End Street Railway Company for two years, when he went to Lincoln, Neb., where he was engaged in construction work. In 1892 he was employed with the Atlantic Avenue Railroad Company in Brooklyn, N. Y., under the late Deacon Richardson. Leaving Brooklyn, Mr. Childs entered the employ of J. G. White & Company, and was assigned to Baltimore, Md., where he had charge of track and overhead construction work. From Baltimore he went to Columbus, Ohio, becoming superintendent for the Columbus Central Railway Company, for which company he laid out the entire track, overhead and pleasure park system. In 1896 he left Columbus to take charge of the construction work at Fort Wayne for the Degnon Construction Company, going to Charleston, S. C., in 1898, in charge of the construction

work on the electric railways of that city. He went to Australia for the first time in the fall of 1898, as assistant engineer for J. G. White & Company, in connection with the electric tramways at Perth, West Australia. In 1901 he returned to America and was placed in charge of the construction for the Toledo & Monroe Electric Railway. He left this position to return to Australia as manager of the Kalgoorlie electric tramways. On his recent return trip to America Mr. Childs made an extensive tour of New Zealand and the Philippine Islands, as well as several cities in China and Japan where electric railways are contemplated or are being built. Before leaving Kalgoorlie Mr. Childs was tendered a banquet by the citizens, and an engrossed testimonial of which the above is a reproduction.

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ELECTRIC LIGHTING.

MERIDEN, CT.—The board of public works has entered into a five-year contract with the Meriden Electric Light Company.

DETROIT, MICH.—Contract in part for construction of generating plant of the Edison Illuminating Company has been let.

HUNTINGTON, L. I.—The Huntington town board has contracted with the Huntington Light and Power Company for street lights.

LOGANSPORT, IND.—It has been reported that $25,000 will be expended the coming year for additional power for the electric light plant.

MT. MORRIS, N. Y.—It is stated that Herbert Wadsworth will install an electric light system at Ashantee, to cost in the neighborhood of $5,000.

BRISTOL, VA.—It is announced that the Bristol Gas and Electric Company will expend a quarter of a million dollars in extending its lighting plant.

WAUTOMA, WIS.—At a recent meeting it was almost unanimously voted to bond the village for a sum sufficient to erect an electric lighting plant.

BARNESVILLE, GA.—The Stanley Electric Manufacturing Company, Pittsfield, Mass., has secured the contract for a $6,000 municipal electric light plant.

WILLIAMSBURG, OHIO—It is reported that the board of public service asked for bids until October 1 for an electric light plant, including engine, generator, switchboard and other material.

PALOUSE, WASH.—The Potlatch Lumber Company has finished the work of installing its electric lighting plant, and its yards and shops are now lighted with both arc and incandescent lamps.

HAZLETON, PA.—City councils in joint session have awarded a five-year contract to the Hazleton Electric Light Company and the Welsbach Lighting Company for illuminating the streets of the city. The contract calls for 100 or more arc lights at $70 each per annum.

ALHAMBRA, CAL.—At the request of the Pacific Light and Power Company, the city trustees have advertised for sale a franchise for the introduction and operation of an electric light and power system in Alhambra, to cover a period of fifty years. It is probable that the company will be the only bidder.

GREENFIELD, MASS.—Work is progressing rapidly on the new dam of the Greenfield Electric Light and Power Company at Gardner Falls, below Shelburne Falls. A large portion of the foundation is already in. The company will purchase a right of way from Greenfield to Gardner Falls for its poles.

LEWISTON, ME.—In order to meet very extensive calls for electric lighting power, the Lewiston & Auburn Electric Light Company is now planning to put in a generator of from 200 to 300 horse-power at its Lincoln Mill station. This generator will be driven from the same wheel that formerly furnished power for the Lewiston, Bath & Brunswick street railway. Its electrical equivalent will be from 2,000 to 3,000 lights.

SIOUX CITY, IOWA—The Sioux City Gas and Electric Company has completed all the improvements which it will make to its plant this year. The total cost of these improvements was $60,000, which is said to be the smallest amount the company has expended in betterments for the past ten years. The company states that next year three times this amount will be required to do the work outlined. The electric lines were practically rebuilt this year, over 1,200 new poles being set up.

BOSTON, MASS.—An order has been issued by the gas and electric light commissioners, approving the issue by the Pittsfield Electric Company of 500 shares of additional capital stock of the par value of $100 each, the proceeds to be applied for the following purposes: The proceeds of 300 shares to be applied for the payment of an equal amount of the promissory notes of the company now outstanding, and the proceeds of 200 shares to be applied for the payment of the cost of additions to the company's plant made subsequent to June 30, 1903.

TELEPHONE AND TELEGRAPH.

WASHINGTON, N. J.—A telephone line will be built connecting Califon and Mountainville.

COLUMBIA, N. Y.—The Columbia Telephone Company is extending its lines through the southern towns of this county.

CHATTANOOGA, TENN.—The Hamilton Telephone Company has been granted a franchise over all the streets of the city.

JOHNSTOWN, PA.—The Huntington & Clearfield Telephone Company has authorized the construction of a line from Clearfield.

PORTLAND, ORE.—The Bohemia Telephone Company has elected the following directors: David Flinn, Frank Wheeler and Frank Jordan.

NUNDA, N. Y.—The directors of the Nunda Telephone Company have decided to construct a line to Dalton and another branch to Brooks Grove.

MACON, GA.—A new telephone system may be placed in Macon, A. W. Zealey and David Goldberg having petitioned council for the privilege of using its streets.

SPOKANE, WASH.—The Rocky Mountain Bell Telephone Company has drawn plans for some extensive improvements in its service in this part of the state.

JAMAICA, L. I.—The New York & New Jersey Telephone Company has bought a plot of ground, upon which it contemplates the erection of a new exchange building to cost $15,000.

CINCINNATI, OHIO—The New Baltimore & Venice Telephone and Telegraph Company has been granted permission to erect poles and string wires on the various county roads.

MIDDLETOWN, OHIO—It was learned that the United States Telephone Company had secured rights of way necessary for a trunk line over the county roads from Dayton to Hamilton.

GALLIPOLIS, OHIO—The Swan Creek Telephone Company has been organized with the following officers: J. C. Lewis, president; John Evans, vice-president; O. Hibert, secretary and treasurer.

NEWPORT NEWS, VA.—The Currituck Telephone Company, of Coinjack, Currituck County, has been chartered with $10,000 capital, authorized to construct telephone lines between the principal towns of that and adjacent counties.

CHARLOTTE, N. C.—The Manning Telephone Company has been chartered, with a capital of $5,000. The company will conduct a business in Clarendon and Williamsburg counties. W. Jenkinson is president, and D. Bradham, general manager.

NORTHVILLE, MICH.—The Northville Telephone Company held its annual meeting and elected the following officers for the ensuing year: President, Dr. J. M. Burgess; vice-president, F. S. Neal; secretary, R. H. Porter; E. L. Lapham, treasurer; M. A. Porter, manager.

BUFFALO, N. Y.—The stockholders of the Frontier Telephone Company have elected the following directors for the ensuing year: Charles W. Goodyear, E. C. Lufkin, Clark C. Ingham, William A. Douglas, Martin Carey, Fred A. Green, Henry H. Persons, James M. Thomas, H. D. Kirkover, Charles B. Hill, Alvan Markle, Samuel L. Wayland, Charles E. Austin, John B. Weber and John Markle.

CARROLLTON, GA.—Judge S. W. Harris, of the Coweta Circuit, has granted to the Gainesboro Telephone Company of this city on petition the right to increase their capital stock from $40,000 to $150,000. This corporation is a long-distance telephone company and covers this county and the counties of Haralson, Heard, Coweta, Paulding, Polk and several miles of lines in Randolph County, Alabama.

MISSOULA, MONT.—Extensive work is being done by the Rocky Mountain Bell Telephone Company in this part of the state. It is expected that the main line will be extended in the near future to Sand Point, Ida., and that while it is being constructed a new line will be run by way of the Great Northern Railway track and Newport, Wash., to Spokane. Present connections between Montana and Spokane are made by way of Wallace, Ida., but press of business requires another line. The company is now rebuilding its system at Wardner, Ida.

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ELECTRICAL SECURITIES.

The market at the close of last week evidenced a tendency on the part of capitalists to accumulate stocks. The early declines of the week were followed by a sharp rally and this has raised hopes that the declining movement and forced liquidation in these issues have ended. While the market continues to give evidence of stability, the public has become so dissatisfied and sceptical that it may be some time before it will venture to take a positive interest in industrial securities. One of the main developments of the week included the declaration of the regular quarterly dividend of the Amalgamated Copper Company. The foreign money market is easy, as is also the local money market. The possibility of war between Russia and Japan has clouded the foreign situation, but the present outlook is peaceful and indicates no immediate disturbance in that direction. All of the large electrical securities showed advances for the week, and the continued declaration of dividends and the condition of the surplus in these institutions, seem to make it certain that the advance will be continued.

New York:	*Closing.*
Brooklyn Rapid Transit	33¾
Consolidated Gas	174⅞
General Electric	148
Kings County Electric	140
Manhattan Elevated	132½
Metropolitan Street Railway	105¼
New York & New Jersey Telephone	140
Westinghouse Manufacturing Company	161

Brooklyn Rapid Transit earnings from July 1, 1903, to October 12, increased $470,000 over the corresponding time last year.

The balance sheet of the Kings County Electric Light and Power Company, as of June 30, 1903, shows total assets of $11,104,145 and liabilities of $10,811,842, leaving a surplus of $292,303.

Boston:	*Closing.*
American Telephone and Telegraph	123¼
Edison Electric Illuminating	230
Massachusetts Electric	77
New England Telephone	122½
Western Telephone and Telegraph preferred	79

The statement of the Edison Electric Illuminating Company, as of June 30, 1903, shows gross earnings of $2,667,809 and expenses of $1,683,085, leaving a net income of $984,724. Other income amounted to $32,502, giving a total income of $1,017,226. Dividends and charges were paid to the amount of $955,971, leaving a surplus of $61,255, as compared with a surplus of $116,098 for the preceding year, and a surplus of $52,393 in 1901. The board of gas and electric light commissioners has granted the company permission to issue 20,000 shares of new capital stock at $200 a share, to provide money for improvements and betterments. The company has purchased seven acres of land in South Boston, and plans for a 75,000-horse-power station have been prepared. Contracts have already been let for the first section of the new station building, and upon the completion of this section of the plant, all of the towns reached by the suburban companies recently purchased will be supplied from the Edison company's Boston station. At the annual meeting of the company, recently held, the old directors were reelected.

Philadelphia:	*Closing.*
Electric Company of America	7⅝
Electric Storage Battery common	48
Electric Storage Battery preferred	48
Philadelphia Electric	6
Union Traction	42⅞
United Gas Improvement	80

It is stated that the Philadelphia Electric Company, at its present rate of earnings, will show for the present fiscal year about $600,000 net profits for the stock.

It is expected that the net earnings of the United Gas Improvement Company for the fiscal year, to end December 31 next, will be close to 12 per cent on the $36,725,000 of stock. Last year they were about 12 per cent on $28,250,000 of stock, or 9 per cent on the present outstanding stock, and were an increase of about $900,000 over 1901.

Chicago:	*Closing.*
Chicago Telephone	120
Chicago Edison Light	145
Metropolitan Elevated preferred	55
National Carbon common	19½
National Carbon preferred	88½
Union Traction common	4¾
Union Traction preferred	33

The Chicago Telephone Company made a total gain in September of 1,603 telephones, making the total now in use 95,628.

It is claimed that the earnings of the National Carbon Company for the first eight months of 1903 will be fully equal to those of 1902, the net earnings of which were $594,371, out of which $315,000 for dividends and $254,396 for depreciation were deducted, leaving a surplus of $24,975. The total surplus shown in the last statement was $156,000.

AUTOMOBILE NOTE.

ENDURANCE CONTEST FROM NEW YORK TO PITTSBURG—The automobile endurance contest from New York to Pittsburg, by way of Cleveland, ended in Pittsburg on October 15. The committee having the arrangements in charge planned a parade for the machines which had finished the run. The first machine in was driven by Mr. Webb Jay, arriving at 11.49 A. M. The second machine was driven by Mr. B. B. Holcomb, arriving at 12.22 A. M. The third machine was driven by P. H. Deming; the fourth by Mr. W. H. Box, and the fifth machine by Arthur Gardner. The parade was led by the car containing the local officials, J. Francis Burke, W. C. Temple, W. Linford Smith and Arthur Banker.

LEGAL NOTES.

WRONGFULLY DISCONNECTING A TELEPHONE FOR NON-PAYMENT OF RENT—The measure of damages for wrongfully disconnecting a telephone because of a mistake as to the payment of rent is held in Cumberland Telephone and Telegraph Company *vs.* Hendon (Ky.) 60 L. R. A. 849, to be the amount which will compensate the patron for the injuries caused by the breach of contract.

THE NEGLIGENCE OF A RAILROAD COMPANY—The construction of a freight platform so near a railroad track that the elbow of a passenger may come in contact with freight on the platform as the passenger is seated inside of a passing car with his elbow resting on the sill of one of the windows of the car and protruding but slightly is held, in Kird *vs.* New Orleans & N. W. R. Company (La.) 60 L. R. A. 727, to be gross negligence on the part of the railroad company, rendering it responsible in damages to a passenger injured thereby.

SUIT ENTERED AGAINST A SUBWAY COMPANY—Corporation Counsel Rives, it is announced, will institute a suit for the city of New York against the Consolidated Telegraph and Electrical Subway Company for an accounting under several agreements which this company has made with the city. The suit will be based on a report made by the commissioner of accounts after an investigation of the affairs of the defendant corporation which was ordered some time ago by Commissioner Monroe, of the department of water supply, gas and electricity. The Consolidated company's agreement with the city was to the effect that after the company had earned ten per cent on the actual cost of the subways, it would pay all excess over that amount to the city. It was also provided that in case in any year ten per cent is not earned by the company, it should be entitled to recoup itself. Another alleged agreement was that after January 1, 1897, the company should sell all the subways constructed by it to the city at actual cost of construction, plus, in case of failure to have earned ten per cent, ten per cent on the actual cost. The investigation by the commissioners of account was to determine the actual cost of the subways. The construction account stood on January 1, 1903, at $7,492,291.62. The expert of the commissioners of accounts challenges this construction cost and asserts that the corporation has violated the agreement in several ways.

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INDUSTRIAL ITEMS.

THE GLOBE ELECTRIC CONTROLLER COMPANY, Amsterdam, N. Y., has recently issued an attractive catalogue descriptive of the electric controller apparatus manufactured by it. The catalogue will be sent on request.

THE MICA INSULATOR COMPANY, New York and Chicago, has recently sent out a postal bearing interesting information in connection with the mica insulators which it manufactures. Price list and descriptive matter will be sent on request.

THE BULLOCK ELECTRIC MANUFACTURING COMPANY, Cincinnati, Ohio, in its October calendar of its great men of science and engineering series gives a portrait in colors of Sir George Biddell Airy, with the accustomed biographical sketch.

CHARLES E. DUSTIN COMPANY, 11 Broadway, New York, has just issued its "fall, 1903, bulletin." This contains a list of alternating and direct-current generators and motors, miscellaneous electric apparatus, transformers, arc dynamos and steam engines which it has for sale. This bulletin will be sent on request.

CHARLES C. MURRAY & COMPANY, engineers, 03 First street, San Francisco, Cal., have issued a booklet entitled "Steam Power Plants on the Pacific Coast." This is a handsome piece of work and gives the power rating and detail of equipment of some of the work which this company have done in the past few years on the Pacific coast and in the Hawaiian Islands.

THE KINSMAN ELECTRIC AND RAILWAY SUPPLY COMPANY, 91 Liberty street, New York city, is the manufacturer of a high-grade automobile cable for which there is a steady demand. This cable is extremely flexible and is so covered with braiding and tape that it is absolutely protected from oil, which is so injurious to the rubber covering of spark coil wire.

THE CUTTER COMPANY, Nineteenth and Hamilton streets, Philadelphia, Pa., is sending out an attractive postal advertising the "I. T. E." circuit-breaker. This circuit-breaker affords automatic and instantaneous protection to motors and generators. It is made in all sizes and for every variety of installation. The company will be pleased to send complete catalogues upon request.

THE EMERSON ELECTRIC MANUFACTURING COMPANY, St. Louis, Mo., is distributing several new bulletins descriptive of direct-current power motors of slow, medium and high speeds, from one-sixteenth to one-eighth horse-power; direct-current motors for slow and medium speeds, from one-quarter to two horse-power, and polishing and grinding motors for alternating currents and direct currents, with chucks mounted on motor shafts.

THE NERNST LAMP COMPANY, Pittsburg, Pa., has issued a valuable treatise on the Nernst lamp by Mr. A. J. Wurts, the electrical engineer who has developed the Nernst lamp to its present practical efficiency. This is a text-book of the highest character and will prove of value to not only the electrical profession, but also to students of electrical science. In addition to the great practical value of the book, the typography and illustrations are excellent in treatment and design.

THE NEWTON MACHINE TOOL WORKS, Philadelphia, Pa., has published a new catalogue, No. 36, descriptive of the engineering specialties in metal-working machinery manufactured at its works at Vine, Twenty-third, Twenty-fourth and Pearl streets, Philadelphia, Pa. This company, in addition to its line of straight machine tools, manufactures a complete line of electrically driven tools of every design. The company will be pleased to receive specifications or requests for this catalogue.

THE EWING-MERKLE ELECTRIC COMPANY, St. Louis, Mo., is the general selling agent for the Bryan-Marsh Imperial incandescent lamp, which was described in a recent number of the ELECTRICAL REVIEW. These new Imperial lamps burn out before they burn dim; that is, these lamps run along for 500 hours at about ninety per cent of the initial candle-power. After the 800 hours, they cross the eighty per cent line and a few hours later burn out. Full information will be sent upon request of the company.

THE PHELPS COMPANY, Detroit, Mich., manufacturer of the Hylo incandescent lamps, through its secretary, W. J. Phelps, writes, in his unique fashion: "It may interest you to know that business in the old reliable 'turn-bulb Hylo lamp' for September was fifty per cent in excess of September last year. It does not look as though that lamp was being sidetracked. It has even more friends than we realized until we began pushing our other new things. If our lamps were only a little more self-making, as well as self-flashing, we could get reckless in publicity."

THE NATIONAL BATTERY FAN COMPANY, 14 South Broad street, Philadelphia, Pa., announces that it has developed a new form of storage battery combining the principles of primary and secondary batteries. The advantages of each type have been retained, so that it may be recharged at a nominal cost, and producing a dry battery capable of being shipped like ordinary merchandise to any part of the country. The advantage of this battery will be the furnishing of electric power to fans and other small machines at isolated points where live current is not available.

THE H. W. JOHNS-MANVILLE COMPANY, 100 William street, New York city, will be pleased to send to any one interested, upon request, a folder describing the Prairie Fire drag, a device for extinguishing prairie fires. The drag consists of a chain mat covered with an asbestos smothering blanket supplied with chains at two corners, and which may be easily and quickly adjusted to drag by the horn of the saddle or by a single tree. A reproduction of a wash drawing by the well-known illustrator, Mabie, shows two mounted cowboys putting out a prairie fire with the drag.

MESSRS. WURMB & BAUMANN, 502 Holland Building, St. Louis, Mo., have developed a new form of electromagnet for which patent No. 682,377 has been granted. The features claimed for this electromagnet are economy of construction, economy of current, and long distance of throw. The electromagnet is made by pivoting the armature directly on the pole end of one of the cores, closing the air-gap at this pole of the electromagnet entirely. In normal position, when the armature is slightly open, it is slightly overbalanced by means of an adjustable balancing weight or by any suitable adjustable spring. When the circuit is opened the spring pin gives the armature the impulse for quick return action.

THE STANDARD WELDING COMPANY, Cleveland, Ohio, will be pleased to send its new catalogue descriptive of electrically welded steel tubing, rims, bicycle parts, etc., to any one interested. This company manufactures seamless steel tubing of all kinds, seamless rims for all types of wheels and tires, Standard clincher rims for wood and wire wheels, and all forms of bicycle tubing. The new catalogue contains, in addition to a description and illustrations of the manufactured products of this company, the normal weight in pounds per foot of Standard seamless steel tubing, decimal equivalents of an inch, and a question sheet from which to select the material best adapted for the purpose intended.

THE CARBORUNDUM COMPANY, Niagara Falls, N. Y., has recently published its catalogue No. 4, descriptive of carborundum manufactured under the Acheson patents. The frontispiece shows the development of the works since 1893, giving comparative pictures of the factory as it existed then and the present plant. The catalogue contains an illustrated reprint of a lecture delivered before the Franklin Institute by Francis A. J. Fitzgerald, entitled "The Manufacture and Development of Carborundum at Niagara Falls." In addition to this there are chapters on "The Characteristics of Carbide of Silicon in the Manufacture of Iron and Steel;" "The Characteristics of Carborundum;" "Carborundum Wheels," together with illustrations and sizes of the special wheels made by this company and a description of other specialties such as carborundum sticks, knife sharpeners, razor hones, sharpening sticks, oil sticks, etc.

THE PERKINS ELECTRIC SWITCH MANUFACTURING COMPANY, Bridgport, Ct., is mailing its new catalogue descriptive of its specialties. The catalogue contains 192 pages and is six and one-half by three and three-quarters inches in dimension, with rounded corners. This makes it a convenient pocket size. The cover is dark green buckram. The front cover design shows a nickel-plated flush-plate with two rotary flush switches. The back cover design is the Perkins key socket with shade-holder rigidly attached to the shell. This is one of the new goods shown for the first time in this catalogue. The catalogue lists 1,200 articles, each article having an individual catalogue number and telegraph code word. The illustrations throughout are in half-tone, and these are especially well done, particularly those of articles made up of porcelain. This catalogue is not being distributed direct to the consumer, but enquiries may be sent to any electrical supply house in the country.

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CHARLES W. PRICE . . . . . PRESIDENT AND EDITOR
STEPHEN H. GODDARD . . . . . SECRETARY AND MANAGER
WM. HAND BROWNE, JR. . . . . TECHNICAL EDITOR
AINSLIE A. GRAY . . . . . ASSISTANT EDITOR

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CHANGES for advertisements should be in this office by *Friday noon* for the following week's issue.

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CONTENTS

EDITORIAL:
Meter Performance . . . 611
The Function of a Fuse on an Electric Car . . . 611
Progress of the International Electrical Congress . . . 612
High-Speed Trains . . . 613
Shop Testing of Motors and Generators for Commercial Service IV, by Bertrand B. Abry . . . 613
The Royal Commission on London Traffic . . . 615
The Electrotechnical Institute of Montefiore . . . 615
Electricity in the United States Government Service, by J. E. Price . . . 616
Animal Mechanics and Motor Vehicle Designs . . . 617
Total and Free Energy of the Lead Accumulator, by R. A. Lehfeldt . . . 618
A Simple Oscillograph . . . 620
An Interesting Foundry Development . . . 621
Book Review . . . 624
Technical Education in the United States . . . 625
Notes on Certain Three-Wire Systems, by Chas. T. Mosman . . . 627
The New York Electrical Society . . . 629
Independent Telephone Association of Southern Indiana . . . 629
Chicago Telephone Company Opens New Branch Exchange . . . 629
Electrical Patents . . . 630
American Institute of Electrical Engineers . . . 632
REVIEW OF CURRENT ENGINEERING AND SCIENTIFIC LITERATURE . . . 634
A Successful Automobile Trip with Edison Storage Batteries . . . 635
The International Congress of Electricity . . . 635
INDUSTRIAL SECTION:
Motor-Driven Double-Head Bolt Cutter . . . 636
A Transformer for Polyphase Circuits . . . 636
Electric Traveling Cranes and Electric Hoists . . . 637
A New Type of Pole-Changer . . . 638
The New Passenger Station of the Lake Shore & Michigan Southern Railway . . . 638
Dispersion Lenses for Searchlight Projectors . . . 639
Gasoline Automobile Handbook . . . 639
CURRENT ELECTRICAL NEWS . . . 640

At the St. Louis World's Fair there will be an exhibit of prime movers of exceptional interest. One will there see all the appliances of the modern power-house and will be able to contrast the newer types of engine with the old. There will be shown some of the finest examples of the reciprocating steam engine, as well as of the newer prime movers, the steam turbines and gas engines of large power. It may be that this will be the last large exhibit of the reciprocating steam engine to be made, for while it can not be said that this type of prime mover has yet been superseded, the gas engine is coming into favor because of its high efficiency, and the steam turbine because of its suitability for electric power stations. And these two types have the element of novelty which furnishes the excuse for making an exhibit. In every-day use, however, the reciprocating steam engine will still find wide application, and it will probably be many years before this machine—which has undoubtedly been one of the most important civilizing factors in the history of the world—will be entirely supplanted, should that day ever come.

METER PERFORMANCE.

One of our lay contemporaries complains because, when making a few remarks about the conditions under which the electric meter must perform its work, we did not go further and explain what may be expected of these instruments, and whether they have a reputation for unreliability and eccentric behavior, which would put them in the same class as water and gas meters, or whether they stand alone.

The Performance of a Good Meter.

There are, of course, good meters and other meters. A good electric meter will be guaranteed by its maker to be accurate within two or three per cent. Indeed, meters can be had which are guaranteed to maintain this accuracy for three years, if not tampered with. A guarantee of this kind is quite satisfactory for commercial purposes, but the electric supply companies are not, in general, satisfied to take things for granted, but test their meters before putting them in place. Further, they test a meter for the consumer, if the latter thinks his instrument is inaccurate.

Tampering with Meters.

Electric meters should always be sealed to prevent tampering, and it may be remarked that it is risky for any one to attempt to influence his meter in any way. Not only are the companies well protected against this by law, but the person who endeavors to make his meter run slow may make it run fast. On the other hand, the wear and tear of service on these meters tends to slow them down, thus giving the consumer the benefit of the change in accuracy. The supply company can make a fair estimate of the power supplied to each consumer, and any sudden changes in the reading of a meter at once attract attention and lead to an examination of the premises.

THE FUNCTION OF THE FUSE ON AN ELECTRIC CAR.

One sees occasionally in the daily press an account of the blowing of the fuse on an electric car. This is described as a more or less serious accident to the car which caused, or very nearly caused, a panic among the passengers. Now, the greatest danger to the passengers lies in the possibility of some unexpected happening causing a panic. It is therefore most desirable that every one should know what may be expected to happen occasionally on a car, and that all should realize that the happening is not necessarily an indication of danger.

Overloads on an Electric Motor.

If a steam engine is overloaded it will stop and refuse to work, although the full pressure of steam may remain upon the piston, and not cause any damage. On the other hand, a motor when overloaded tries its best to do the work thrown upon it. If it can not run at full speed it will run at whatever speed it

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can. As the speed decreases the current through the motor increases, and the motor adjusts itself to that speed at which the turning effort is sufficient to cause rotation and do the work. If the effort demanded of the motor is so great that the current which passes through it when standing still is not sufficient to cause rotation, the motor will, of course, not turn, but the current will continue to flow unless interrupted by a suitable mechanism.

The Action of the Fuse.

The current which will flow through a motor when it is standing still is in almost all cases far in excess of that which the motor is designed to carry; and, indeed, in a well-designed motor a current dangerous for the motor will be reached before the motor has been stalled. The effect of this heavy current on the motor, if allowed to continue, is to heat the windings to a dangerous degree and destroy the insulation, possibly setting it on fire; and it is to prevent this occurrence, whether due to careless handling of the car or to unexpected causes, that the fuses are used. A fuse is simply a short piece of wire of such size that it will be melted by a current which, if allowed to flow through the motor for any time, will damage it. When a fuse blows, then, it simply means that one of the safety devices on the car has operated to prevent damage to the motor. The melting of the fuse opens the circuit and cuts off the current from the motor. To protect the car the fuse is enclosed in a fireproof box.

The Circuit-Breaker.

There is another device for accomplishing this purpose, which is known as the circuit-breaker. This is a switch controlled by an electromagnet, which opens whenever the current reaches a certain dangerous value. This mechanism is now generally installed upon electric cars in addition to the fuse. It is often placed on the roof of the platform over the motorman's head, where it is easily reached and it is set to operate at a higher current value than the fuse, because the circuit-breaker acts almost instantaneously, while it takes a little time for the fuse to be melted. Now, a motor can stand for a second or two a current which would destroy it if applied for a longer period. The circuit-breaker, then, takes care of heavy overloads and the fuse protects the motor against those smaller currents which are dangerous if applied for a considerable time.

The Blowing of a Fuse.

When a fuse blows there is generally a volatilization of the metal of the fuse and a slight explosion. These explosions usually cause a report and some smoke. When the circuit-breaker is opened it draws an electric arc in breaking the circuit, and as in this arc a considerable amount of energy is dissipated in heating the air, there may be here also something of an explosion; but in neither case is there any danger to the passengers when the apparatus is properly installed. The fuse and the circuit-breaker are safety devices, the operation of which indicates, not that there is danger to those on the car, but that danger to the motors has been averted.

PROGRESS OF THE INTERNATIONAL ELECTRICAL CONGRESS.

We understand that the work of organization of the International Electrical Congress of St. Louis is going steadily forward, and that the movement is receiving the widest recognition, both at home and abroad. The second meeting of the Committee of Organization was held at the Cataract Hotel, Niagara Falls, N. Y., on September 18, with a full attendance of the executive committee and a good attendance of the general committee. A large amount of work was accomplished at this meeting, as during the lapse of time since the first meeting a number of committees have been at work formulating definite reports on certain branches of the congress programme.

Joint Meetings of the Electrical Associations and the Electrical Congress.

Among the more important matters that have now been definitely decided is that of the holding of joint meetings with the congress of several of our national electrical associations. The associations are to be invited to hold, if not all, at least a part of their annual conventions conjointly with sections of the congress. By this co-operation important papers by American engineers will be given a double prominence. They will be printed both as parts of the congress proceedings and in the transactions of the appropriate participating national electrical society.

Electrical Associations to Participate.

Thus far six of the national electrical societies have decided in favor of the electrical week at St. Louis as the time and place of their conventions of 1904, and have by their decisions assured not only the success of the electrical week, but have paved the way for the greatest assemblage of electricians that has ever congregated.

Invitation to Foreign Associations.

The congress committee will also extend invitations to all the foreign national electrical bodies. This action will stimulate the interest of over-sea electricians in visiting America next summer.

The individual interest of the foreign electricians in developing closer relations with their American brethren is shown by the fact that prominent electrical societies of the Old World are arranging to have official representation and headquarters at the exposition. It is their intent to make these headquarters tokens of the electrical development of the home countries, so that they may offer hospitality as from their own door steps.

Movement for International Standards.

One of the most important and perhaps far-reaching efforts of the congress committee is in the direction of starting a movement favoring international standardization in things electrical. A resolution, that passed unanimously, calls for pointed expression on this subject by eminent men of England, Germany, France, Italy, etc. It is to be hoped that all that, and more than, the resolution contemplates will be forthcoming, and that the chamber of delegates of the congress will find the time ripe for the establishment of a permanent committee on international electrical standardization which will from time to time report to properly accredited electrical bodies in the participating countries.

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HIGH-SPEED TRAINS.

In a recent issue one of our esteemed engineering contemporaries took occasion, in noting the successful attempts made in Germany to run cars over a special road at speeds exceeding one hundred miles an hour, to make a few well-considered remarks upon the desirability and practicability of running trains at such high speeds under ordinary conditions.

Are Fast Trains Desired?

The question was asked, who would care to travel at such speeds? The answer to this can only be found by an actual trial, but one can not help thinking that there is a large number of travelers who would be attracted by very fast trains. In addition to the time saved, there is keen enjoyment in fast traveling. However, few passengers board a train for the pleasure of riding. They always want to go somewhere, and, in general, the sooner they get there the better. Therefore, the faster the train, the better are they pleased. It is not to be expected that high-speed trains will be put in service unless they can be operated with safety and comfort; but if high-speed operation can be shown to be safe, we do not think that the railroads will have difficulty in securing passengers.

Fast Running Brings Signaling Troubles.

Our contemporary also points out how difficult it will be to operate a road over which trains are run at one hundred miles an hour by the block signal system, and the sensible conclusion is reached that such trains can only be run over a track built for them alone. It is said that a mechanical signal can not be worked satisfactorily with a greater length of wire than 2,000 feet. With the present train speeds it is not uncommon to place the distant signal 2,500 feet back of the home, and, therefore, for trains running at one hundred miles an hour, the distant signal ought to be at least 7,500 feet back, because the power stored in a railway train varies as the square of the speed, and all of this must be absorbed by the brakes to stop the train. The difficulty of operating a mechanical signal at this distance can, of course, be overcome by using some other system. An electrical signal can be operated at a distance of 7,500 feet as easily as at a distance of seventy-five.

Another trouble with such high speeds will be in giving an engineer a signal which can not be misunderstood. With a train running at one hundred miles an hour and a signal that can be seen 1,000 feet away, the engineer has less than seven seconds to verify the reading of the signal. If the signal, due to weather conditions, or otherwise, can not be seen for more than 200 feet, the engine runner would have just one and one-half seconds to decide whether his train was dashing to safety or destruction. Can not this difficulty be overcome by installing these signals, not singly, but in duplicate or triplicate a proper distance apart? There would be no more difficulty in operating three signals placed, say, 500 feet apart, electrically from a station 7,500 feet away from the nearest one, than to operate one. Moreover, a number of engineers are working on automatic signal systems which will, in addition to the signal on the side of the road, operate a signal within the engine cab. A system of this kind would overcome all signaling difficulties.

High-Speed Roads Not Improbable.

It is hardly possible that sustained speeds of one hundred miles and more will be common for some years, but it would be unwise to predict that such speeds are not practical. In addition to the special track, a high-speed line should be completely fenced in and there should be no grade crossings either of other lines or wagon roads.

SHOP TESTING OF MOTORS AND GENERATORS FOR COMMERCIAL SERVICE—IV.

BY BERTRAND B. ABRY.

THE DIRECT-CURRENT SERIES (RAILWAY) MOTOR.

It is here proposed to discuss the shop tests and characteristic curves of the railway motor in particular and the ordinary series motor in general.

The varying conditions of railway work, such as loads and speeds, necessitate a motor which will meet these conditions, if satisfactory service is to be obtained. The series motor is essentially a variable field machine. It is this inherent feature that makes it especially adaptable to railway service. For example, a large starting torque is necessary to accelerate a car, and the series motor meets this requirement, by virtue of its automatically varying field. The operation of "throwing on" the controller gradually increases the voltage across each motor with a corresponding increase in speed. After reaching full multiple we have practically a constant voltage, but on a level there is an excess torque over and above what is actually needed to overcome the resistance to the moving car. This excess torque will continue to accelerate the car, the rate of acceleration gradually decreasing until the torque exerted by the motors just balances the train resistance, when the speed becomes constant. As the rate of acceleration gradually decreases until constant speed is reached, the torque and current also diminish, and thus the motor field strength is automatically varied with the speed.

These inherent features are, of course, characteristic of the series motor in general, but it is especially desired to study the usual tests applied to a railway motor, since this type of a series motor is perhaps most extensively used and best known.

As earlier pointed out, there are two general classes of tests: those applied to new designs and carried out in detail, and tests less complete and of a general nature, applied to standard motors built in large numbers.

We will consider in this case the usual shop tests taken on some one particular design, since the general tests made on standard motors built in quantities consist mainly of temperature runs and insulation tests. We will assume that a new motor has been built and that the following tests are to be made:

1. Iron loss and friction test.
2. Friction test.
3. Speed test.
4. Brake test.

1—IRON LOSS AND FRICTION TEST.

In this test the motor is wired as shown in Fig. 10. It is not belt-driven as in the case of shunt and compound motors, because in a series motor any change in the field current produces a like change in the armature amperes, and hence the shunt-motor method of measuring iron loss is not used. As shown in the diagram, a resistance rack is placed in parallel with the motor armature, and most of the line current shunted through it.

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Just enough passes through the armature to supply the iron and friction loss.

The voltage across the armature is held constant throughout the test and the following observations made:

Speed.	Main Amperes.	Armature Amperes.	Armature Volts.	Watts Lost (Calculated).

The last column is calculated from the armature amperes and volts. The product is the watts lost in the iron and the bearing friction and windage. Note that these losses are inseparable in this test, due to the fact that there is always some friction, and more or less windage. The iron loss is a function of the current and voltage, therefore, after computing the watts lost for different currents, we may plot what is called the iron loss and friction curve, as shown in Fig. 11. It is customary to plot also the ampere curve at the same time. It now remains to determine the friction curve itself. When this is plotted, the difference in the ordinates of the two curves will give the iron loss at different loads.

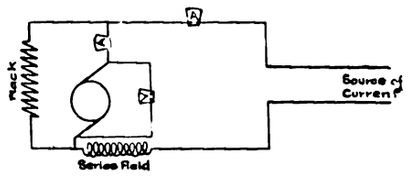

FIG. 10.—WIRING FOR IRON LOSS TEST.

2—FRICTION TEST.

To make this test disconnect the rack entirely and run the motor "light;" *i. e.*, begin with an impressed voltage of fifteen or twenty volts, increasing gradually, say, twenty-five volts at a time until the limit of armature speed is reached. For each impressed voltage the current will not exceed an amount equal to the friction and windage loss. The voltage and current being low, the iron loss is negligible. When ready to begin the test observe the following:

Speed.	Armature.		Watts Lost (Ca culated)
	Amperes.	Volts.	

As before, the watts lost are computed from the armature amperes and volts. Taking speed and watts as ordinates, the friction curve is plotted with the iron loss and ampere curve. Their general shape and relation to each other are indicated in Fig. 11.

Theoretically the friction varies directly as the speed and we would expect to obtain a straight line. Actual results, however, give in most cases a friction curve bending upward slightly at higher speeds. This may be accounted for as follows:

Higher speeds are obtained by increasing the voltage, consequently the "negligible" iron loss increases slightly. The windage also increases and adds to this loss, especially at the higher speeds. On the other hand, cases have been noted where the friction curve bends downward. This would indicate a decreasing bearing friction, but it is an exceptional case.

Attention is called to the relation of the ampere and iron loss and friction curves. Since the iron loss is a function of the current, we would expect changes in the current to produce corresponding changes in the iron loss. That these changes do occur is quite evident from the curves. As the motor speeds up the current decreases and the iron loss likewise. We would expect this relation to continue until the motor speed became constant. However, it

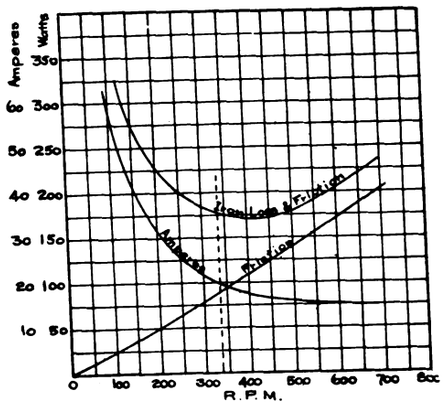

FIG. 11.—IRON LOSS AND FRICTION CURVES—SERIES MOTOR.

will be noted that the iron loss and friction curves bend upward after a certain speed is reached, instead of continuing downward with the current. This is due to the fact that at low speeds the ratio of the iron loss to the friction is large. This ratio gradually approaches 1 and at a certain speed equals 1, as indicated by the vertical dotted line cutting the two curves in Fig. 11. As the speed increases beyond this point, the inverse ratio holds. That is, the ratio of the friction to the iron loss gradually increases. In other words, although the iron loss tends to decrease as the speed goes up, the friction increases faster after a certain speed is reached, and the result is an upward bend in the curve.

Having plotted these curves accurately we may at once determine the iron loss itself by measuring the difference of the ordinates of the two curves at different speeds.

It is usually customary to plot these differences, or the actual iron loss, in the shape of iron loss curves, for any current desired. We will assume that it is desired to plot the iron loss curves corresponding to 100, 150, 200 and 300 amperes. Take for the ordinates, volts and watts as shown in Fig. 12. Then from the test curves corresponding to Fig. 11 find the loss in watts, as explained above, for different speeds and corresponding voltages. For convenience, tabulate as follows:

Amperes (Say, 100).	Volts (t orrected for Total Drop in Machine).	Watts Lost, or Iron Loss (Difference of Ordinates of Two Curves).

Since the iron loss is also a function of the voltage, to obtain true curves the voltage must be corrected for the total drop in the machine (which is the total resistance drop plus the brush drop) for the particular current chosen. That is, at 100 amperes the total drop corresponding to this current, and depending on the total resistance and brush drop, must be added to the voltage. Hence if we have noted the watts lost corresponding to certain observed voltages, say, 150, 200, 300, etc., we must increase these an amount equal to the total drop in the machine which we will assume amounts to ten volts at 100 amperes. Therefore the "watts lost" points on the 100-ampere iron loss curve should be plotted at 160, 210, 310, etc., volts.

In this manner any number of iron loss curves may be plotted for different currents. From the general shape of the curves it will be noticed that the iron loss does not vary in direct proportion to the voltage. In an actual case, where the curves are plotted accurately, it will be found that doubling the voltage increases the iron loss from two and one-half to three and one-half times.

Attention is also called to the fact that these curves do not pass through the origin, for the reason that it is necessary to impress a certain voltage on the motor, sufficient to overcome the drop in the machine before it will operate; and the

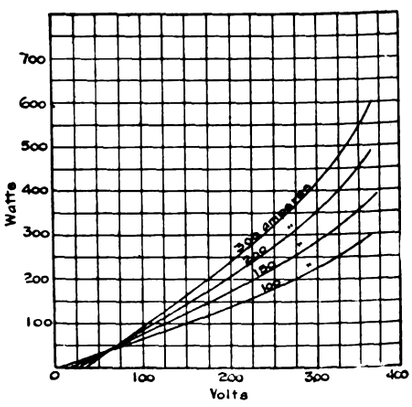

FIG. 12.—IRON LOSS CURVES—SERIES MOTOR.

larger the current the greater the drop, hence for the larger currents the curves cross the X axis at points still further from the origin.

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THE ROYAL COMMISSION ON LONDON TRAFFIC.

(From Our Special Correspondent.)

The following full text of the reference to the Royal Commission, appointed early in the year to enquire into the means for transportation in London, conveys at once the far-reaching character of the enquiry which is now being instituted. To enquire into the means of locomotion and transport in London and to report (*a*) as to the measures which they deem most effectual for the improvement of the same by the development and interconnection of railways and tramways on or below the surface, by increasing the facilities for other forms of mechanical locomotion, by better provision for the organization and regulation of vehicular and pedestrian traffic or otherwise, and (*b*) as to the desirability of establishing some authority or tribunal to which all schemes of railway or tramway construction of a local character should be conferred, and the powers which it would be advisable to confer upon such a body.

The first thing attempted was an enquiry into the efficiency and sufficiency of legislation as applied to locomotion and transport, chiefly tramways. At present in Great Britain powers to build tramways are obtained as follows: (1) By a provisional order granted by the Board of Trade under the Tramways Act of 1870. In this case the provisional order has to be confirmed by Parliament. (2) By a bill promoted by Parliament itself. (3) By a light railway order granted by the Light Railway Commissioners under the Light Railway Act of 1896. In this case the order has to be confirmed by the Board of Trade, without any reference whatever to Parliament. At the very commencement of the enquiry it was conceded by the Board of Trade officials that this legislation was unsatisfactory and conflicting for many reasons. For instance, the Tramways Act of 1870, as is obvious, was drafted at a time when electric traction in its present day form was not dreamed of; yet practically not one modification of it has been attempted. The one outstanding objection to it is what is termed the local veto, or the clause which makes it incumbent upon promoters to obtain the consent of the road authority before any scheme may even be put before Parliament. The standing orders of Parliament render it impossible for any bill in connection with which this condition has not been fulfilled being even accepted. Again, the terms of purchase under the 1870 Act are such that a tramway company would, at the end of the twenty-one years or so, receive from the local authority taking over the lines nothing whatever for good will, and merely the material price of the undertaking, *viz.*, stock, etc. Thus there has never been any inducement to a company to keep its undertaking in an efficient condition, unless better terms have been arranged with the local authority.

These disadvantages, however, while not applying *en bloc* to the other two methods of legislation, nevertheless reflect upon them. It is possible for two rival promoters for the same district to seek powers under different legislation, and the mere fact that one body gets through its business quicker than the other, gives the line over to one promoter without any consideration of which scheme is best suited to the needs of the locality. All these, and many other points, were given in evidence before the commission, which, more or less recognizing the unworkable nature of the legislature's machinery, asked for opinions as to the desirability of establishing a central authority or tribunal before which all schemes of locomotion relating to London should be placed.

All over Great Britain we have what are known as the tramway authority and the road authority. In many provincial towns these powers are both vested in the local authorities, so that conflict of parties is to a large extent avoided. In London, however, the London County Council is the tramway authority, and each of the twenty-seven borough councils is the road authority for its own district. Thus the present position is that any private company wishing to construct new lines has to obtain the consent of both the county council and the borough council, and the county council, for its tramway schemes, has to obtain the consent of the borough council. The borough councils are precluded by law from constructing tramways, and although the county council has leased some of its lines to a company in the north, it has now set its face against any company-built lines being again undertaken, although Parliament did this year override the county council in one particular instance in respect of a very short length of line near the borders of the county. To all intents and purposes this leaves the question of locomotion in London in the hands of the London County Council and the London borough councils, the latter having the right to veto any scheme for tramways put forward should it so please, a position which, naturally, is not very acceptable to the county authority. There has always been friction between these various borough councils and the county council, particularly in respect of road widenings for new tramways.

Now as to the establishment of a special tribunal having full and complete jurisdiction in regard to means of locomotion, there was a pretty general consensus of opinion that the existence of such a body would be beneficial, for, from the tramway company promoters' point of view, it would at once abolish the local authority veto, and allow any scheme to be put forward for consideration. But the London County Council asserts that it and it alone should be the deciding factor in tramway matters, and that the abolition of the borough council veto would only mean that it (the county council) would have to submit to examination at the hands of another and more powerful body without in its turn having any control over outside promoters coming into London. Its proposition was, therefore, that a special tribunal as proposed should be established for the purpose of dealing with railways only, and that the county council should have the final word in the matter of tramways.

An attempt was also made by the Royal Commission to ascertain from witnesses expert opinions as to the best means of extending the present means of communication, but it must be confessed that very little agreement has, as yet, been arrived at. In spite of the underground shallow tunnel tramway which is now being constructed in one portion of the city, this method is not highly thought of unless, as in this instance, it is built with a new street.

Surface tramways are impossible in the city and its immediate connections owing to the narrow streets and disinclination of the city authorities to agree. Therefore it looks as if the suggestion that surface tramways should run from the suburbs as near the inside as possible, and then for passengers to continue across the city with tube railways, was the only one left. The tube railways come to the centre of the city and stop there, thus increasing the congestion at that point.

Evidence will be tendered at the resumption of the sittings by tube railway and other managers. In the meantime, however, all progress regarding means of locomotion in London has been stopped pending the report of the Royal Commission.

London, October 17. A. W.

The Electrotechnical Institute of Montefiore.

The catalogue of the Electrotechnical Institute of Montefiore, at the University of Liege, Belgium, has been received. This gives a good description of the electrical equipment and illustrates the apparatus used in the study of intense currents, high potentials, machine testing and operation, study of wave-forms, etc. Courses are offered at this institution in mining engineering, electrical engineering, electrochemical engineering and mechanical engineering.

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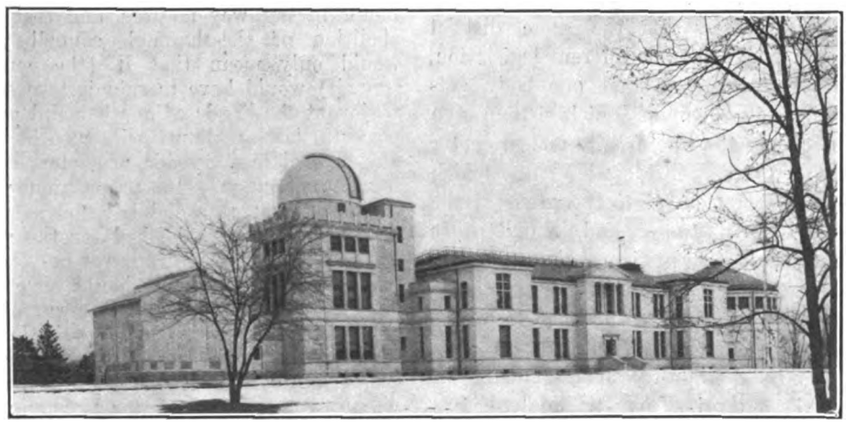
ELECTRICITY IN THE UNITED STATES GOVERNMENT SERVICE.

BY J. E. PRICE.

In the matter of using electricity Uncle Sam sets a good example to his progressive people. He employs it for light and elevator service in the department buildings, for running machinery, and also for lighting in his huge printing office, money-manufacturing shop and navy yard at Washington; and then he uses it in three peculiar ways, in connection with the heavens, the earth and the air. To these latter interesting features may be added a magnetic department, which has to do with scientific study, not much known to the public.



MAIN BUILDING, NAVAL OBSERVATORY.

Two of the peculiar electric features mentioned are found at the Naval Observatory—which is located on Georgetown Heights, near Washington, D. C.—and they concern the getting of correct time and its distribution for public clock service. The other feature is wireless telegraphy, about which much has been written, of experiments being made by the government and the use of such an invention in connection with the life-saving service, etc.

In regard to "keeping tab" on time electricity, of course, is not the main factor, but it is a most useful and necessary adjunct, and it marks time—sets clocks in many places with unfailing regularity.

There are many clocks at the Naval Observatory, but those which are connected with the chronograph department are of most interest. They embrace the electric feature in the time system; some having to do with mean time, but the most important one with astronomy.

This timepiece is called the sidereal (star) clock, and is used in connection with the transit circle. It is connected with a chronograph, in the same room, and with the galvanic system of the observatory, by means of a platinum rod, and a small globule of mercury. The latter is so arranged on a metallic support, that at each oscillation of the pendulum the platinum point touches the mercury when the pendulum is at the middle of its arc, closes the circuit and transmits its fractional time message, to be recorded by an automatic marker on the table-sheet on the chronograph. Thus a continuous marking goes on, unless interrupted; and this interruption plays its important part in getting correct time.

Contrary to public idea, getting exact time does not depend mainly upon sun observation. One rotation of the earth, according to opinions of scientific time-gaugers, does not make a complete day; but the time between the appearance at meridian of a fixed star and its reappearance in the same position, gives the exact diurnal period.

The observer, through the transit telescope—across the smaller end (inside) of which are stretched a number of spider-web threads—marks the star almost at meridian, and as it comes to the meridian line, outlined by the threads, he presses an electric button, or lever, and thus causes the recording-pen of the chronograph, above mentioned, to leave its zig-zag course around the revolving sheet and make a short line, which represents meridian star time.

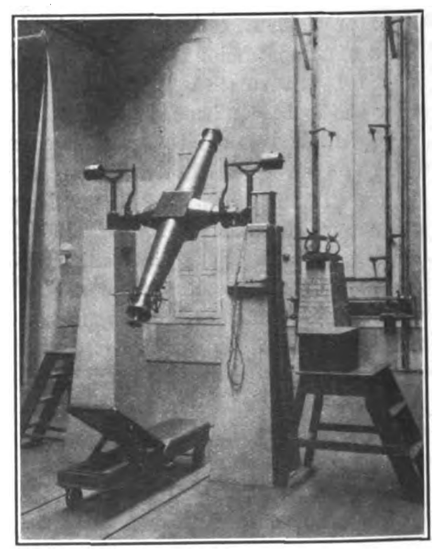
Now the sidereal clock record is compared with absolutely correct star-time tables, which show what the proper record should be; and then the difference, if there is any, between clock and table is corrected and the result is perfected by reference to the mean time chronographic record. After figuring out all differences, "time is in condition" to be electrically recorded wherever there is a clock connected with the wires of the Western Union Telegraph Company.

To this company "time is surely money"—and money all the time. And not a cent is paid to Uncle Sam for his time—the time it takes him to make first-class time—and also nothing for wear and tear of instruments.

The telegraph company makes about $1,000,000 per year out of this time business, in which it is without a rival—although the government will give to any one who can utilize the privilege the service rendered the Western Union company. But that company now gives all necessary service desired, keeping about 70,000 clocks correct, charging for so doing $15 per year for each clock.

These are set at noon each day by an automatic arrangement in each electric equipment, which responds to the beat of the sidereal clock in the Naval Observatory, when its hands point to twelve and let the time current go.

A few minutes before this hour business over the Western Union wires is suspended, and operators throughout the country put their instruments in shape to form an unbroken circuit, from the observatory to every place where ticks a clock to be electrically influenced. There is a hush over all the great telegraphic system. Then the time bell strikes, and instantly the time-message flashes over the wires. It is twelve o'clock.



TRANSIT TELESCOPE.

Concerning earthquake shocks, electricity acts as a registering force. Until the electric cars, which run near the Naval Observatory, began the too free distribution of current, there were at that place an earthquake detecting arrangement and a magnetic observatory—two attachments of much scientific interest. But, though the magnetic department does not now form part of the observa-

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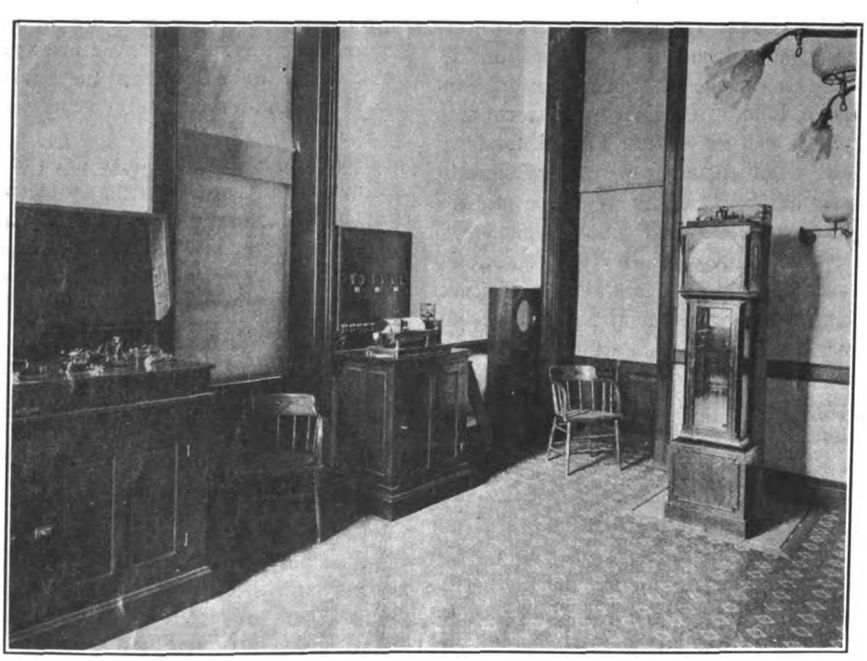
tory's outfit, there are four others belonging to the government. These are located at Los Angeles, Cal.; San Antonio, Tex.; Madison, Wis.; and Key West, Fla.

For detecting earthquake shocks a seismograph and seismoscopes are used. These are set upon solid foundations, which can be affected only by earth tremors. There are two seismoscopes employed; one being set upon a pier in a separate building, where are also clocks electrically connected with both seismoscopes in such manner that when the earth begins to tremble they leave their supports and thus start an electric current which stops the clocks, and record of the occurrence is made by the seismograph.

Another source of earthquake information is found in the magnetic observatory. One of the latter—as seen by the writer at the Naval Observatory—was situated both above and underground. The above



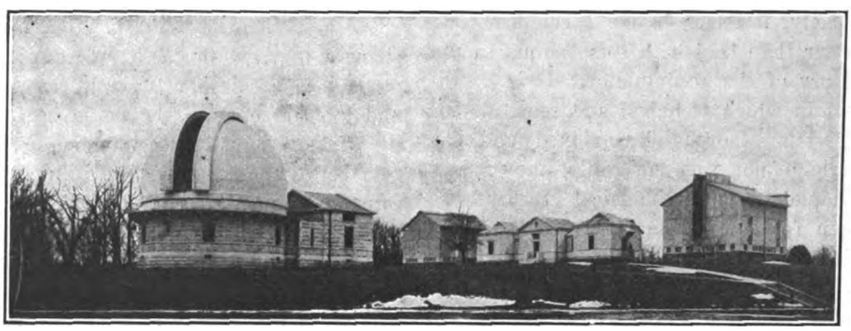
INTERIOR OF TIME-SERVICE ROOM, SHOWING STANDARD CLOCK.

ground portion consisted of a small one-story structure (in which could be seen many peculiar instruments, dip-circle apparatus, seismoscopes, compass-testing stand, etc.) and a big conical earth mound, the latter perforated by ventilating pipes. Underneath this mound (the building and mound are still there) there was a room in which was kept a magnetic outfit used for gathering data concerning terrestrial magnetism.

It is known that the earth is a huge magnet, and that it is continually emitting magnetic waves which have their courses and influence according to conditions. One manifestation of magnetic current was recently witnessed in the marked disturbance of the magnetic needle at one of the magnetic observatories in this country, near the time of the second eruption of Mount Pelee.

The underground room mentioned had double walls with air-spaces, and was kept at an even temperature. The work done there was carried on principally by what might be called "automatic photography."

The apparatus consisted of three balanced magnetic needles enclosed in a glass case, each mounted on a stone pillar, a clockwork paper-sheet carrier, and three narrow wooden channel boxes, each about six feet long. The boxes branched out from a central box which contained the clockwork machinery, and each entered the needle case situated at its end. At the back of each of the three needles there was a small mirror reflector which, with the aid of a spot of light centered on each, projected the position of the needles through the channel boxes and upon a sheet of sensitized paper. The latter, by action of the clockwork, had a continuous movement, and thus, for a period of two days, took a photographic outline of all the motions of the magnetic needle, caused by magnetic disturbance. If, when the sensitized paper was taken out of the machine and developed, only straight lines were found, no magnetic disturbance had occurred; the zigzag line told of the presence of magnetism.



SHOWING TRANSIT INSTRUMENT HOUSE AND DOME, 26-INCH EQUATORIAL TELESCOPE HOUSE.

The chief business of a magnetic observatory is the study of atmospheric electricity and earth currents, their force, direction, etc., thus obtaining scientific information which may be applied in several ways. One of these relates to the correction of the mariner's compass. And when there is an earthquake disturbance the magnetic needle is influenced by increased flow of earth current, sometimes before the earth begins to shake.

Animal Mechanics and Motor Vehicle Designs.

The reason for the failure of many of the early types of automobiles is discussed in the *Mechanical Engineer* (London), in its current issue. At first sight a three or four-horse-power motor would seem to afford ample margin, but experience soon taught the fallacy of comparing these machines with horses. The average output of a horse is generally estimated at 22,000 foot-pounds per minute, though Watt, in his desire to be generous, allowed fifty per cent more than this, and counted 33,000 foot-pounds per minute as one horse-power for his engines. This rating is for continuous effort, but for a short time a horse is probably capable of doing work at ten times this rate, as, for instance, in starting a heavy load or drawing up hill; and it is this element of flexibility which automobile designers did not take into account. These considerations show why a motor vehicle, to maintain an average speed of, say, twelve miles an hour, requires a motor of a very much greater power than one operated by animals. The motor, in fact, must be armed with sufficient power to meet any emergency, and this at times may be ten times the average demand.

Great power provision, however, brings other troubles in the shape of additional weight, and a satisfactory solution of high speeds and comfortable traveling in a motor vehicle is to be sought in increasing the power without increasing the dead weight. It is in this direction that the French builders are developing their business, and this explains their success in building motor-driven vehicles.

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TOTAL AND FREE ENERGY OF THE LEAD ACCUMULATOR.[1]

BY R. A. LEHFELDT.

In choosing a subject on which to address the opening meeting of the Faraday Society, it seems to me I could not do better than deal with some points in the theory of the accumulator. It is a subject in which technical and scientific interests are thoroughly combined; and it is perhaps not very generally known how completely electrochemical theory has been found to harmonize with the experience of technicians, how satisfactorily it brings together many experimental facts, and how suggestive it is. I have little to say to-night that is new; what I aim at is to bring into as clear a light as possible one salient aspect of physics as applied to the lead accumulator of the technical electrician.

The chemical reaction of the accumulator I take to be

$$\tfrac{1}{2}Pb + \tfrac{1}{2}PbO_2 + H_2SO_4 \rightleftarrows PbSO_4 + H_2O.$$

(Read from left to right on discharge, and from right to left on charge.[2])

That this, on the whole, accords with the facts there can be no doubt. The evidence in favor of it—chemical, electrical and thermodynamic—is a more than sufficient proof. It is quite possible that certain minor points are not explainable without taking other actions into account. Elb's observations on plumbic sulphate, $Pb(SO_4)_2$, seem to show that that substance plays an important part, at least in the formation of spongy lead. But it will not be necessary for my present purpose to pay attention to such possibilities.

Taking the above equation to be correct, I wish to point out how the general laws of energy allow one to draw conclusions with regard to the electromotive force of the cell in which the reaction takes place.

For the purpose of analyzing the transformations of energy involved, the reaction on discharge may be regarded as consisting of three parts:

(a) From the electrolyte of the accumulator remove one molecule of sulphuric acid (H_2SO_4).

(b) Cause this to react with the dry solids Pb and PbO_2.

(c) Mix the molecule of water thus formed with the electrolyte.

Action (b) is the same, whatever the concentration of the electrolyte may be; actions (a) and (c), on the other hand, involve that concentration. Accordingly, we may separate the energy, and therefore the electromotive force of the reaction, into a fixed part, depending on (b), and a part varying with concentration, depending on (a) and (c).

We have then to determine the energy changes involved in these processes; the method is applicable to both the total and the free energy. It would be inappropriate to go at length into the distinction between these two quantities; yet I can not help remarking that the distinction, which has occupied physicists for a quarter of a century, is not generally enough noted even now. And as the conception of free energy is the most important of all in physical chemistry, it can hardly be insisted on too much. It is, moreover, one of which it is very difficult to form any mechanical image.

When a chemical system suffers a transformation, such as that involved in the action of the accumulator, it loses a certain amount (sometimes negative) of energy, and since all energy, indiscriminately, is capable of transformation into heat, it is only necessary to perform the reaction in a calorimeter to find out how much. But all energy is not indiscriminately capable of doing work—despite its name—and with a chemical change a certain amount of ability to do work is associated; this amount being distinct from the change in total energy. Moreover, it is not mechanical work merely that is in this position; many kinds of energy, perhaps all except heat, are freely interchangeable among themselves, and yet not with heat.

We have therefore to recognize two grades of availability in energy—not an indefinite gradation, which would perhaps be easier to understand, but two planes, so to say, a higher and a lower. With regard to the former, a chemical reaction has a certain energy value; with regard to the latter, another energy value, which may be either greater or less than the first. The value on the higher plane—*i. e.*, of chemical, electrical, mechanical actions—is called the free energy of the reaction; that on the lower plane, of thermal actions, the total energy. And the total energy is "conserved" in any case; the free energy is conserved if the action remains within the limits appropriate to the higher plane.

I—TOTAL ENERGY.

There are many ways of expressing the composition of a sulphuric acid solution. It will be most convenient to choose the molecular fraction in the present instance; *i. e.*, if z molecules of H_2SO_4 be mixed with $1 - z$ molecules of H_2O, z is taken as the expression of the strength of the acid. As an instance of the meaning of this, I take an acid of ordinary strength, for which $z = 0.05$. This may be stated in various forms, as follows:

Molecular fraction, . .	$z = 0.05$.
Composition, ...	$H_2SO_4 . 19H_2O$.
Percentage by weight, .	22.27% H_2SO_4.
Grammes H_2SO_4 per litre,	258.
Normality, ...	5.26 equivalent per litre.
Density, ...	1.161.

Let χ be the heat of reaction of the pure materials (process (b) above) for the quantities shown in the chemical equation, and let Q be the heat of formation of the dilute acid used as electrolyte, per molecule, *i. e.*, Q is the heat evolved by mixing z H_2SO_4 with $(1-z)$ H_2O. [In the example chosen, mixing 0.05 molecule or 4.9 grammes of strong sulphuric acid with 0.95 molecule or 17.1 grammes of water.] Q is found by experiment, and we have to express in terms of it the changes of total energy involved in (a) and (c).

Suppose the reaction to proceed to an infinitesimal extent, so that dz molecules H_2SO_4 are used up, and dz molecule H_2O formed, for every molecule of electrolyte. Then the concentration which was formerly z has become $z - dz$. The heat evolved (negative in amount) in consequence of the removal of acid, and that (positive) due to addition of water to the electrolyte, are together expressed by $-\frac{dQ}{dz}dz$. Hence in processes (a) and (c) the heat is $-\left(\frac{dQ}{dz}\right)$, and the total heat of reaction of the accumulator is expressed by—

$$\chi - \frac{dQ}{dz}$$

This conclusion, only in a less simple form, was, I think, first arrived at by Dolezalek,[1] to whom the theory of the accumulator owes so much.

Q has been determined by J. Thomson, Pickering and others. I have taken Pickering's numbers[2] in the following calculations. When Q is plotted as a function of z the curve obtained is hardly regular enough to take differential coefficients off; I have therefore adopted the artifice of combining the graphical method with an empirical formula. Over the range required, *i. e.*, from $z = 0$ to $z = 0.25$, the curve is roughly parabolic. I therefore choose a parabolic formula conven-

[1] A paper read before the Faraday Society, June 30, 1908.

[2] I have written the above equation with the quantities required to convey one "faraday" of electricity (96,000 coulombs). This, I think, is a practice that electrochemists might adopt generally with advantage.

[1] *Wied. Ann.*, 65, 896.

[2] *J. C. S.*, 57, 112.

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ient for calculation—not necessarily the nearest to the truth that can be found—and draw a curve showing the differences between this and the experimental data.

Before giving the numbers it is necessary to remark on the unit used. Quantities of heat are properly expressed in joules—no electrochemist, I hope, will use the unsystematic, inconstant and unnecessary calorie. For electrochemical purposes it is desirable to express all heats of reaction per equivalent, and not, as in thermochemistry, for molecular quantities; but we may go a step further and divide the result by 96,600—the number of coulombs transported by an equivalent of matter. The result will be a number of volts corresponding to the heat of the reaction, and one may be permitted the slight inaccuracy of saying, for brevity, the "heat of reaction in volts." It must be remembered, of course, that the number of volts thus arrived at is not that actually given by the reaction, but that which would be given if all its energy were spent in producing current.

With this explanation, then, I may say that the heat of formation of sulphuric acid solutions is roughly—

$$Q = 0.8\,z - 1.2\,z^2 \text{ volts.}$$

The deviations from this formula are too large to ascribe to errors of experiment; I have therefore plotted them on a large scale diagram. To determine $\frac{dQ}{dz}$ I calculate from the above formula $0.8 - 2.4\,z$, which forms the greater part, and get the small correction by tangents to the curve.

The results are given in the following table:

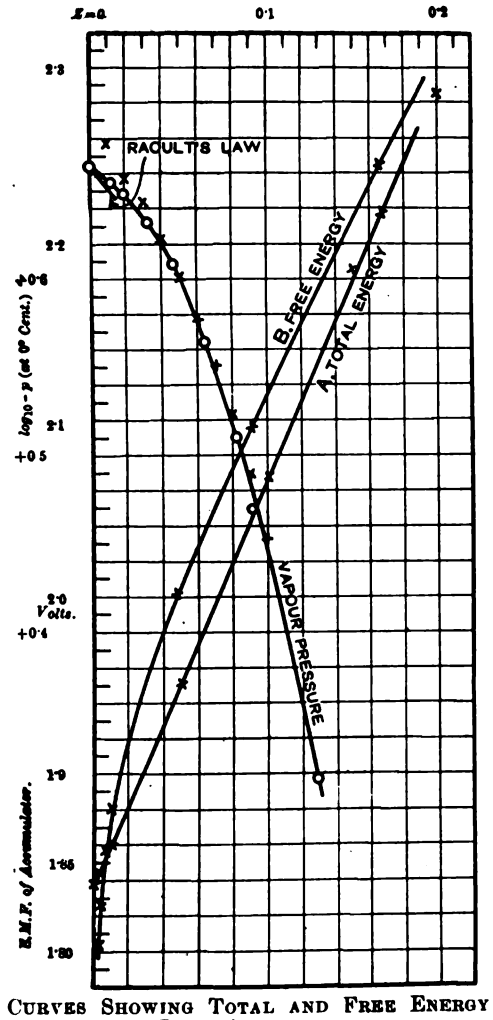
z	$\frac{dQ}{dz}$ (volts)	
0	0.787	From Pickering's measurements. Temperature, 18°.
0.0025	0.781	
0.01	0.765	
$\frac{1}{200}$	0.680	
0.05	0.674	
$\frac{1}{100}$	0.579	
0.10	0.557	
0.15	0.440	
$\frac{1}{6}$	0.407	
0.20	0.340	
0.25	0.253	

These numbers give the variation of the total energy of reaction; but we have also to find χ in order to know the total energy itself. Two methods are available. The heat of reaction has been found calorimetrically in the case of acid of strength $z = 0.0025$. Tscheltzow[1] gives for the molecular quantities 88,800 calories = 186,580 joules per equivalent, or 1.931 volts; Streintz,[2] from a different series of reactions, 86,800 calories = 182,280 joules = 1.887 volts.

Secondly, we may adopt the thermodynamic formula $(E - T\frac{dE}{dT})F$ for the heat of reaction.

(Where E = electromotive force
T = absolute temperature
F = quantity of electricity.)

If we adopt the same mode of expression for the quantities of energy as before, F = 1, and the "heat of reaction in volts" is given by $E - T\frac{dE}{dT}$ merely.



CURVES SHOWING TOTAL AND FREE ENERGY OF LEAD ACCUMULATOR.

The degree of consistency between the data may be judged by the table below, in which χ is calculated by both methods.

The numbers in the last column should, of course, be constant; they actually vary by 1 to 2 per cent from the mean, which, considering the number and difficulty of measurements involved, is fairly satisfactory. χ, as calculated from the heat of reaction, is certainly too high, so it appears that this has been overestimated. The true heat of reaction is probably less than even Streintz's value.

Taking the mean value of χ and combining it with the tabulated values of $\frac{dQ}{dz}$ as the most trustworthy final results, we get what is shown in the figure, curve A. This is the total energy of the reaction—

$$\tfrac{1}{2}Pb + \tfrac{1}{2}PbO_2 + H_2SO_4 \rightleftarrows PbSO_4 + H_2O$$

expressed by its equivalent in volts, for various strengths of acid.

II—FREE ENERGY.

The free energy of a reaction may be estimated in various ways, and two of them have been actually worked out for the accumulator.

(1) The first is to measure the electromotive force (E). For this, multiplied by the quantity of electricity (F), flowing, gives the electrical work done (EF); or abbreviating, as before, we may express the equivalent of the free energy by the voltage E merely. Herein lies the extreme importance of electromotive-force measurements in physical chemistry.

(2) We may compare the free energy values in two solutions of different strength by studying the process of distillation. If two accumulators with electrolytes of different densities be put in opposition, the stronger will charge the weaker; the total amount of Pb, of PbO_2, and of $PbSO_4$ will be unchanged; but there will be less strong acid and more weak after the action is over. Now just the same thing could be accom-

TEMPERATURE FIFTEEN DEGREES.

z	Heat of Reaction.				$\frac{dQ}{dz}$	χ
0 0025	1.923				0.781	2.704 Tscheltzow
do.	1.879				do.	2.660 Streintz
	E	$\frac{dE}{dT} \times 10^4$	$T\frac{dE}{dT}$	$E - T\frac{dE}{dT}$		
0.01	1.881	− 7	− 0.020	1.901	0.765	2.666
$\frac{1}{200}$	2.002	+ 32	+ 0.092	1.910	0.680	2.590
$\frac{1}{100}$	2.097	+ 11	+ 0.033	2.065	0.579	2.644
$\frac{1}{6}$	2.246	+ 6	+ 0.017	2.229	0.407	2.636
....	2.348	+ 4	+ 0.011	2.337	0.253	2.590
					Mean	2.625

[1] *C. R.*, 100, 1458 (1885).
[2] *Wied.*, 53, 698 (1894).

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plished by distilling some water from the weak accumulator into the strong one, and some H_2SO_4 from the strong into the weak. I need not go into details of the process, as these have been worked out by other writers; but it is clear that if we take E as the measure of the free energy of the accumulator reaction with acid of a certain standard density, we can find what it is for any other strength of acid in terms of vapor pressures.

I have collected and recalculated the best data I can find as to these two methods, and the results are shown in the figure. Curve B gives direct measurements of electromotive force. The other curve shows Dieterici's[1] measurements of vapor pressure at 0 degree. But as the process of calculating electromotive force from this is not a satisfactory one, I have reversed it and calculated the vapor pressure from the electromotive force; the results are shown by small crosses near the vapor-pressure curve. The vapor pressure for $z = 0.05$ is assumed. It will be seen that the other points lie near the curve of observation, but the agreement leaves something to be desired.

The curve of free energy follows that of total energy in its general course. The difference between the two represents, as is well known, the "latent heat" of the cell, or, otherwise stated, the term $T\frac{dE}{dT}$; it is consequently a measure of the temperature coefficient of this cell; this is positive over most of the range, but negative for very dilute acid, and zero for $z = 0.006$. For that concentration alone the free energy is equal to the total energy. This point was determined by Dolezalek by direct experiment, as $z = 0.012$. Here, again, though the experiments support the theory in a general way, the agreement is not quite what might be hoped for if the constants of sulphuric acid solutions were systematically redetermined.

APPENDIX.

If Ω is the change of free energy corresponding to the reaction (in equivalents)—

$\frac{1}{2}Pb + \frac{1}{2}PbO_2 + H_2SO_4 = PbSO_4 + H_2O$,

when undiluted H_2SO_4 is used; and if W is the free energy of formation of the mixture $z\ H_2SO_4 \cdot (1-z)\ H_2O$, then the change of free energy due to the above reaction when taking place in a solution of strength z is $\Omega - \frac{dW}{dz}$.

The electromotive force E of an accumulator is therefore found by dividing this quantity by the "faraday" F (= 96,600 coulombs), or

$$E = \frac{1}{F}\left\{\Omega - \frac{dW}{dz}\right\} \quad . \quad . \quad . \quad (1)$$

Now $\frac{dW}{dz}$ may be found in terms of vapor pressures as follows:

Given one molecule of mixture of strength z, and a small quantity of dz molecule of H_2SO_4, mix these, and remove from the mixture dz molecule of H_2O. We have then obtained one molecule of mixture of strength $z + dz$, or in chemical symbols—

$$z\ H_2SO_4 \cdot (1-z)\ H_2O + dz\ H_2SO_4 = (z+dz)\ H_2SO_4 \cdot (1-z-dz)\ H_2O + dz\ H_2O.$$

The change of free energy in this reaction is therefore $\frac{dW}{dz}$. To evaluate it, suppose the acid added and water removed reversibly by isothermal distillation.

Let p_o p be the vapor pressures of pure water and of water in the given mixture respectively.

p'_o p', the vapor pressures of pure sulphuric acid and of sulphuric acid in the given mixture respectively.

R, the gas constant.

T, absolute temperature.

Then it is well known that—

$$\frac{dW}{dz} = RT\left\{\log_e \frac{p'_o}{p'} - \log_e \frac{p_o}{p}\right\} \quad . \quad . \quad (2)$$

Hence,

$$\frac{d^2W}{dz^2} = RT\left\{\frac{d\log_e p}{dz} - \frac{d\log_e p'}{dz}\right\} \quad . \quad (3)$$

But in virtue of the thermodynamical relation[1]—

$$z\frac{d\log_e p'}{dz} + (1-z)\frac{d\log_e p}{dz} = 0 \quad . \quad . \quad (4)$$

We may eliminate from (3) the vapor pressures of sulphuric acid, which are too small to measure, and obtain—

$$\frac{d^2W}{dz^2} = \frac{RT}{z}\frac{d\log_e p}{dz},$$

or, from (1)—

$$\frac{dE}{dz} = -\frac{RT}{zF}\frac{d\log_e p}{dz} \quad . \quad . \quad . \quad . \quad (5)$$

This equation may be made use of either to determine E from p, or p from E; but, in practice, allowing for the difficulty of obtaining trustworthy empirical formulæ, it is the latter that is more satisfactory. For this purpose we may write:

$$\log_e p = -\frac{F}{RT}\int z\frac{dE}{dz}\,dz.$$

Direct evaluation of this integral involves the impracticable practice of obtaining differential coefficients of the observed electromotive forces. It is therefore necessary to integrate by parts:[2]

$$\log_e p = \frac{F}{RT}\left\{\int E\,dz - Ez\right\}.$$

[1] *Wied.*, 50, 61.

[1] For the history of this relation, see Ostwald *Lehrb. d. Allg. Chemie*, Vol. II, p. 638.

[2] Lehfeldt, *Phil. Mag.*, April, 1901.

The results given in the text and accompanying plates have been obtained graphically from data given by Dolezalek;[1] they are given in terms of the cadmium cell as 1.0220 volts. I have therefore reduced them in accordance with more recent determinations of the standard cell as being 1.0187 volts. Thus reduced they are:

z	E
$\frac{1}{101}$	1.881
$\frac{1}{51}$	2.001
$\frac{1}{11}$	2.096
$\frac{1}{6}$	2.245

[1] *Theorie des Bleiaccumulators*, p. 33.

A Simple Oscillograph.

The oscillograph is a useful instrument for studying the phenomena of alternating currents, but, unfortunately, the instruments perfected by Blondel and Duddell are too expensive to come into general use. The *Electrical Engineer*, of London, describes a simple oscillograph devised by A. Wehnelt, which is not expensive and which has been used successfully for ordinary frequencies. The vibrating part of this instrument is formed of a loop and hard-drawn silver wire supporting a mirror. The two sides are parallel and from two to three millimetres apart. When a current is passed through this wire with the magnets excited, the mirror is deflected to an extent approximately proportional to the current strength, the apparatus acting as a D'Arsonval galvanometer. If the current varies periodically, instantaneous deflections will still be proportional to the instantaneous current values, provided that the natural period of the moving system is very short compared with the period of the current, and also that damping of the system is very great. By employing a powerful magnet and a tightly stretched wire, both these conditions may be fulfilled. The wire is mounted on ebonite, with a tightening arrangement which allows the amplitude curves to be varied at will. A small three and one-half ampere arc lamp is used as a source of light, the beam being rendered parallel by means of a lens. For lecture purposes a revolving mirror throws the curve on the screen, and by a simple arrangement of two of these instruments, both the current and electromotive-force curves can be shown simultaneously, and the effect of varying the constants of the circuit is plainly demonstrated. This apparatus can be used if the periodic time of the change to be considered is not less than 0.01 second, as the natural time of swing is 0.003 second. In the Duddell oscillograph this is only 0.0001 second.

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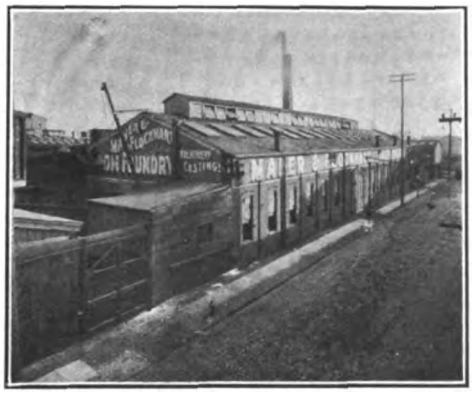
AN INTERESTING FOUNDRY DEVELOPMENT.

THE LIBERAL USE OF ELECTRIC MOTORS AFFORDS CONSIDERABLE ECONOMY IN HANDLING RAW MATERIAL AND CASTINGS.

In any line of industry it is one thing to modernize by building all new works where the latest improvements may be readily incorporated and provisions for expansion allowed, but it is quite another matter to keep an old plant abreast of the advancing times and its facilities adequate for the increased demands upon its producing capacity. The foundry of Messrs. Maher & Flockhart, in Newark, N. J., is an example of a success in the latter class, for while it had its beginning in a small way, with only such means as that time afforded, it is to-day employing about 400 men and conducting a large business on a profitable basis, due to the fact that the owners are alive to the advantages of improved methods and perfected machinery.

The original works, erected in 1882, occupied a space about 100 feet square, on the corner of Polk and Clover streets, Newark, N. J. Since that time they have been extended on all sides until they now cover an area of two and one-half acres, the regular layout of which is shown on an accompanying plan. The apparent lack of system in the arrangement of parts was the unfortunate but unavoidable consequence of this bit by bit growth. Each addition was made in what was considered at the time the most advantageous manner, although the outcome as a whole has not proved all that could be desired. However, the disadvantages of the worst locations have been largely removed by installing conveying appliances both out of doors and in, in the shape of industrial railway tracks and communicating cranes.

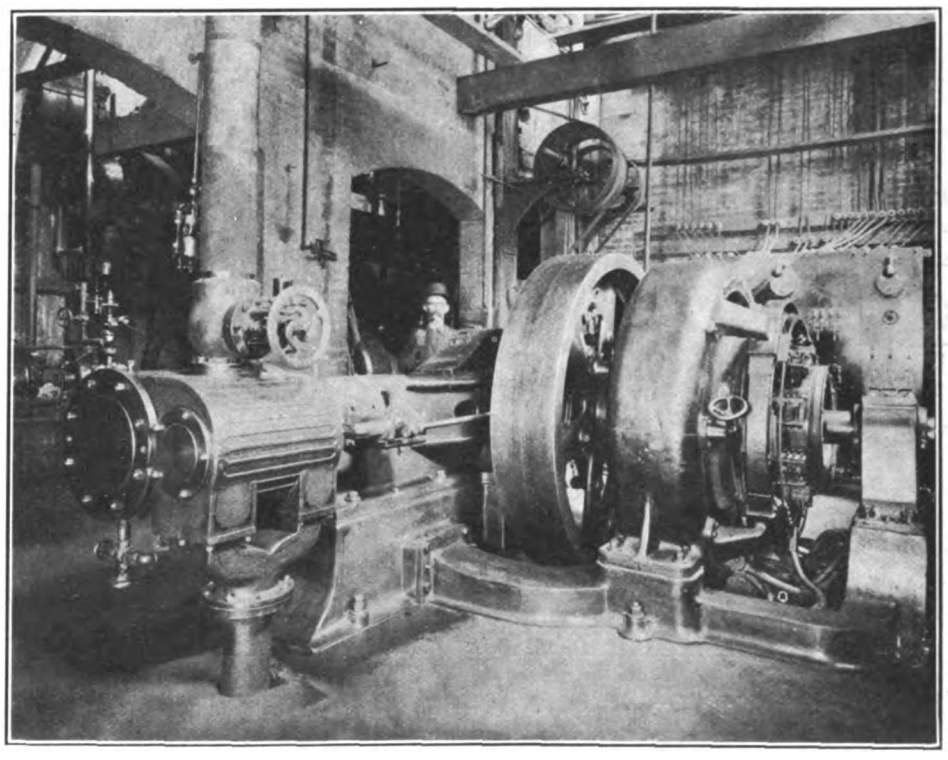
One of the neatest features contributing to convenience is the scheme for delivering supplies into the yards by freight. The tracks of the Central Railroad of New Jersey pass close to the grounds and being elevated to avoid grade street crossings through the city were easily connected with two spur trestles which branch into the yard. Beneath the trestles are numerous storage bins into which the contents of the cars may be dumped directly, giving a selective distribution and requiring no handling of the material until it is needed for use. Under the trestle terminating near shop No. 2 are bins for the following: Jersey clay for clay-wash; kaolin for furnace and ladle linings; sand for sand-blast; soft coal for the boilers; coke and pig iron. The other line of bins is used to store stove coal for the core ovens; soft coal for the boilers; Jersey sand for dry-sand work; fire sand; Albany sand and Waterford sand for green sand moulds. There are also two narrow bins, or chutes, secured on the outside



EXTERIOR VIEW OF THE MAHER & FLOCKHART FOUNDRY, NEWARK, N. J.

of the larger ones, which are used to hold pea-coal and flour. A sufficient stock of coal, sand, etc., is always carried in storage to cover a period of four months and avoid shutting down for anything but a prolonged failure to receive supplies.

Shops Nos. 1, 2, 3 and 4, indicated by those numbers on the plan, are the largest buildings, and constitute the foundries.



VIEW IN ENGINE ROOM, SHOWING HARRISBURG ENGINE DIRECT-CONNECTED TO A CROCKER-WHEELER GENERATOR.

Foundry No. 1 produces all of the largest castings, some of them weighing as high as fourteen tons; No. 2 is used only for small castings, and No. 3 provides for intermediate sizes up to two tons. Primarily No. 4 was intended for a cleaning shop, but it has been necessary of late to utilize it also as a foundry for castings under eight tons in weight. The remainder of the buildings include the engine and boiler plant, machine shop, numerous cleaning rooms, core rooms, pattern shop and storage rooms, stables, etc.

The engine and boiler plant, located near the centre of the group, though one of the smaller parts, is nevertheless of prime importance, since it is the source of power upon which all else is dependent. The rooms are side by side, separated by a brick wall. In the boiler room are two Coatesville tubular boilers; one of 150 boiler-horse-power is seventy-two inches in diameter, nineteen feet long, and contains 100 three and one-half-inch tubes; the other has a capacity of 125 horse-power, is sixty-six inches in diameter, nineteen feet long, and contains 100 three-inch tubes. A forty-inch sheet-iron breeching conveys the gases of combustion from the boilers to the base of a stack of the same material and diameter, 108 feet high. Steam is generated at a pressure of 100 pounds and conveyed by short lines to the steam-consuming apparatus, all of which is located in the adjoining room, consequently there is very little lost by condensation in the steam piping.

The engine room contains two steam-driven air compressors; a Harrisburg standard horizontal high-speed fifteen and one-half by sixteen-inch engine, direct-connected to a Crocker-Wheeler 100-kilowatt direct-current generator; and a thirteen by twelve-inch, 150-horse-power Ball

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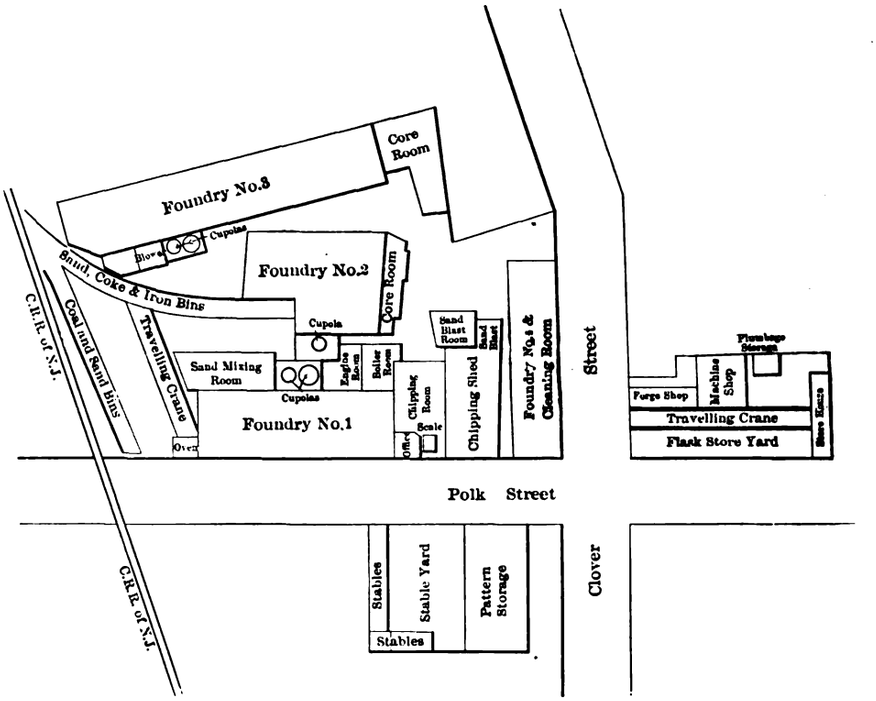
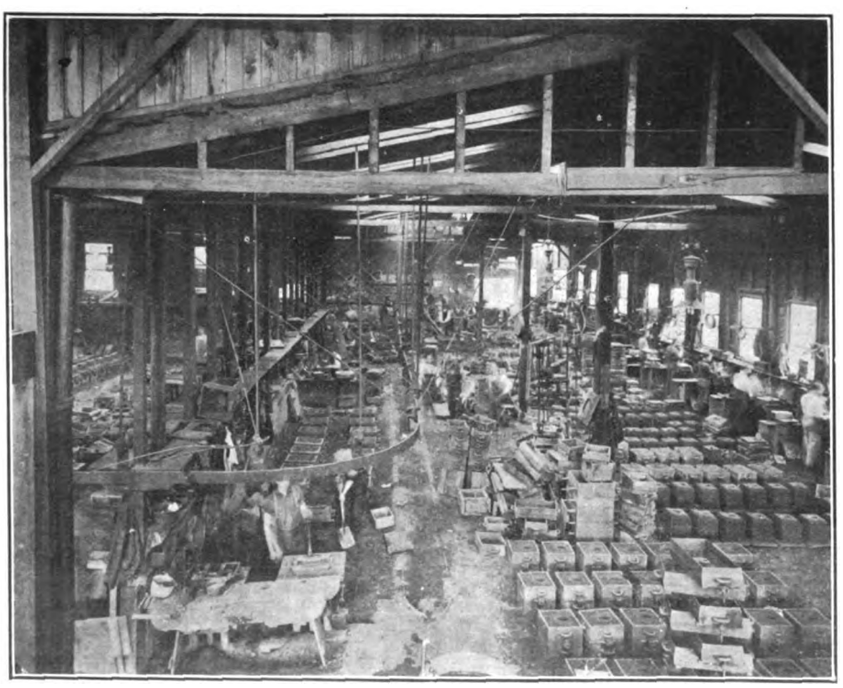
engine, running at 275 revolutions per minute, and driving a line shaft from which are belted a Benjamin F. Kelley & Son duplex, single-acting, six by six-inch boiler-feed pump; a Crocker-Wheeler thirty-kilowatt, compound-wound, 125-volt generator, running at 800 revolutions per minute; an Ingersoll-Sergeant eight by eight-inch, double-acting air compressor, at 125 revolutions; and a B. F. Sturtevant No. 9 horizontal bottom-discharge blower. A No. 8 Sturtevant blower, belt-driven by a Crocker-Wheeler forty-five-horse-power motor, completes the apparatus found in the engine room. This blower provides forced draft for the cupola which supplies foundry No. 2, and the No. 9 blower serves whichever furnace is in operation in foundry No. 1. The Ingersoll-Sergeant and one of the steam-driven compressors, a Clayton ten by ten by thirteen-inch pump running at 150 revolutions per minute, both deliver into a three by six-foot cylindrical tank, which supplies all pneumatic hoists, shipping tools, etc. A pressure governor on the steam supply of the Clayton compressor automatically maintains the pressure within the tank at about eighty pounds, while the belted compressor runs continuously. Similarly the boiler-feed pump is in constant operation, it having been found cheaper to short-circuit the cylinders when the required water level



PLAN OF FOUNDRY WORKS, SHOWING DISTRIBUTION OF BUILDINGS.

City water is used for the feed as the water from the artesian well under the engine room is unfit for that purpose. The latter is raised from the well by



NO. 2 FOUNDRY FOR SMALL CASTINGS.

in the boilers is reached than to provide for stopping and starting attendance. This is accomplished by an automatic by-pass which allows the water to surge back and forth between the alternately acting cylinders at a small waste of power, the speed being but eighteen revolutions per minute. In case the pump becomes disabled the boilers may be fed by an injector.

steam or air pressure through a Watson deep-well ejector to a 3,000-gallon tank on the roof and is used in the foundries for clay washes, sand wetting, etc.

On bright days, during the forenoon hours, the small belted generator is capable of carrying the entire electric load, but in the afternoon, when the furnaces are in operation, it is necessary to run the direct-connected set. This has a capacity of 100 kilowatts at 125 volts and a speed of 250 revolutions per minute. An accompanying cut shows the set and the switchboard controlling the electric light and power distribution.

The other steam-driven air compressor is used to supply two sand blasts for cleaning castings, and was manufactured by the Franklin Iron Works, of Port Carbon, Pa. It is double-acting, with steam cylinder twelve inches in diameter, air cylinder sixteen inches, and stroke sixteen inches long. It runs normally at eighty-two revolutions per minute and supplies about 130 cubic feet of air per minute at a pressure of twenty pounds to the square inch.

From the engine room the main line shaft extends over the boilers into the chipping and grinding room, where it drives three double emery grinders, and continuing still farther belts to two tumblers and a Root exhaust fan. The chipping room is one of several where the finished castings are cleaned and trimmed, both hand and air chisels being used. The tumblers, which were but recently installed, are thirty-six inches in diameter by forty-eight inches long, and are of an enclosed pattern manufactured by the W. W. Sly Company, of Cleveland, Ohio. Unlike the old style, which allowed the dust and dirt to sift through perforations and settle where it would,

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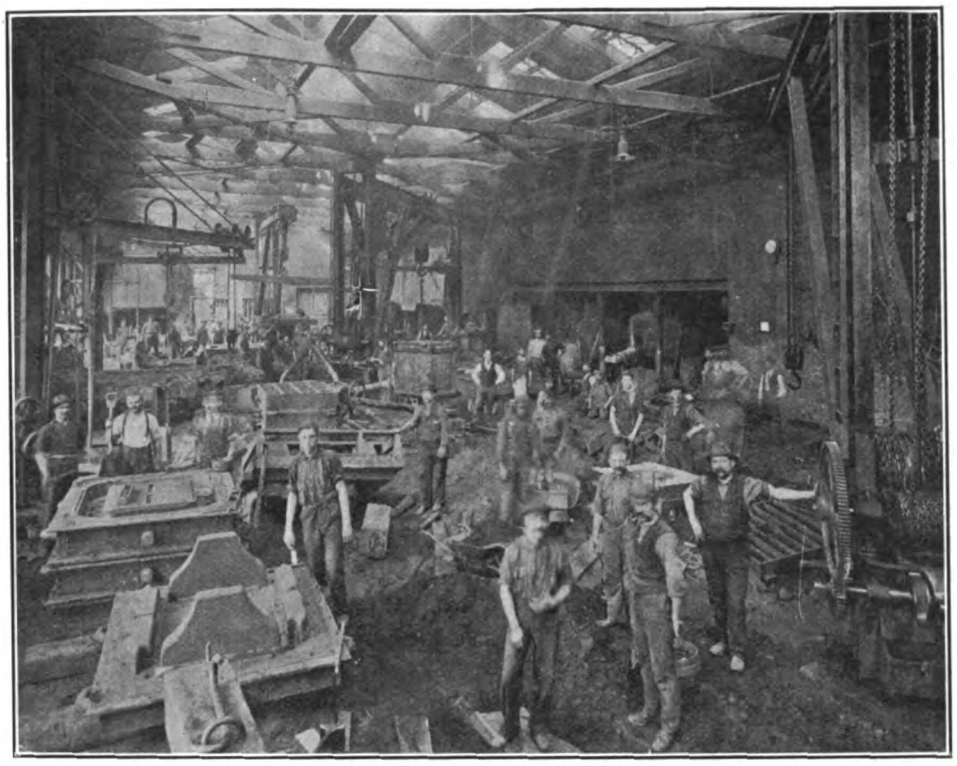
these are devoided of their dirt by an exhaust fan connecting with an enclosed elevated bin. From time to time the accumulation in the latter is dumped through a gate at the bottom into cars and removed.



Interior of No. 1 Foundry Where the Largest Castings Are Made.

In the opposite direction the engine room line shaft is extended into the furnace room off foundry No. 1, where it is belted to a freight hoist used in charging the three adjacent cupolas which serve foundries 1 and 2, and also to a No. 6 Buffalo blower. This is used in connection with a special process for baking large dry sand moulds without the use of an oven, that is said to accomplish the work in less than half the time required in oven baking. The blower discharge is piped under ground to a convenient fixed point near the centre of the foundry and from this a temporary pipe connection is made to the mould to be baked. A fire is built in a rectangular sheet-iron stove, placed on top of the mould, through which the air is passed just before it enters the runner. The hot air is thus delivered to all parts of the mould in the most even manner possible, and being under pressure dries out the moisture very rapidly.

The engine room line shaft also drives a long shaft in foundry No. 1, furnishing power by cross belts to three jib cranes, having capacities of ten, twenty and fifteen tons respectively. These were manufactured by the Farrel Foundry and Machine Company at Ansonia, Ct., and are arranged in a line through the middle of the shop as close together as possible without interfering with one another. In addition there are three hand-power jib cranes of four tons capacity each, two on one side of the shop and one on the other, placed so that they will reach to the larger cranes. The shop is 192 feet long by fifty-three feet wide, but every part of it, except the extreme corners, is accessible to one or another of these six cranes. As before stated, there are two cupolas to this shop. The older one, a fifty-six-inch Colleau furnace, melting from five to seven tons an hour, is seldom used now except in slack seasons. The new one was furnished by the Whiting Foundry Equipment Company, is seventy-two inches in diameter and will melt between ten and twelve tons an hour. For the baking of dry sand moulds and cores there are six ovens, the dimensions of which are interesting as showing the quantity and size of the work which may be baked at one time. All are sixteen feet deep; one is ten feet wide and nine feet high, the rest are eight feet high, one being twelve feet wide, two seven feet wide, and two eight feet wide. Each oven has an iron car running on rails which receives the charge to be baked from the cranes and is then rolled inside. A baking lasts overnight, about twelve hours, the average temperature during that time being about 220 degrees Fahrenheit. To supply the heat a fire is built in the pit at the rear of each oven, using enough coal to last about eight hours. For the rest of the time there is very slight loss of heat until the doors are opened in the morning.

The shaft in this foundry is belted through the wall to two sand mixers in the adjoining core and sand room. One of these is a slowly revolving screen for mixing and sifting the ingredients for the dry sand work. The other is a Sellers horizontal, centrifugal, green sand mixer and runs at about 1,000 revolutions per minute. Another dry sand mixer is located near shop No. 3 and is driven by a

Foundry No. 3 for Medium Size Castings.

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five-horse-power Crocker-Wheeler enclosed motor.

The small casting foundry No. 2 has about 7,500 square feet of floor space, exclusive of core and furnace rooms. Cranes are not needed here; instead there is an overhead track and trolley system extending around the room for conveying large ladles from which the smaller hand ladles are filled. The cupola is a fifty-six-inch Whiting, having a capacity of about six tons an hour. Much of the work done in this shop consists of large quantities of castings from the same pattern and for this several moulding machines are used, each where skilfully handled is capable of turning out from two to twenty moulds an hour, depending on their size.

Foundry No. 3 is 177½ feet long by sixty-seven and one-half feet wide with a line of pillars down the centre, and each half served by two four-ton traveling cranes. One is an electric crane with Crocker-Wheeler motors. At present the other three have hand-travel and pneumatic hoists, but these are soon to be equipped with electric travel to increase the speed of handling, and electric hoists on account of the poor efficiency of air hoists and the difficulty of keeping the necessarily long lines of rubber hose in repair. Two cupolas serve this foundry, one being a seventy-two-inch Newton, built by the Northern Engineering Works, of Detroit, Mich., and the other a fifty-six-inch Whiting. But one is used at a time, the choice depending upon the amount of work on the floor. The blast is furnished by a Root rotary pressure-blower, driven at 100 revolutions per minute by a Crocker-Wheeler thirty-five-horse-power open-type motor, and a direct-acting pneumatic lift is used for elevating coke and iron for charging the furnaces. There are three ovens similar in construction and operation to those in shop No. 1. Two are eight feet wide by eight feet high by twelve feet deep, and the other is ten feet wide with the same height and depth.

Shop No. 4 is thirty-seven feet wide by 154 feet long and contains two electric traveling cranes, one of ten tons capacity, installed by Pawling & Harnischfeger, of Milwaukee, and one of five tons capacity, put in by the Cleveland Crane and Car Company and operated by Crocker-Wheeler crane motors. Whenever any casting is done in this shop the metal is brought in a large ladle car from No. 1 foundry. The system of tracking, laid on a gauge of forty inches, connects all parts of the works, even crossing Clover street, as shown on the plan. The cleaning shop beside No. 4 is well fitted to handle moderate-size work rapidly. It is divided longitudinally and has two hand-power cranes of 3,000 and 6,000 pounds capacity respectively, serving one-half, and a 4,000-pound electric traveling crane, controlled from the floor, serving the other half.

A small but indispensable part of the plant is the machine shop on the other side of Clover street. Although it is in an out-of-the-way place, this disadvantage is more than compensated for by the conveying facilities already described and the absence of dust and dirt making it easier to keep the machine tools clean and in good shape. Alongside of the machine shop is a yard for the storage of idle flasks. To handle the heavier flasks there is a hand-operated traveling crane in the yard, which is also of service in passing machinery to be repaired to the four-ton hand crane in the machine shop. The tools in the shop include a Pennsylvania drill press, a twenty-six-inch Prentiss back-gear crank-shaper, an F. E. Reeden ten-inch lathe with a fourteen-foot bed, a Bickford forty-eight-inch radial drill, a forty-eight-inch by twenty-foot planer, a twenty-inch Pond lathe with a twelve-foot bed and a Sanderson bolt and screw cutting machine, taking stock up to three inches in diameter. Power is provided through line shafting by a fifteen-horse-power Crocker-Wheeler shunt-wound motor, running at 1,200 revolutions per minute. Since the plant is operated strictly as a foundry and does not presume to contract for outside machine work, this shop is ample in size and equipment for its purpose, *i. e.*, the keeping of the mechanical features in the best possible condition by providing repairs and improvements whenever they are demanded.

BOOK REVIEW.

"Engineering Preliminaries for an Interurban Electric Railway." Ernest Gonzenbach. New York. McGraw Publishing Company. Cloth. 6 by 9 inches. 71 pages. 6 diagrams. Supplied by the ELECTRICAL REVIEW at $1.

This little volume is a preliminary report, probably being an augmented transcription of an actual report covering the conditions as given in the text, on a prospective interurban electric railway, sixty-two miles in length. This is a feeder for a large manufacturing city and serves several towns and hamlets, the largest having a population of 21,000 and being one terminus of the road. It shows judgment, experience and common sense in the matters of selection of system, schedule, character of service and in fact nearly every subject included in the report. As stated in the introduction, it is not a general work covering all conditions, but there is much good advice in the book that is applicable to other classes of electric railways. The method of arranging the schedule is ingenious and apparently practical; the comparison between the third rail and trolley fairly made and the result convincing. The dominant note that runs through the whole report is the necessity for breaking away from the precedent set by city street railways, and designing interurban roads on entirely different lines—a sensible and wise opinion. There are a few points which, however, would seem to be open to criticism. For instance, sixty inches apart seems an unnecessarily great distance to separate the wires of a three-phase transmission line sixty-two miles in length (the station is for good reasons at one end of the line); also the road is to cost $1,963,750, and the proposed bond issue is $2,000,000 of five per cent. Therefore, to merely build the road these bonds must sell at par, and when underwriting companies pay par for five per cent bonds on an interurban electric road, paralleled by a steam railway, the millennium will have come. The price of $120 per kilowatt for power station equipment, exclusive of buildings, seems about $45 too high. Good stations of the character mentioned can be easily built for $75 per kilowatt. As a report, it is too lengthy and wordy for a financier who has no technical knowledge to wade through, though, as before stated, the original report has no doubt served simply as the basis for this book, and the reasoning and detail which appear, while objectionable in a regular report, are here necessary to make the work helpful. Of especial importance is Mr. Gonzenbach's insistence for heavy ballast and plenty of it, for block signals and for proper accommodations for the passengers, both as to rolling stock and waiting rooms. The total cost per mile of the equipment specified is $29,750, a figure which is justified by the various considerations set forth. This book is a fine example of a preliminary report and worthy of the careful attention of any electric railway engineer.

In the Moebius process of refining silver, the metal is deposited from a solution of its nitrate by a heavy electrical current, coming down in the form of loose crystals, which are brushed off the cathode and caught on muslin trays. The process is a commercial success.

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Technical Education in the United States.[1]

Early this year it was decided by the governing body of the Northampton Institute that it was desirable, in view of the expected rapid developments of the day classes in engineering, for the principal to make an educational tour in America for the purpose of investigating the present conditions of higher engineering education there and its relation to the various industries for which students are being trained. This trip was made during the spring of this year, and the results of the investigation are given in this preliminary report.

Early in the investigation it became evident that the most important part of the enquiry, and that calling for the greatest attention, was the ascertaining of the views of employers and manufacturers on the products, in the shape of graduates, turned out by the engineering colleges and schools. This point was kept well in view throughout the tour.

The results of the enquiry are, for convenience, divided into four classes, according as they relate to the students, to the colleges and schools, the subsequent careers of the students, and the views of employers and manufacturers, as well as others competent to form valuable opinions on the work carried out and its bearing and effect upon the industries and manufactures of the country.

STUDENTS.

Enquiry being mainly directed toward the higher engineering education, the students chiefly referred to will be those who enter the engineering faculty of the university or the day classes of a polytechnic or technical institute with a view to graduating as engineers. These students are mainly drawn from youths who pass through the high school course or its equivalent. They are usually ready at eighteen years of age to enter the university or the technical college and complete their training in a further four-year course.

It would perhaps be supposed that the students who, from fourteen to eighteen years of age, take the manual training course would be better prepared for engineering training than those who take the more general high-school course. Educationalists, however, are by no means agreed upon this point, many holding that the high school provides better material for subsequent professional work. This adverse opinion with regard to the manual training schools is probably due to the fact that some of them are not content to prepare for the higher engineering courses in the universities and technical colleges, but encroach on the domain of the latter, with the result that, attempting too much, the students are badly grounded and their knowledge is superficial.

When the student enters the college he is older than the corresponding student in England, and his general education, on the average, has been carried to a higher point. He is therefore better equipped to take advantage of the training offered by the professional school. Not but that the better or even the average pupils turned out by some of our best and most modern English schools at sixteen and one-half or seventeen years of age are as well trained as the older graduates of the high schools in the United States. On the other hand, owing to the chaotic state of secondary education in England, vast numbers of pupils fifteen years old and upward annually leave the secondary schools with their education "finished," who, in the United States, would not be qualified to pass out of the grammar school.

To sum up, the students taking up a collegiate engineering training from the secondary schools can be counted in hundreds, as compared with tens or less in England. They enter the colleges at a later period of life and are better prepared, on the average, for the work.

In addition to these students there is a fair average of older students, consisting of men who have been obliged, through various circumstances, to start practical wage-earning life at an early day, and who have saved the necessary money and returned to school discipline and training with very definite objects in view, and not infrequently become the most successful of the engineering students. This is because they are men endowed with the determination to make their way, and they form a most useful leaven in giving a tone of earnest work to the school.

THE COLLEGES AND SCHOOLS.

These consist of the various colleges and schools of engineering, the numerous state and other universities, and also of certain technical institutes which devote themselves largely, if not exclusively, to engineering education. Generally the curriculum occupies four years. The first two are devoted to an ordinary scientific training in mathematics, chemistry and physics, though often subjects of general —as distinct from professional—educational value are included, and sometimes mechanical drawing, which is distinctly professional, is added. Frequently in these two years a certain amount of time is given to workshop practice. With these exceptions, the actual engineering training does not commence until the third of the four years, and in many cases even in this year a certain amount of time is devoted to non-professional subjects. In the last year of the four a crowd of professional subjects is introduced, with the result that, in many cases, the student is unable to assimilate all that is placed before him, especially as a certain amount of time has almost invariably to be given to a graduating thesis, without which he can not obtain the coveted diploma.

In regard to the length of time occupied, the opinion in the United States, is divided, but many who have carefully studied the subject hold strongly that the period is too short for the training which is attempted, and that another year of professional study should be added before the graduate is sent out to practical work. In some cases this opinion has been carried into effect.

Turning to the buildings in which the schools are housed, and the equipment of the laboratories and workshops, we find still greater differences from the conditions obtaining in England. In none of the institutions of higher engineering education visited was there less than one large building solely devoted to engineering. In most cases, besides one large building, there were two or more additional buildings for special laboratories and workshops. To one accustomed to the similar provision made in England, the accommodation provided seems at first to be lavish; but in many cases, on enquiry, it was found that those responsible for the work deemed the provision inadequate. The great expansion that has taken place is of comparatively recent growth. Many of the buildings have been erected in the last ten years, so that in this respect England is not so far behind in point of time if it will only face the necessary cost. Certainly, no time is to be lost. It may perhaps be argued that the equipment in the United States is too lavish and much of the money spent on palatial buildings might have been employed for more utilitarian purposes. At any rate, the money for buildings—architecturally splendid in many cases—has been readily found, and this fact alone may justify the expenditure. The further fact, already mentioned, that in many cases extensions are being pushed forward may be taken to answer—though not completely—the other assertion of too lavish equipment. The net result is that

[1] Abstract of the report of Principal R. Mullineux Walmsley, of Northampton Institute, England, on his American tour.

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in the best of the schools the student in his third and fourth year handles machinery and apparatus of the latest and most up-to-date pattern and of a size adequate to elucidate the principles and solve problems on an engineering scale. Moreover, owing to the attitude of manufacturers, contractors and others, the student frequently has opportunities of testing and experimenting with a much larger plant in actual operation outside of the school, and thus, both inside and outside, is brought face to face with problems in a manner which will recur when he takes up the real business of engineering life.

The staff of an engineering college is one of the most difficult problems which has to be faced. It is absolutely essential that each of the members should have had practical commercial experience in the particular branch of the subject he is called upon to teach, and it is more than desirable that he should also be a trained teacher. The two conditions, in most cases, are incompatible, for the man who has given sufficient time to practical commercial work to suit the first requirement has perforce had little or no time to devote to training. On the other hand, the man who possesses the necessary practical experience has a value outside of the college which is not paralleled in literary and other branches of education. Moreover, even in the subjects that are not distinctly professional, such as mathematics, physics and chemistry, it is usually, though not so widely, deemed desirable that the teacher should have practical engineering experience. It follows from the above that for the most suitable kinds of teachers in engineering, the colleges will have to compete with the open market in a manner which does not obtain in most branches of education.

It is universally the custom in the United States, not only to give the engineering professors opportunities for outside work, but to require that they shall actually undertake such work, so as to keep themselves abreast of the various lines of progress in the profession. However, many hold that the colleges can not and do not attract the right class of teachers, except in a very few special instances, and that they should bid higher if the education offered is to be of the right kind. The general conclusion is that the colleges, on the whole, are staffed with good men, but there is still room for improvement and that this can only follow by still further raising the remuneration of teachers.

THE SUBSEQUENT CAREERS OF THE STUDENTS.

It was found that the attitude of employers toward the graduates of colleges and technical schools was not the same in all cases. On the whole, it may be said that not only do the employers view with favor applicants for employment who can produce the graduation certificate of the engineering department of a university or of a technical school, but that many go further than this and will not accept as apprentices for their technical staff any man who can not produce such a certificate. All the employers offer a living wage at the start of the service and do not charge any premium. In fact, the premium apprentice appears to be unknown in America.

After having gained admission to the profession by entrance in a works or obtaining some other position at a living wage, the subsequent career of the college graduate depends, as a rule, upon himself far more in America than in England. It is very freely asserted that outside influence is not permitted to push forward less competent men to the detriment of more competent ones. Special enquiries on this point confirm this assertion. As a rule the competent graduate rises quickly, and at the end of the first six months finds himself advanced to a more highly paid position; and within two years from leaving college, the best of the men occupy well paid and responsible positions.

During the first two or three years after leaving college there is a considerable rearrangement of the relative positions of the graduates. It may, however, be said that, on the whole, even the mediocre men obtain good positions on the commercial, if not on the scientific side of practical engineering, and that the best men rise very rapidly to excellent positions.

VIEWS AND ATTITUDES OF EMPLOYERS.

Briefly, it may be said that the most important manufacturers and employers regard the work done in the colleges as being of material and vital importance and absolutely indispensable to the development and progress of engineering industry. More than one captain of industry enlarged upon the necessity of an adequate supply of trained and disciplined brains as being essential to the prosperity of his firm, and many expressed themselves as prepared to do anything within reason to ensure the continuity of such a supply. The moral influence of this attitude of the employers toward the schools is of great value in directing the attention of parents and guardians of the youths who desire to be engineers, to the necessity of college training and its bearing upon their subsequent prospects of success.

There is, however, a minority of employers and other practical men which does not agree with this opinion. Even those favorably disposed sometimes freely criticise important details, either of methods, equipment or staff. One important point on which it seems almost impossible to obtain any consensus of opinion from the employers is as to the value of the school workshop training, the extent to which the methods of commercial workshops should be copied, and the position a workshop should take and the amount of time which should be devoted to it in training. The most generally expressed opinion is that the schools should not attempt to copy too closely the commercial workshops, for in so doing they run the risk of leaving too little time for other important matters with which they are more competent to deal. But the most modern workshop methods should be brought to the notice in a practical form, especially those methods which tend toward cheapness and accuracy in production.

MANUAL TRAINING SCHOOLS AND TRADE SCHOOLS.

The report also takes up manual training schools and trade schools. It is not thought that the results obtained by the manual training schools are satisfactory. The schools are staffed with men trained as schoolmasters and not as engineers. They attempt to cover too much ground, and the graduates are not as well prepared to enter the technical courses of colleges as graduates from the high schools. On the other hand, these schools do not form a good source of supply for bench hands, gang bosses and foremen, for their graduates are unwilling to commence low down enough in the factory to make good machinists and fitters.

At the trade schools which were inspected the students are taught the various trades by practical work. Little or no general education is given and, on the whole, such schools which aim at but little beyond a place in an ordinary commercial workshop are not recommended.

The Republic of Paraguay to Subvention Engineering Students.

On July 3, 1903, the Congress of the Republic of Paraguay passed a law authorizing the president to subvention five young men to the amount of $65 gold each per month, for the purpose of carrying on their studies in engineering at some university in Europe.

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NOTES ON CERTAIN THREE-WIRE SYSTEMS.[1]

CHAS. T. MOSMAN.

The present tendency in electrical developments is toward the serving of large districts from large central stations. This tendency naturally leads to alternating-current distributions for light and power where under other conditions direct current might be used. The new work of to-day is thus largely alternating, or alternating converted to direct current for final distribution.

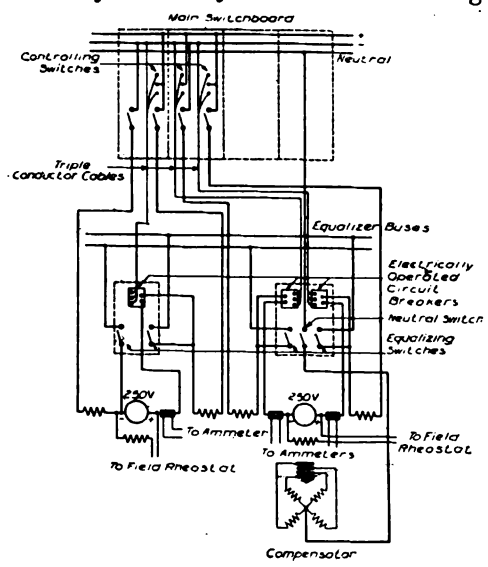

FIG. 1.

Existing direct-current installations are continually expanding, and many are being adapted to receive power from large alternating-current stations. It is necessary to carefully consider the new conditions to be met and the various methods and apparatus with which to meet them, before placing orders. New plants of a more or less isolated character may be best served by direct current, although where there is any doubt as to which is advisable it is well to give the alternating current the preference on account of the ease with which such a system is extended. A discussion of direct-current systems in general would be an undertaking of large dimensions, hence I will bring to your attention but one or two points which may prove interesting.

The direct-current lighting and power work of to-day in this country is principally three-wire. The advantage of the three-wire system lies in the transmitting voltage being twice that of the receivers, hence upon the advent of the 250-volt incandescent lamps it was natural to expect an extensive adoption of a 500-volt three-wire system, this system having the added advantage of enabling duplicate generators to serve light and power and railway. The 500-volt three-wire system is particularly applicable to manufacturing plants using electricity principally for power, with incidental lighting, and to central stations serving a comparatively scattered load within a somewhat limited radius.

A comparison of 250-volt and 500-volt underground three-wire systems will show that the superiority of one over the other depends upon the density of the load, the proportion of the total load that is incandescent lamps, the size of the motor units connected to the system, the cost of producing additional power and the cost per kilowatt of the generating equipment. In large cities served by a central generating station and many substations containing converters for supplying the three-wire network, the load is quite dense, and it can be shown that in many cases the savings in copper and number of substations, due to the higher voltage, is more than offset by the increased power required by the high-voltage lamps.

The lower the density of the load, the lower the proportion of incandescent load

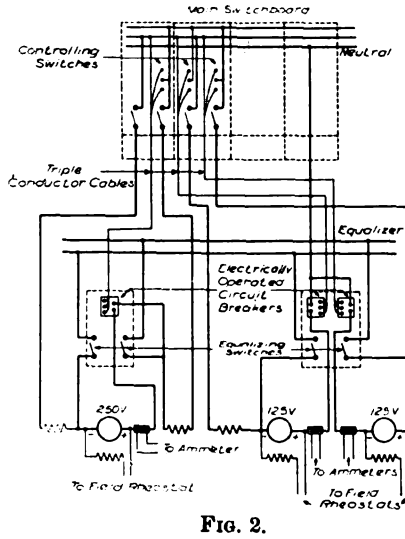

FIG. 2.

at the total load, and the lower the cost of power and generating apparatus, the greater becomes the advantage of the 500-volt three-wire system.

The 500-volt system is at a disadvantage due to the higher cost of arc lamps, meters, fan motors, incandescent lamps, cutouts, rosettes, circuit-breakers, etc., the prices being higher in approximate accordance with the accompanying table.

Article.	Per Cent Higher Price.	
Incandescent lamp....	11	3.8 watts per c.p.
Incandescent lamp....	25	3.4 watts per c.p.
Arc lamp	33⅓	2 in series
Arc lamp	50	twin carbons
Wattmeters	30	3 wire
Wattmeters	0	2 wire
Cabinet panels.....	5	
Circuit-breakers.. ...	25	D.P. 500 volts
Switches.....	0	D.P. 250 volts
Switches.....	75	D.P. 500 volts
Fan motors	10	250 volts
Rosettes.....	7	250 volts
Fuse plugs.....	60	250 volts
Snap switches.....	0	250 volts
Lamp sockets.....	0	250 volts

Two hundred and fifty-volt incandescent lamps may be obtained of 3.8 and 3.4 watts per candle-power, having the same useful life and candle-power area as the 3.1 watts per candle, 125-volt lamp.

Arc lamps may be connected two in series at the disadvantage of comparatively complicated wiring and the necessity of burning two lamps when one only is required, or a twin carbon lamp may be used at the disadvantage of a more complicated mechanism and probable high maintenance cost. A single-carbon, 250-volt lamp gives an objectionably purple and unsteady arc. This excess of purple rays necessitates the use of denser globes than those used with 125-volt lamps, in order to produce the same quality of light.

A decision in favor of a 500-volt three-wire system should not be made without first giving due consideration to alternating current. The advantages of continuous current over alternating are mainly the following:

First—The possibility of the use of storage batteries.

Second—The possibility of operating high-speed passenger elevators direct from the lighting distribution.

The efficiency of a storage battery is low and the maintenance usually high. For these reasons it can not always be considered an economical investment. Storage batteries may, however, be considered essential for the power service of a dense business district, on account of their value in supplying sudden demands for current due to summer showers or a breakdown or burning off a short-circuit in an underground system. They are also of great value in maintaining good regulation.

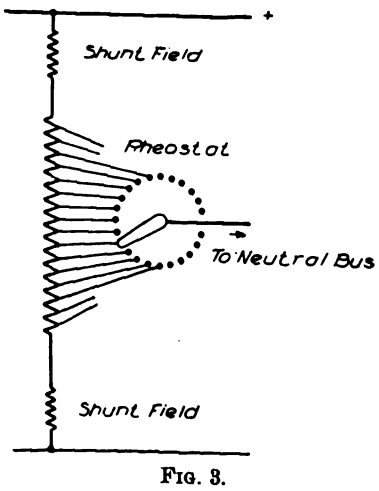

FIG. 3.

The induction motor with collector rings and variable external resistance will give good results on all but the higher speed elevators. A district in which a 500-volt three-wire system is particularly applicable would probably not contain any

[1] Paper read before Ohio Electric Light Association, Columbus, Ohio, October 13, 14, 15.

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high-speed elevators; such a district could well be served by alternating currents, using possibly a separate power circuit. A city of 100,000 inhabitants would probably have a dense business section containing high-speed elevators, and large

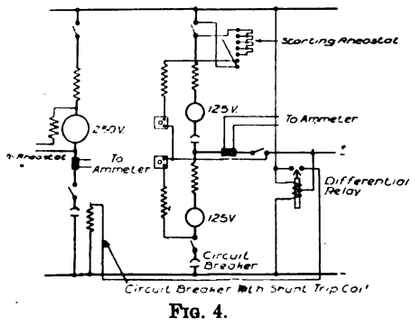

FIG. 4.

residence districts having a comparatively light scattered load. Such a city may be served by a three-phase generating system, a three-wire network, using high-efficiency 125-volt lamps, and fed by single-phase primary feeders, being used for the business district; the power load of which is carried by a 500-volt, direct-current power circuit fed by rotary converters or motor-generator sets. Three-phase feeders should be run through the residence districts, the lighting load being carried on one phase only, the third wire being run into such districts as offer light power load.

The large cities contain extensive districts where the load is of such density that the 250-volt three-wire system with high-efficiency lamps is most suitable. They also contain large suburban districts which may be best served by alternating current. A combined continuous-current and alternating-current generating system with rotaries or motor-generators to connect the two is well suited to such cities. Chicago, Boston, Philadelphia, Cleveland, Toledo and Columbus may be mentioned as examples of such an arrangement.

There are many cities which might be well served by an alternating-current system, which have had a three-wire direct-current system in operation before the advent of large alternating central stations, and the systems have assumed such proportions as to preclude all consideration of alternating currents for the denser sections. This fact may explain the eventual use of a combined alternating and direct-current generating system by such cities. The ease with which an alternating system may take on surrounding towns through step-up transformers should not be lost sight of and constitutes a great advantage.

From the above it appears that there is little justification for an extensive use of the 500-volt three-wire system in this country.

The larger three-wire systems are almost without exception served by shunt-wound generators. An increase of the generating capacity of such a plant is easily accomplished by adding units having the voltage of the outers. The smaller plants are using compound-wound generators, three-wire generators and sometimes balancer sets. The combination of compound-wound generators of different voltages on a three-wire system, for example, 125 and 250 volts or 220 and 440 volts, requires special attention to the switching, equalizing and indicating arrangements in order to secure proper parallel operation.

Figs. 1 and 2 show desirable arrangements.

The equalizer switches, ammeter shunts and circuit-breakers are placed on panels near the generators. The circuit-breakers

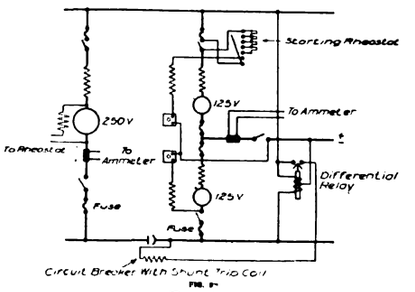

FIG. 5.

are closed and tripped electrically from the main switchboard. The low-voltage machines have their series windings on the side opposite to that connected to the neutral wire, *i. e.*, half of them are equalized on the positive side and half on the negative side. The high-voltage machines are provided with two series windings in order to admit of proper equalizing with the low-voltage machines. In the case of machines with compensators and collector rings for derived neutral, *i. e.*, three-wire generators, two series windings are necessary in order to secure with unbalanced loads a compounding approximating that with balanced loads.

It is desirable on lighting systems supplied by both low-voltage machines and three-wire machines, to provide switches in the connections between the neutrals of the compensators and the neutral bus-bar. With these switches open it is possible through the low-voltage machines to raise the voltage of one side of the system above that of the other to compensate for unequal line drop due to unbalanced load.

The proper sequence of operation of switches and circuit-breakers when connecting a machine to the bus-bars is as follows: First, close the equalizing switches. Second, go to the main switchboard and close the main switches. Third, having obtained the proper voltage relations, close the circuit-breakers by means of the controlling switches on the main switchboard. The inverse sequence should be followed when disconnecting a machine from the bus-bars.

Three-wire generators when operating separately, or in conjunction with others of the same class, or with compound machines of the same voltage but without collector rings and compensator, may be connected as shown in Fig. 1.

Low-voltage compound-wound machines connected on the two-generator method should always be connected as shown in Fig. 2, whether or not other generators are connected across the outside wires.

The advisability of the indicated arrangement of series windings where both high and low-voltage machines are installed, has been explained above. It is desirable to use the same arrangement when installing only low-voltage machines, in order that high-voltage machines may be installed later without extensive changes in existing panels. With the series fields arranged as shown, the circuit-breakers should be placed as in the diagram, in order to minimize the chances of a short-circuit in the station wiring causing a machine to operate as a short-circuited series generator.

A great saving in cost of cables for the moderate and larger size generators results from the placing of circuit-breakers and equalizing switches near the generators, and for the sake of uniformity

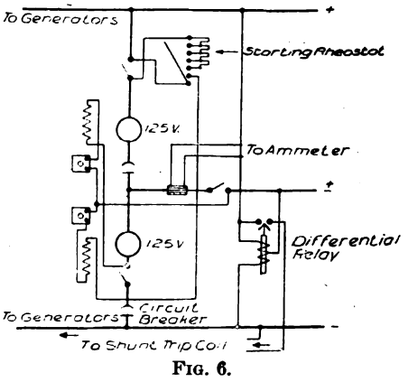

FIG. 6.

this arrangement may well be adopted for the smaller generators also.

A balancer set is sometimes depended upon to provide a neutral for a system having only high-voltage generators. The simplest way to start such a set is to connect the two armatures in series through a starting rheostat across the main buses.

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It is necessary when starting to disconnect the common connection of the fields from the common connection of the armatures. Otherwise, when starting up, the field of the machine having its armature connected to the starting rheostat will receive the full potential of the system, due to the other machine having its field short-circuited by its armature. If another balancer set or other means of obtaining a neutral is in use, it is essential that the common connection of the armatures be disconnected from the neutral bus when starting; otherwise, one side of the system will be short-circuited by one of the machines.

It is advisable that the shunt fields shall in normal operation be connected between the neutral bus and the main buses, in order to secure independent control of the voltages of both sides of the system. This may be obtained by means of one rheostat common to the two fields and in series therewith, having the switch blade of the rheostat connected to the neutral bus. (See Fig. 3.) This type of rheostat is objectionable due to the extreme difficulty in predetermining its design. Two independent rheostats should be used and may be the standard for the machines composing the balancer set.

A system depending upon a balancer set for its neutral, must be protected against the consequence of a short-circuit on one side of the system, causing the full potential of the main buses to be impressed upon the other side of the system, with destructive results to the lamps and other devices connected thereto. This may result from the automatic disconnection of the balancer set due to short-circuit, or if the set is not provided with automatic circuit-opening devices, from the flashing over of the commutator of the machine on the short-circuited side. Protection may be afforded by a differentially wound relay with coils connected across the two sides of the system and contacts normally closed. These contacts close a circuit through shunt trip coils on the circuit-breakers of the main generators. This relay will operate and trip the circuit-breakers in the event of an abnormal rise of potential on either side of the system. A system having the generators protected by fuses should include an electrically tripped switch so placed in the main buses as to separate the balancer set and distributing system from the generators. The differential relay should be connected to trip this switch in event of a short-circuit or abnormal rise of potential on either side of the system.

The series fields of balancer sets may be placed on the positive side of both machines and equalized with other balancer sets in the usual manner.

Fig. 4 indicates the proper connections of a compound-wound balancer set and compound-wound generators; both being protected by circuit-breakers. Fig. 5 indicates the proper connections of similar machines protected by fuses and with an electrically tripped switch in the main bus.

The fields of shunt-wound balancer should be connected as shown in Fig. 6. It is to be noted that each machine has its field connected across one side of the system and its armature to the other. This tends to maintain balanced potentials on the two sides of the system with unbalanced loads.

The New York Electrical Society.

The New York Electrical Society, on the evening of Monday, October 19, was addressed by Professor W. E. Ayrton, of the Central Technical College, London, on "An Informal Talk on Some Electrical Measuring Instruments and Recent Use of Them." Professor Ayrton is a member of the British educational commission which is visiting the United States, and although very busy, consented to give the society the above talk, dealing with various electrical instruments, the operation of which electricians in this country are not yet very familiar with. Many of the results which can be obtained from these instruments are of great delicacy and effectiveness, and the lecturer gave to the society many of the details which are not yet on record. Professor Ayrton made copious readings from a work entitled "The Electric Arc," of which his distinguished wife, Mrs. Hertha Ayrton, is the authoress. This is the first time that the society has ever been addressed by a fellow of the Royal Society, and, on closing his talk, Professor Ayrton was greeted with prolonged applause. A discussion followed, in which Louis B. Marks, Professor Pupin and others took part.

Before the lecture there was a short business meeting. The temporary appointment by the president of Mr. E. H. Mullin to take the place as vice-president of Mr. H. C. Townsend, recently resigned, which had been approved by the executive committee, was ratified by the society.

The following members were elected: William Thomas Taylor, Schenectady, N. Y.; George W. Travis, Brooklyn, N. Y.; Sydney Hogerton, New York city; Adolph G. Keonig, New York city; Edgar H. Berry, New Brighton, N. Y.; Howard S. Rich, New York city; Dr. John Woodman, New York city.

The committees appointed for the season are:

Finance—H. D. Betts, chairman, W. S. Barstow.

Examining—W. I. Donshea, chairman, Douglas Burnett.

Reception—F. C. Bates, chairman, E. H. Mullin, H. A. Sinclair, G. H. Guy.

Membership—J. R. Strong, chairman, Albert F. Gans, Putnam A. Bates, Joseph Bijur, Louis B. Marks, Frederick A. Scheffler.

Papers and meetings—G. H. Guy.

Independent Telephone Association of Southern Indiana.

The fourth annual convention of the Independent Telephone Association of Southern Indiana will be held at Evansville, Ind., Tuesday and Wednesday, November 10 and 11. The opening session will be held at two o'clock Tuesday afternoon. The programme will consist of papers and addresses promoting the best interests of independent telephony, and special entertainment will be provided for the visitors.

The officers of the Independent Telephone Association of Southern Indiana are G. A. Kienle, president, Huntingburgh; C. D. Knoefel, vice-president, New Albany; E. W. Pickhardt, secretary, Huntingburgh; T. M. Thom, treasurer, Lamar.

Cassier's Magazine for November.

Cassier's Magazine for November will contain a number of articles on engineering topics of more than ordinary interest. One of these articles is by Mr. John Goodman, on "Superheated Steam for Steam Engines." An article by Reginald P. Bolton, on "The Apartment Hotel in New York," delineates some of the engineering problems of this subject and their solutions. "Electric Searchlights, Their Use Afloat and Ashore;" "Locomotive Building in Germany;" "The Microscope in Engineering;" "Fuel Losses in Steam Plants and How to Determine Them;" "Oil-Fired Furnaces," and a number of current topics will also be included.

Chicago Telephone Company Opens New Branch Exchange.

The Chicago Telephone Company opened its new Douglas exchange 170 East Thirty-fifth street, Chicago, Ill., during the week of October 12. Beginning Monday, October 12, and ending Saturday, October 17, the company opened the exchange to the public and issued invitations for the purpose of inspecting the apparatus and viewing its operation. Mr. A. D. Hawk is the manager of the southern division of the Chicago Telephone Company.

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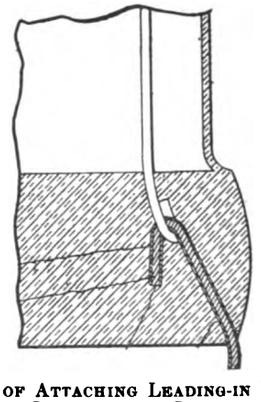
Electrical Patents.

An English electrical engineer, Mr. Job T. Niblett, of Greenwich, London, England, has patented in this country a new storage battery. This invention relates chiefly to secondary or storage batteries, and has reference more particularly to the employment in such batteries of the material known as "kieselguhr" or "infusorial" earth, the highly absorbent nature of which, as well as its power of resisting the action of acids, is well known. The invention is designed to improve both the active material or coating of the plates and also the porous or absorbent separators, blocks or plates which are commonly interposed between the electrodes. This is accomplished by incorporating with such active materials and also with the materials from which the said separators or blocks are made a certain proportion of infusorial earth, whereby great porosity, both in the active material and the separators, is attained, and hence the improved cells are capable of very high rates of charge and discharge, while they can, if desired, be made practically into what are known as "dry" or "afluidic" cells. In applying the invention to primary batteries a plate of the aforesaid active material mixed with kieselguhr can be used in conjunction with a plate or plates of zinc or other suitable metal. In carrying out the invention the electrodes, which need not have the usual grid or support, are formed of lead oxides or other compounds and of kieselguhr, which are suitably compressed or moulded so that they form coherent plates analogous to the well-known lithanode plates. The active material in the above may consist of ordinary lead oxides mixed with electrolyzed lead or lead compounds which have been electrolytically prepared, or which have been so prepared that they are analogous to electrolytic compounds. Owing to this, the physical changes in the plate while in use are less likely to occur, and the active material is also rendered conductive by the presence of the electrolytic materials. The active material thus mixed with kieselguhr possesses a great degree of permeability as distinguished from the actual porosity found in some types of plate at present constructed. In other words, while the active material made up according to the invention is to the eye apparently homogeneous and compact, yet it is in its nature permeable to a high degree by the electrolyte and in no way dense and resistant to solution. The result is due to the presence of the kieselguhr, of which all the fibres or particles act as minute ducts to convey the electrolyte thoroughly into the body of the material by capillary attraction. It is superior to what is ordinarily known as "porosity," which is due simply to small holes in the material, because these holes soon get closed up by sulphate or by the swelling of the active materials. Owing to its being permeable in this way, the material can be formed in very much less time than is usually required, and the capacity of the cells made with plates of the same is very great, since practically the whole mass of the material is in action at the same time and not simply the outer layer or face of the plate. The proportion of kieselguhr may, for example, be one to five per cent for the positive pole-plate and two and one-half for the negative pole-plate; but this may be varied, and is greater the thicker the plates or blocks are required to be. The electrolyzed portion of the active material may be previously prepared from a plastic mass consisting of lead oxides or compounds made into a paste with sulphuric acid. This mass is placed in lead trays or the like and subjected to electrolytic treatment analogous to that of "forming." It is then discharged slowly in any convenient way, which causes it to assume a crystalline form very advantageous for use in the subsequent stages. The mass is then dried and pulverized and mixed with the untreated lead oxides or compounds—say, in the proportion of one to two—and the necessary proportion of kieselguhr is added at the same time, the whole being made into a paste with sulphur of ammonia, sulphuric acid, or other medium which will tend to form insoluble or partly insoluble compounds and so promote the setting. The mass is then filled into the grip or support or is moulded under pressure or otherwise to the desired shape in cases where it is to be used in the form of plates or slabs only. The inventor has found in some cases that the active material gives very good results if only the ordinary lead compounds are used—that is to say, the electrolyzed portions of the mixture may be omitted, if desired. This greatly simplifies the manufacture, while the porosity imparted by the kieselguhr is sufficient to accommodate any swelling or physical change that may occur among the molecules of the active material during the charging and discharging of the cell. For instance very satisfactory plates may be made up of about equal parts of litharge and red lead mixed with two and one-half per cent of kieselguhr and then moulded to the desired shape. The above description relates to the mode of manufacturing the plates or electrodes of the improved cells. The manufacture of the improved porous absorbent separating plate previously referred to is as follows: This is formed wholly or principally of kieselguhr, wetted, for instance, with sodium silicate and formed by moulding or compression into thin sheets or slabs, which are burned to render them hard or firm without impairing their porosity. In some cases it may be mixed into a paste with china-clay and water instead of sodium silicate and be then moulded and burned. To further increase the porosity, if desirable, powdered charcoal, coke or coal may be incorporated with the mass. These materials will be burned out during the kilning and leave behind corresponding cavities in the plate. The product may be used as a separator for the electrode in the ordinary way or may be interposed between them to serve as a medium for holding the electrolyte when it is desired to make the battery up as a block or pile in the most compact form after the manner of so-called "dry" batteries.

Improvements in connection with lead-in wires of incandescent electric lamps have been devised by Messrs. John C. Entroken and William S. Everett, of Malvern, Pa., who have assigned a one-fourth interest in the patent obtained thereon to Mr. Sheldon M. Custer, of Wayne, Pa.



Method of Attaching Leading-in Wires in Incandescent Lamps.

The object of the invention is to provide an efficient and economical means of attaching a platinum or other coated lead-in wire to the stem of such a lamp, so designed as to effectually prevent any leakage of air into the bulb after the vacuum has been established. Attempts have been made to utilize platinum-coated lead-in wires in incandescent electric lamps because of the material reduction in cost which would result from the use of a platinum-coated wire instead of the solid platinum wire now universally em-

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ployed; but such attempts have proved failures by reason of the fact that it has not been possible prior to this invention to prevent leakage of air from the stem by the embedded lead-in wires into the bulb, thereby destroying the vacuum. It

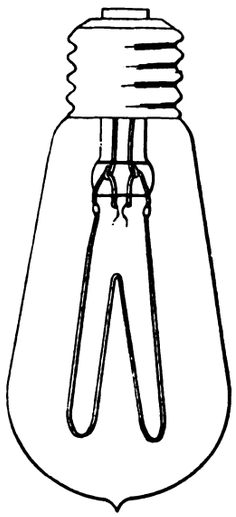
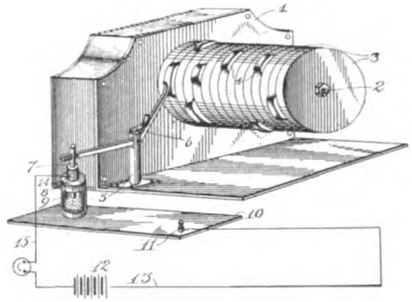


FIG. 1.—METHOD OF ATTACHING LEADING-IN WIRES IN INCANDESCENT LAMPS.

has been commonly supposed that this leakage occurred between the outer surface of the coated wire and the mass of glass of the stem in which the said wire has been embedded; but the inventors have discovered that this leakage occurred between the metallic core and the platinum coating. By their invention, they are able to prevent the said leakage, and thereby to successfully apply a coated lead-in wire to electric lamps. The improvement consists, broadly, in the employment, in connection with an electric lamp, of a coated lead-in wire having the end otherwise exposed to the air or to which air had access sealed against such access of air between the coating and the core of the wire and, further, in such a coated lead-in wire having such end glass sealed against access of air, and, further, in such a coated lead-in wire having such end bent and embedded in the glass of the stem, whereby it is sealed against access of air and furnishes a ready means of connection with the conducting wire.

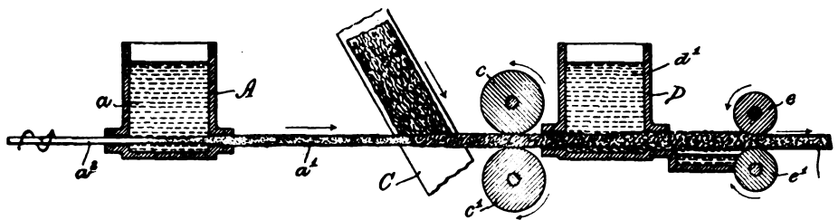
The accompanying illustration is a perspective view of a novel contact maker for electrical signs, patented by Mr. Conrad F. Lancaster, of East Liverpool, Ohio. The numeral 1 indicates the casing for the clockwork, which it is not deemed necessary to show, as any ordinary form may be used. From the casing projects a stem 2, having its outer end threaded and provided with a nut, while a shoulder is formed near the case 1. This stem is attached to a clockwork and revolves when the same is set in motion. Discs 3, having cam portions 4 formed thereon, are held on the stem 2 between the aforesaid shoulder and nut, the latter being screwed up tightly when it is desired to prevent their movement on the stem. Opposite each one of the cam-discs is set a



CONTACT-MAKER FOR ELECTRIC SIGNS.

post 5. Each post carries a spring-pressed lever 6, one end of which is in contact with its cam-disc. The opposite end of the lever carries a plunger 7, which passes through an insulating bushing 8 into the cup 9; the latter being partly filled with mercury, as shown. It is obvious that the motion of the cam-disc will move the lever and cause the plunger to rise and fall in the cup. Both cup and plunger are made of some good electrical conductor. A plate 10, provided with a binding-post 11, is connected with a battery 12 by means of a wire 13. The insulated bushing 8 has a binding-post 14 mounted thereon, the end of the post contacting with the plunger. A wire 15 leads from the binding post 14 to the battery 12. One of these wires passes through whatever lights it is desired to effect by means of the especial cam selected. It now becomes plain that when the clockwork is in motion the cam-discs are rotated and the electric circuit is completed by the plunger dipping into the mercury. It is obvious that the circuit will remain closed so long as the lever is in contact with the cam portion of the discs. The length of these portions can thus be arranged to suit any desired exposure of light. It will also be plain that the discs can be arranged upon the stem in any desired manner and such changes in that arrangement can be made as from time to time may seem advisable, without it being necessary to disturb the wiring.

John A. Heany, of Philadelphia, Pa., has patented a new method of producing insulated electric conductors and has assigned the patent to the Teter-Heany Developing Company, of Charleston, W. Va., and Philadelphia, Pa. Referring to the illustration, the metallic conductor or wire is immersed by being drawn, preferably through a bath in a vat or tank A of an adhesive substance, in order that the surface or wire may be coated with a layer or coating a^1 of such adhesive material. After the surface or wire has received its coating or layer a^1, asbestos in a fibrous form is twisted or coiled in its flocculent condition on to the rotated traveling coated wire a^2, as indicated by the arrow, in order that the minute particles or fibres of the flocculous material will thoroughly intermesh with the adhesive substance a^1 of the conductor or wire, to such an extent as that under required compression by means of compression devices c and c^1 the same will be intimately compacted on to the conductor a^2 to uniformly insulate the conductor throughout. The asbestos in its flaky or fibrous condition is supplied from a traveling-belt c, and in its travel it is taken up by the sticky covering or coating of the rotating conductor a^2. The conductor a^2 is then preferably fed through a bath of a non-destructible fire and water-proof cement or paste d^1 in a vat or tank D, which consists of a clay, as kaolin, six parts, by weight, or a lime product, as the proportion of four parts, by weight. or a metallic oxide, as alumina, two parts, by weight, or an alumina product, as sulphate of alumina, one-half part,



METHOD OF PRODUCING INSULATED ELECTRIC CONDUCTORS.

by weight, or an acid product, as borasic acid, one sixteenth part, by weight. This composition is thoroughly mixed and then one part, by weight, mixed or combined with a gluey adhesive substance in the proportion of four parts, by weight. The above proportions of the different ingredients in parts by weight may be varied and still good results be obtained. This may be the commercial glues or a mixture of glues or adhering substances heated with water or made to form a solution of the required consistency. Some of the common or commercial glues, mixed with fish-glue, as practice has demonstrated, give excellent results. The coated, covered and fire and water-proofed conductor a^2 is then passed between preferably a pair of squeeze-rolls c and c^1 for removing any surplus of the final coating of cement or paste to the conductor a^2, and then the thus-treated conductor a^2 is permitted to dry. When thoroughly dry the flocculent asbestos will be found to be embedded and surrounded with the coating and cement or paste and also united to the conductor and with the latter in such a condition as not to be affected by heat, also fire and water-proof, thereby specially adapting such a covered wire for use as a conductor for electric purposes.

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American Institute of Electrical Engineers.

Two Railroad Papers Read and Discussed.

THE 180th meeting of the American Institute of Electrical Engineers was held in Carnegie Hall, New York city, Friday evening, October 23, 1903.

President Arnold called the meeting to order at 8.30 o'clock.

Secretary Pope announced that the use of the Chapter Rooms of Carnegie Hall had been secured for the meeting and possibly arrangements would be made for its continued use, but that the meeting hall of the Chemists' Club was also being considered, and it might be secured.

He also announced that at the meeting of the board of directors in the afternoon thirty-four associates were elected, and the following associates were transferred to full membership: William Howard Cole, Singapore, British India; William Atwood Hall, Lynn, Mass.; William Weedon Cole, Elmira, N. Y., and Walter I. Slichter, Schenectady, N. Y.

President Arnold introduced Dr. Cary T. Hutchinson who gave an abstract of a paper entitled "The Conditions Governing the Rise of Temperature of Electric Railway Motors in Service."

Dr. Hutchinson, in introducing his paper, said that it was practically a continuation of one he prepared a year or more ago, comparing in a general way the motor capacity and energy consumption required to make various speeds at different distances. In the previous paper, however, he assumed roughly that an ordinary tramway motor would stand an average loss of three per cent; that was an approximation, and done to carry the thing to a common conclusion. If any other value could be substituted for three per cent, the same processes could be carried through. He had carried the methods through in a different way in this paper. These had been applied to motors for any I^2R losses or core losses, and he had taken into account the results shown in service tests, tests in which the motor ran backward and forward, the being temperature measured.

Dr. Hutchinson said what he was getting at was the method of determining the different variables entering into the question of motor capacity and energy consumption, to discover a method which seems to lend itself to determining the division applicable to a motor of any radiation, and any amount of motor acceleration; to determine the different points as definitely as possible. It had been necessary to make a number of approximations and he pointed out in his oral statement which were approximations and how closely they came to the figures in the paper. He believes that curve sheets, plotted for the different motors, showing the half dozen motors made by each of the manufacturing companies, would serve a very useful purpose if disseminated, in giving information.

President Arnold said that some had found, in practice, when they had had a serious problem confronting them, that some of Dr. Hutchinson's original conclusions were nearer correct than they were assumed to be at the time the first paper was delivered. He was therefore glad that Dr. Hutchinson had presented the matter again, expanding upon it, and carrying it further so that one could ascertain something about the heating capacity of motors in selecting them for railway work. This is becoming a matter of greater importance every day, as the size of railway motors increases. He called upon Mr. A. H. Armstrong, of Schenectady, to open the discussion.

Mr. Armstrong said there were one or two things in connection with the paper that he thought worthy of very careful note. One of them was that the author had followed through a method of determining velocities in the motor, had carefully followed them out through a performance of the motor in practice, segregating the losses, dividing the armature and field losses and giving their ratio, and subsequently comparing these losses to the actual performance of the motor by means of experimental tests.

This was a subject that had received a good deal of attention on the part of various companies manufacturing motors and was really the fundamental theory upon which to get the capacity of a railway motor. The service is more or less complex and consists of frequent startings, coasting and stoppings, and not only is the work intermittent, but the speeds are variable, conditions of ventilation are variable, and at first sight the proposition seems complicated, indeed. The paper had not spent so much time on detail as it has in attempting to bring out in broad scope the service capacity of railway motors. He noticed one or two points which had not been touched on, perhaps not being necessary in the rather broad manner in which the subject had been taken up. One of them was the fact that the inertia of the rotative parts had been neglected. This might amount to much on slow-speed work, such as thirty miles an hour, but in rapid transit problems it would amount to considerable, reaching perhaps a factor of twelve or fifteen per cent, on such rapid transit problems as the New York elevated road. On suburban runs, reaching sixty miles, the acceleration of the small parts of the total energy consumed may not reach more than three or five per cent, due to the fact that the cars are operated for long distances at constant speed. Leaving out this factor was not a serious matter, in any sense. He noticed, however, that the paper was based upon the fact of a constant friction rate, and the author assumed 13.6 pounds per ton. Assuming the same friction for all speeds, and the problem is only worked out at one friction rate, the conclusions arrived at, therefore, in the final curves can not be in any way assumed as general in their application, due to the fact that train friction, especially car friction, varies with the speed. In fact, a friction rate of 13.6 pounds to the ton would not have universal application outside of rapid transit problems involving the use of four or five cars in a train and operating at speeds not above thirty miles an hour. If the problem is to be treated in a broad way it is necessary to assume a number of friction rates, according to the load, composition of train, number of cars in train, different shape of cars, etc., and not only plot the motor capacities for a single friction curve, a curve varying at different speeds, but different friction curves, each having different values at the same speed. That had not been done and led to complicated results in some of the conclusions in the paper. For instance, the paper was based upon maximum speeds reaching twenty-five, fifty and seventy-five per cent above the speed at which static resistances are cut out. With an allowance of 13.6 pounds per ton, it is possible to get these different maximum speeds, and from tests which the General Electric Company has made, and which have been corroborated by other authorities, it has been found the friction for single cars of light construction sometimes reaches a factor of fifty or sixty pounds per ton at a speed of sixty miles or more. It is obvious,

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therefore, that any general conclusion based on friction rate of 13.6 pounds per ton must fall through when single cars are operated at high speeds. One of the examples given contemplates a maximum speed of fifty miles an hour, so that the author had in mind, evidently, a universal application of his curves.

Mr. Armstrong quoted some figures on the maximum speed which it is possible to reach with different friction curves. For instance, single cars operated alone at a maximum speed of thirty miles per hour, with a motor of modern construction, having ordinary speed torque curve, makes it possible to reach a speed double that at which static resistances are cut out; in other words, expressed in the terms of the author's paper, a factor of 200; for two cars, operated at the same speed if possible, 226; while for a train of heavy cars, using the curves which are given here for such work, a factor of 250 is obtained. The curves in the paper of 125, 150 and 175 would hold for this class of work. For higher friction rates, however, that is for single-car operation at speeds of fifty, sixty or seventy miles, possibly seventy-five miles per hour, this factor is not possible. For single-car operation it is hardly possible to get above the factor of 123; for two cars 140; for a train of heavy cars, giving the lowest friction rate, we possibly could reach 190. If the conclusions were based on a factor of 150, and the paper carried the factor through, it would be hard to apply the results to universal railway work, especially in high-speed problems. He looked upon the results of Dr. Hutchinson as being applicable more especially to suburban work or slow maximum speed work, similar to the rapid transit problem on the New York elevated railroad; but they would hardly touch the underground rapid transit system on account of the high speeds adopted.

Dr. Hutchinson gave a table in his paper showing the motor capacities for certain runs. Mr. Armstrong gave some figures evolved by some practical tests of motors as to the energy consumed, which actually gave, as far as energy consumed and relative motor capacity are concerned, some results in good agreement with those in the paper. Moreover, figures obtained for relative motor capacity were still more remarkable as checking very closely indeed with the paper.

However, he did not find the same uniformity of agreement in the figures for the horse-power performance based on one-hour rating with seventy-five degrees rise. He would, under similar conditions, recommend a motor of half the capacity recommended by the author, still feeling sure that temperatures of seventy-five degrees could not be exceeded.

It had been found that at speeds approaching sixty miles an hour it is possible that the motor capacity will vary after some temperature rise as much as twenty per cent, depending upon the composition of the train, whether a single car is operated alone or whether a single car is operated in a train consisting of five or six cars or more. It is necessary to treat the high-speed suburban problem upon the basis of a friction curve plotting a number of them, to meet the different conditions, and finding the motor capacity that best applies to the condition at hand. The energy consumption also obviously becomes a factor of the initial friction assumed, especially for very high speeds, sixty miles or more. In slow speeds and in the paper read by the author where a small friction rate is assumed and the acceleration of the train demands a greater amount of energy, the friction is of secondary importance and does not affect greatly either the motor capacity or energy consumed. At higher maximum speeds, approaching sixty miles per hour, it is especially for single-car work where the friction is known to be high, it is necessary very carefully to figure this and it will be found that the energy consumption depends directly upon it. For a single car of twenty-five tons, operating fifty miles an hour, the friction rate may run as high as fifty. So that it is necessary to consider the friction rate and elaborate it or complete it for other friction rates than that given by the author for the high speeds.

Dr. Hutchinson in reply said that Mr. Armstrong had tried to apply a method to certain cases which was not intended to be applicable. His own paper applied to one friction rate, and if it was desired to apply it to another friction rate, more curves must be made. There were one or two points in connection with Mr. Armstrong's remarks which he hardly felt able to discuss without knowing more definitely how Mr. Armstrong got at them. Regarding the question of motor capacity, and the figures presented by Mr. Armstrong, the trouble is that his own figures call for a run of 7,000 feet and those of Mr. Armstrong for one mile only. They check pretty closely and correctly, if that difference is born in mind.

Simple curves can be worked out for each particular friction rate desired. The various maximum velocities of 125, 150 and 175 were merely taken for the purpose of comparison.

President Arnold called upon Mr. A. H. Armstrong to present his paper entitled "A Graphic Recording Ammeter." He said that he was really reading another man's paper, that Mr. Robinson, of the research department of the General Electric Company, has designed the instrument.

In connection with the previous paper, there had been various curves plotted on the blackboard and the paper itself showed the necessity of a recording instrument capable of reading violent fluctuations in current accurately on a car that is moving and jarring the instrument, starting and stopping, thus subjecting it to strains and inaccuracies which we did not expect previous instruments to live under. Previous to the inventing of an instrument that would do this work, it has been the universal custom to appoint a number of observers to take readings of various lengths of time, two seconds is about as quick a time in which a man could take a reading, one reading and another man taking down the results, all the men working at the stroke of the gong, the whole process being tedious and open to criticism of being more or less inaccurate. With the introduction of heavier railroad work, where the motors aggregated several hundred horse-power, where temperatures had to be reliable, where the actual duty of a motor could be plotted beforehand with a great degree of accuracy, the need of such an instrument was felt; an instrument that would enable us to make preliminary tests and record the readings with a considerable degree of accuracy.

This instrument was brought out by the General Electric Company, not so much to put it commercially on the market or for general application, as it was to enable them to better study and let others have the benefit of that study of the subject of railway motors in operation. The instrument itself consists of two coils carrying line current or a part of the line current. Inside is a secondary coil energized from a separate source and a storage battery. There is an ammeter to keep this current at the required strength and to calibrate the instrument by using different strengths of current. The power used in the instrument is considerable, and owing to the fact that it is used on railway work but several hundred kilowatts are involved; it may use several hundred watts in its operation, as such a quantity would not be noticed in the total power equipment of the train.

The instrument has a "dead-beat" attachment, and is very nearly "dead-beat." It reaches its maximum reading instantly, does not go beyond, and comes immediately to zero. The instrument and samples of its work were exhibited.

The meeting then adjourned.

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Reviews of Current Engineering and Scientific Literature.

Statistics of Electric Railways in France.

A set of quite complete statistics of the railways of France is here published, all classes of roads being considered. A summary of the data for the electric railways up to January 1, 1903, is as follows: The total length of the lines is 1,994.7 kilometres. The total power is 73,997 kilowatts. On these roads there are operated 3,004 motor cars. There are eighty-five lines using the overhead trolley only, there are three using the underground conductor only, five with the third rail and eight with accumulators. There are thirteen lines using both accumulators and trolley, but there are four with a mixed trolley and conduit system, thirty-one with a mixed surface contact and trolley, and three using a trolley on ordinary roads. Ten years ago there were but 37.4 kilometres of electric railway in France with a total power of 1,525 kilowatts operating with twenty cars. There were two trolley lines, one third rail and two accumulator systems.—*Translated and abstracted from L'Industrie Electrique (Paris), September 25, 1903.*

Railway Cross-Ties.

Much ingenuity has been expended during the past twenty-five years in a search for a substitute for wooden cross-ties. Steel and concrete have been tried, but so far without entire satisfaction, at least in this country. The need for some substitute is becoming more imperative every year, because, although there has been a great increase in demand, there has been no corresponding increase in the supply of first-class ties. The railroads have been forced to make use of inferior timber and all kinds which formerly would not have been accepted. There has, however, been an extended use of treated ties, the endeavor being to make inferior wood more valuable. It is said that the life of a white oak tie has fallen from nine years to four or five years because of poor quality as well as the harder service. California red wood is rapidly worn by sand under the rails. Beech is worthless. Red oak is good for only four years, though by chemical treatment this and other woods may be made to last from ten to fifteen years, but it is difficult to secure a thorough treatment which will last. Under such conditions it is strange that one variety of wood, a native of the United States, has not found a wider use, as this wood is practically immune to the attacks of rot fungus. This is catalpa speciosa, a rapid-growing tree. The earliest railways of southern Indiana, southern Illinois and southeast Missouri were constructed near the catalpa swamps, and whenever possible made use of this wood, and engineers on these roads now have samples of ties which were in use fifteen or twenty years ago. Many of these older ties have been removed, because they were not thick enough for the new heavy rails, but when removed few of them were found to be badly decayed. Some of these ties have been in use thirty-one years, during which time five sets of white oak have decayed and been removed, but the catalpa is sound to-day. Poles of this wood were also made use of for the telegraph lines; several hundred of which still remain in use.—*Abstracted from Arboriculture (Indianapolis), October, 1903.*

The Electrified Mersey Railway at Work.

Comparison is here made of the operation of the Mersey railroad since its conversion to electricity with that while steam was used. The entire absence of smoke, both in the stations and tunnel, is one of the most noticeable improvements. When steam was used the trains accelerated rapidly when descending the incline from the station, and mounted but slowly the rise to the other station. With the motors this change of speed is hardly noticeable, the trains running at a practically uniform speed. Trains are run throughout the day every three minutes, there being a total of 750 trains for the working day. Under the old conditions there were about 283 trains for each week day. The effect of the change in motive power and schedule was an immediate and large increase in the traffic. In the first full week of service 125,272 local passengers traveled over the railway, an increase of 37,619 over the number carried for the last week of the steam service. Compared with the corresponding week of last year, the increase was 32,875. There has been an increase in the taking of forty-five per cent on the amount taken during the last week of the steam service, and forty per cent on the amount taken in the corresponding week last year. Excluding the holiday traffic in Whitsun week, the traffic shows an increase since the electrified service began of thirty-five to forty per cent. These figures relate only to what is termed local traffic, and do not include passenger traffic with distant stations on other railways worked over the Mersey railway. It was believed by the officials of the Mersey road that, when the clearing house returns were received, a material increase would have to be made to the increase of thirty-five to forty per cent reported in the local traffic.—*Abstracted from the Tramway and Railway World (London), October 8.*

Experiments on Selective Wireless Telegraphy.

The system of selective wireless telegraphy developed by Mr. Anders Bull was described in the ELECTRICAL REVIEW for January 24, 1903. In this article the inventor gives a short account of some practical tests conducted at the invitation of the Marconi Wireless Telegraph Company. The system is yet in the experimental stage, and the tests were conducted with the sole view of ascertaining the possibility of secretly communicating between stations and the further possibility of sending messages by means of selective telegraphy to several independent receivers at the same time. The first tests were conducted between the Marconi stations at Chelmsford and Bloomfield, a distance of three and one-half kilometres. These having proved satisfactory, the receiver station was removed to Frinton-on-Sea, Chelmsford acting as the sending station. These stations are fifty-five kilometres apart, but on account of intervening hills the district is rather unfavorable to wireless telegraphy, and the equivalent at sea would be about four times as long. Atmospheric disturbances rendered the tests difficult. The sending station was equipped with a single air wire, the receiving station using a "jigger." The air wires were fifty-three metres high. It was found that the Marconi receivers, although exceedingly sensitive, could not be used, as one of the chief conditions required by this system is the quick and distinct marking of the impulses received. A special tapping device was designed and is here described. In this the relay current is interrupted by the movement of the decohering armature before the coherer has ceased to vibrate. The speed of transmission is the same as that with the ordinary Marconi apparatus, and under favorable conditions, messages were received very clearly. These results were obtained with primitive apparatus, and the inventor believes that they demonstrate that the system is applicable for all practical purposes where it is desirable to prevent outsiders from tapping messages.—*Abstracted from the Electrician (London), October 2.*

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Successful Automobile Trip with an Edison Storage Battery.

A successful tour from Boston to New York was made last week in a carriage equipped with the new Edison storage battery. There were no mishaps, except a little trouble with one motor toward the end of the run and at no time was the carriage stalled, though some stiff hills were climbed. The following is a report of the trip in detail:

Left Boston October 20, at 11.30 A. M. The carriage was formerly a Columbia tonneau belonging to Mr. Charles L. Edgar, president of the Edison Electric Illuminating Company of Boston. It was driven by Mr. H. M. Wilson, of the automobile department of the Edison company. This carriage Mr. Edgar had fitted up with a new Edison storage battery, removing the tonneau and making it a single-seated carriage, and putting in sixty-eight cells, in place of the forty-four lead cells, the weight of the battery being practically the same as before. The carriage was equipped with two eighty-volt motors.

On the first charge the carriage ran through to Worcester, passing through Wellesley Hills, Southboro and Northboro, arriving at Worcester at 4.45 that afternoon. It remained at Worcester overnight, charging part of the time at an automobile garage at a low rate, and for a short time the following morning at the Worcester Electric Light Company's station at a high rate. The start from Worcester was made at 12.30 on Wednesday, October 21, and the run was made through to Springfield without any trouble whatever. The famous Leicester hill was climbed, a hill that has stalled a great many automobiles and which all automobilists dread. The battery gave out 100 amperes of current during a greater part of the time, and at the discharge reached 102 amperes. From Leicester to Spencer, on the run to Springfield, the road is very hilly, and at Brookfield it was almost impassable. In fact, for an eighth of a mile it was necessary to take to the sidewalk, passing between a line of trees and the stone wall and fences, owing to repairs that were being made to the road at that time. From Westboro to Palmer the road was also very bad. In fact, it is the most abominable piece of road in Massachusetts. Arrived at Springfield at 6.34 P. M., the cyclometer recording sixty-three and one-half miles from Worcester. On reaching Springfield the carriage could have run ten miles more, if necessary, on the same charge. It was placed on charge from 8.30 to 11 P. M., at a twenty-ampere rate.

On the following morning the carriage was on charge from 8 to 11 at forty amperes. Left Springfield at 11.15 on Thursday, and arrived at Hartford at 1.45 P. M. Was on charge at Hartford two hours at forty amperes, and continued to New Haven that afternoon, arriving there at 9.10 P. M. Most of the way between Hartford and New Haven is a good macadam road, but there are some bad sandy stretches and rough country roads, but no grades of any account. At New Haven went on charge for two hours at a low rate, owing to the poor facilities for charging there. In the morning changed over the wiring on the switchboard and put the carriage on for three hours at a higher rate, leaving New Haven at 1 o'clock. Reached Bridgeport at 3.50 P. M., charging at Bridgeport one and one-half hours at thirty amperes. Continued to Stamford through a hard rain and over heavy roads. At Stamford the carriage remained on charge overnight, leaving there on Saturday morning. From Stamford to New York, owing to the rain of the night before, the roads were very heavy, and in many places the normal conditions of the road were wretched, being sandy and rough. At Portchester a stop of two hours was made. Rear wheels were taken off and gears, brake bands and pinions thoroughly cleaned and oiled. After leaving New Rochelle it was noticed that the motors were taking more current than necessary to drive the carriage on a level, and it was found that one of the motors was heating up. Stopped thirty-five minutes to examine motor and allow it to cool, and then continued to New York, the motor drawing current considerable above the normal rate. Arrived at 1684 Broadway at 4.45 Saturday afternoon, and upon examining motor it was found that an armature band wire had broken, which accounted for the extra discharge rate required to run the carriage, and the consequent heating of the motor.

The total distance from Boston to New York, according to cyclometer, indicated 249⅛ miles, this being about five miles more than the actual distance, owing to losing the road on two occasions. The trip could have been made in much shorter time, and charging facilities been better. The various charging outfits in the different towns are equipped merely for small carriages charging at low rate, and in only Worcester and Stamford was it possible to charge the battery at the rate desired. The actual running time was twenty-four hours and fifty-six minutes, making the average speed ten miles an hour.

Preliminary Programme of the International Electrical Congress.

The International Electrical Congress will be held at St. Louis during the week beginning September 12, 1904, in connection with the Universal Exposition. This is the week preceding the session of the great scientific congress appointed by the exposition.

On the morning of September 12 a general convocation will be called. On the four succeeding days the eight sections will be held simultaneously. On the final day, September 17, a second general convocation will be called.

As at present proposed, the international congress will comprise three distinct features: First, a chamber of delegates, appointed by the various governments, which will consider matters requiring international action. Second, the main body of the congress, divided into the following sections: General theory—Section A, mathematical and experimental; applications—Section B, general applications; Section C, electrochemistry; Section D, electric power transmission; Section E, electric light and distribution; Section F, electric transportation; Section G, electric communication; Section H, electrotherapeutics. It is purposed to invite prominent men in various parts of the world to contribute special papers on the subjects represented in the various sections and their subdivisions. Third, conventions will be held simultaneously in connection with the congress, by various electrical organizations in the United States. It is the intention that each section of the congress may be able to hold its meetings under some plan of conjunction with the organization or organizations devoted to the progress of the work selected by that section. The following prominent organizations will cooperate: American Institute of Electrical Engineers, the American Electrochemical Society, the National Electric Light Association, the Association of Edison Illuminating Companies, the Pacific Coast Transmission Association and the American Electrotherapeutic Association.

The plans of the committee of organization are to invite all interested in electricity and its applications to accept membership in and to attend the congress if possible.

The fee for membership has been fixed at $5, and each member will receive a copy of the report, which will be published in one or more octavo volumes. Those intending to subscribe should signify their intention to Dr. A. E. Kennelly, Harvard University, Cambridge, Mass., general secretary of the committee of organization.

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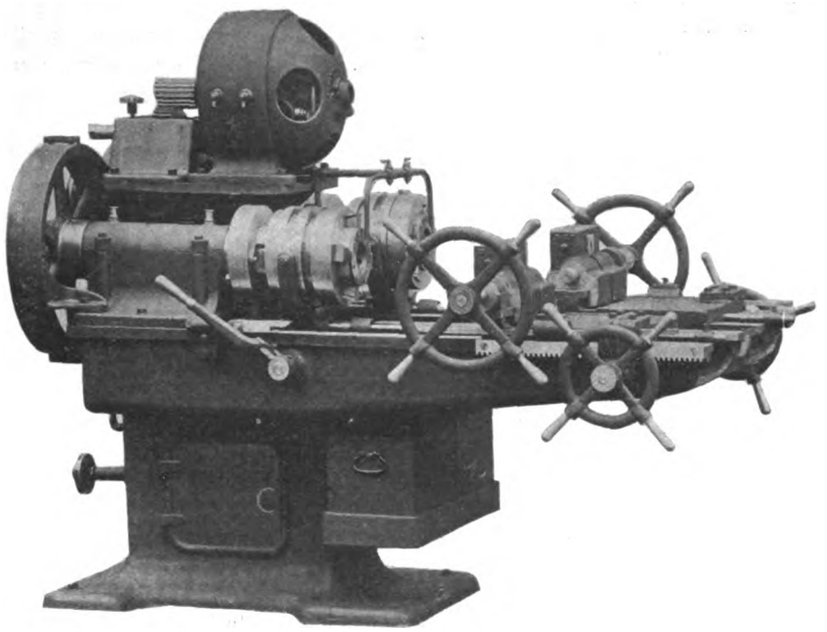
INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Motor-Driven Double-Head Bolt Cutter.

The accompanying illustration represents the standard type of double bolt cutters with motor drive as brought out by the Reliance Machine and Tool Company, Cleveland, Ohio. This machine is in all its details the same as its standard well-known machine with the exception of the belt pulley, this being replaced by the motor. This motor is placed between and above the head stocks of the machine, keeping it absolutely free from oil and chips and thereby occupying no valuable floor space. The specifications for this machine, which was primarily built for one of the United States navy yards, called for an exceptionally large range of speed and novel means were devised to meet these conditions. A three-horse-power reversible, variable speed motor was used, giving a speed variation of three to eight, and by means of gears placed between the pinions on the motor shaft and the main pinion on the machine this ratio increases from one to six. By means of a speed controller, which is not shown in the illustration, in connection with the motor, eighteen spindle speeds are obtained. This arrangement, it is stated, has proven to be very satisfactory and is meeting with universal favor. While in this particular case and in many subsequent ones the Crocker-Wheeler motor and Cutler-Hammer controller were used, the manufacturer is prepared to furnish any standard electrical equipments and connect the same either by direct gearing, belt or silent chain.



MOTOR-DRIVEN DOUBLE-HEAD BOLT CUTTER.

A Transformer for Polyphase Circuits.

The Kuhlman Electric Company, Elkhart, Ind., has designed a new transformer for polyphase circuits, replacing the individual transformers made use of in ordinary practice in power and lighting circuits by a composite transformer having separate magnetic circuits combined as are the wires of a polyphase circuit.

This transformer, for both lighting and power loads, draws equally from the several primary phases. This feature, together with several others of importance, makes this type of transformer of great service for polyphase circuits. The advantages which the manufacturer claims for this transformer are as follows: Secondary distribution for power service which equally loads the three primary phases and maintains balanced voltages; secondary distribution with mixed lighting and power load which draws equally from the several phases; compactness of construction and improved appearance; reduced weight and less cost as compared with its equivalent capacity in single-phase units; wide range of voltage which may be obtained, and simplicity of connections.

Fig. 1 shows a front view of a polyphase transformer assembled, and Fig. 2

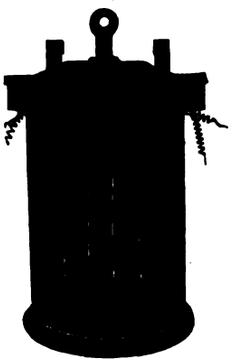


FIG. 1.—POLYPHASE TRANSFORMER.

shows the apparatus installed on the proper hanger. Fig. 3 shows the three-phase four-wire connection.

To complete the full line of polyphase transformers the company has designed a

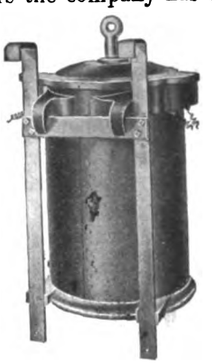


FIG. 2.—POLYPHASE TRANSFORMER ON HOOK.

two-phase composite type which is placed in the line of cases as shown in Fig. 1. In addition to its use as a two-phase transformer, it may be used on single and three-phase circuits.

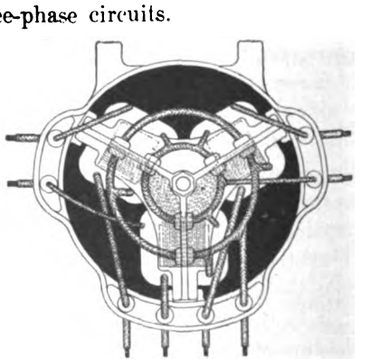


FIG. 3.—THREE-PHASE, FOUR-WIRE CONNECTION.

The case is cylindrical in form, which gives room for a comparatively large body of oil, and has a large external radiating

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surface, ensuring low temperature rise under continuous full load.

The coils are wound directly on the iron, with one primary and two secondary sections on each leg, and it is stated that all the connections of a three-phase circuit which may be made with three separate transformers are possible with the construction of this transformer.

The following are some of the voltages which may be obtained from the same transformer: One thousand volts primary —100, 200, 173, 346 volts three-phase; 100 and 200 volts six-phase; 100, 200 and 346 volts three-phase four-wire. Two thousand volts primary—200, 400, 116, 232 volts three-phase; 116, 232 volts six-phase; 116, 232, 400 volts three-phase four-wire.

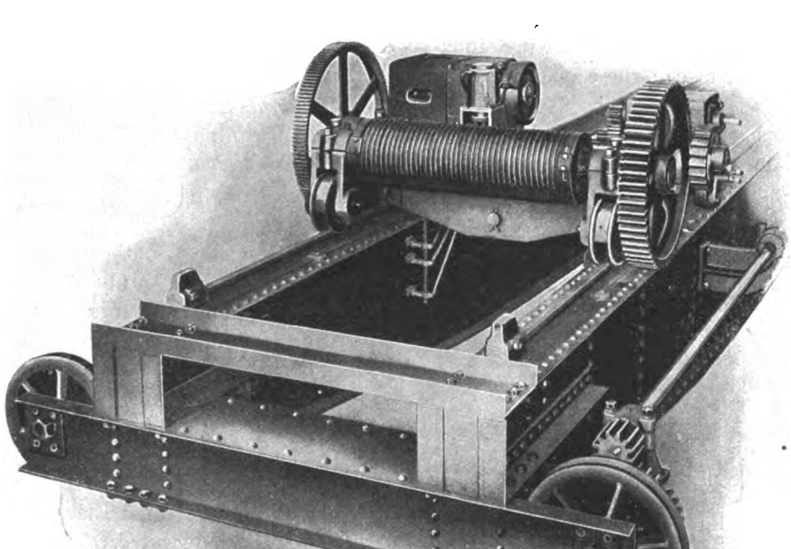
Electric Traveling Cranes and Electric Hoists.

The accompanying illustrations show an electric traveling crane with trolley in place and an "Armington" electric hoist built by the Cleveland Crane and Car Company, of Wickliffe, Ohio.

The Cleveland electric cranes are designed to meet the requirements of the most severe continuous service. The design, material and workmanship are of the highest order, and all apparatus is built to fulfil the most exacting requirements.

The electric traveler, as delivered, includes the bridge with operator's platform, trolley and running block, the whole complete ready to be placed on the runway track. The electrical connections are made complete to the main feed wires along the crane runway.

A factor of safety of at least five is used in the design of all details, and a larger factor of safety where conditions require it. The bridge may be dsigned as a single I-beam girder, single-plate and angle or double-plate and angle (box girder), depending upon the span, capacity and speed required. In case of a long span and high speed, a girder of the lattice truss type, with auxiliary bracing, may be most suitable. The bridge trucks are usually built of box section from structural steel. The girders are rigidly connected to the bridge trucks with fitted bolts and lock washers. The bridge gears have teeth cut from the solid and are of ample face to ensure a minimum amount of wear.



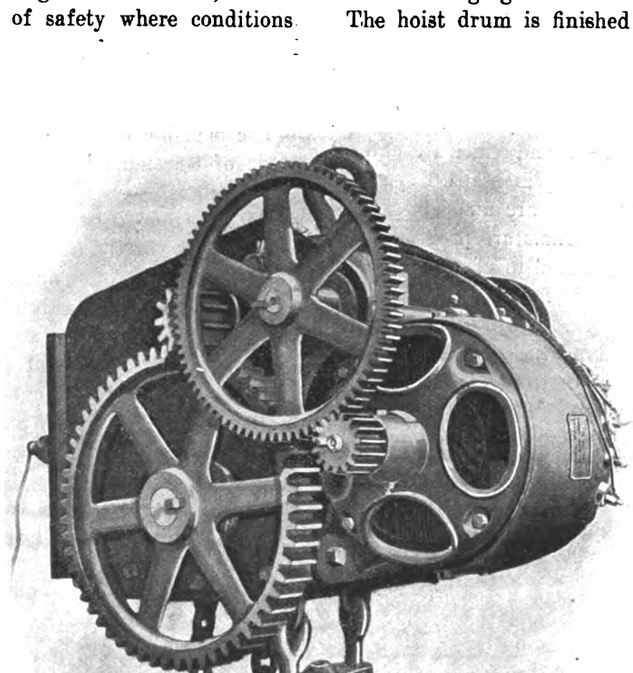
CRANE WITH TROLLEY IN PLACE.

The cab is of ample size for all electric controlling mechanism under the care of the operator and to allow sufficient floor space for operating all the crane functions easily. A powerful foot brake to control the speed of bridge travel is furnished for use by the operator in the cab.

The trolley consists of a cast-steel or iron frame carrying all the mechanism required for hoisting and racking the load. The trolley gears are cut from the solid, and all the hoist gears are of steel. The pinions on both trolley and bridge with less than twenty teeth are cut from solid steel forgings.

The hoist drum is finished with right and left-hand grooves, keeping the load equally distributed on both girders.

The track wheels for both the bridge



ELECTRIC HOIST.

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and trolley are double-flanged, cast of steel or charcoal iron with chilled tread. The tread is designed for the required runway rail and is ground true to diameter.

A mechanical safety load brake is provided with each crane. This is self-lubricating, entirely automatic, and keeps the load under control at all times. By reversing the motor the lowering is effected through this brake with regularity and safety.

The electric brake, of the solenoid type, operates on the armature shaft of the hoisting motor. This brake automatically releases when hoisting or lowering, and is immediately applied when either motion ceases.

The running block is built entirely of steel, and all sheaves are lined with bronze bushings. The hook is forged from best grade chain iron and is made to swivel freely under the heaviest load. The best grade of short-link crane chain or best pliable crucible steel hoisting rope is used with all the running blocks.

Ample provision is made for lubrication where required. All shaft journal bearings are provided with compression grease cups.

The "Armington" electric hoist shown in the accompanying engraving is designed for use where a power hoist which is easily operated and efficient, and at the same time occupies a small space, is desired. The hoists are made largely of steel, and the journals are provided with bronze bearings bored in place, giving accurate alignment for gears. No differential or worm gearing is used, the gears being all of the spur type, heavy pitch and cut from solid forgings.

The motors are of the series-wound multipolar crane type. The controllers are of the face-plate type, and the construction makes them fireproof. The contact pieces are substantial and durable, and the resistance sufficient to regulate the speed of motor from no load to full load. The controller lever is so arranged that the circuit opens automatically, and must remain so unless the trolley rope is in the hands of the operator. The load is entirely sustained by an automatic safety brake, and, in descending, the load moves only as long as the operator pulls the pendent rope. The load is raised only as long as the operator desires, and should he suddenly leave, the motor stops automatically and the load remains where it was left suspended by the brake. The hook is well proportioned, made of forged steel, and swivels easily.

The Cleveland Crane and Car Company, in addition to the apparatus described above, makes a number of special forms of hand and electric jib post and car cranes and hand-power traveling cranes.

A New Type of Pole-Changer.

The Illinois Electric Specialty Company, 171 South Canal street, Chicago, Ill., is placing on the market the Illinois pole-changer. The accompanying illustration shows one of these pole-changers, which is but nine by six by five inches in dimensions, weighs five pounds and is adapted to all alternating circuits.

This apparatus is simple, rigid and compact in construction. Its mechanism is mounted on an oak base covered by an

NEW TYPE OF POLE-CHANGER.

oak hinged box with beveled plate-glass front. The instrument is so constructed that it will work in either a horizontal or ordinary position, admitting of its being mounted on a cabinet, hung on a wall, or in any other convenient place. In operation it is practically noiseless, and therefore not objectionable in the working room.

The machine has three contact springs made of German silver, and the contact points are of heavy sheet platinum. The contact springs engage alternately from their opposite sides, and consequently can not be forced out of their normal position by extended use. The manufacturer states that it is impossible for any of the parts to get out of adjustment, as the whole mechanism is securely mounted and locked in one solid heavy brass frame. It is also stated that the machine never requires adjusting after leaving the factory, except for regulating the speed, which is done by simply sliding a small bolt on the end of the vibrator rod.

The instrument is adapted for use where either or both alternating and pulsating currents are required, and especially meets the requirements of heavily loaded party and long toll lines.

A condenser is mounted in the base of the machine, and is permanently bridged across the ringing circuit. This entirely controls on common-return systems what is known as the generator noise, and also reduces to a minimum sparking at the contact points. A resistance coil is also placed in the battery circuit to prevent any injury to the machine by an excessive flow of current in case of accidental short-circuits.

There is no consumption of main battery current, only when the operator presses the ringing key. This reduces the cost of maintenance, which consists only of battery renewals.

The New Passenger Station of the Lake Shore & Michigan Southern Railway.

The accompanying illustration shows the new passenger station of the Lake Shore & Michigan Southern Railway, which was opened on July 12 of the present year. This is known as the La Salle street station, and the building extends along Van Buren street, between La Salle and Sherman streets, Chicago. This is one of the most conveniently located passenger stations in Chicago, being in the heart of the business district and the only one on the Union Elevated loop. All of the Chicago elevated railway trains stop in front of this station and are connected with it by a covered passageway, so that trains may be taken directly from the second or main floor level without descending into the street.

The main building is thirteen stories high, with a frontage of 213 feet. It is

NEW LA SALLE STREET STATION OF LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

202 feet deep, the area being 43,026 square feet. The train shed is 213 by 575 feet, and the power-house is 220 by 145 feet. The first floor contains dining room, ticket offices and a lobby 100 feet square. The space devoted for baggage room purposes is 110 by 360 feet in size. On the second floor is the main waiting room, ladies' waiting room, gentlemen's smoking room, waiting room for elevated railway trains, and ticket offices. The total area of waiting room space on this floor is 17,322 square feet.

Alaskan Telegraphy.

The connection of Seattle and St. Michael's by telegraph is now complete. Messages are forwarded to Nome by mail.

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Dispersion Lenses for Searchlight Projectors.

The Carlisle & Finch Company, Cincinnati, Ohio, has recently brought out a new design of searchlight wherein its "Dispersion" lens can be used and at any instant can be substituted by the regular lens with practically no trouble. The "Dispersion" lens, as the name implies, is a glass lens to be used in searchlights for the dispersion or spreading out of the light.

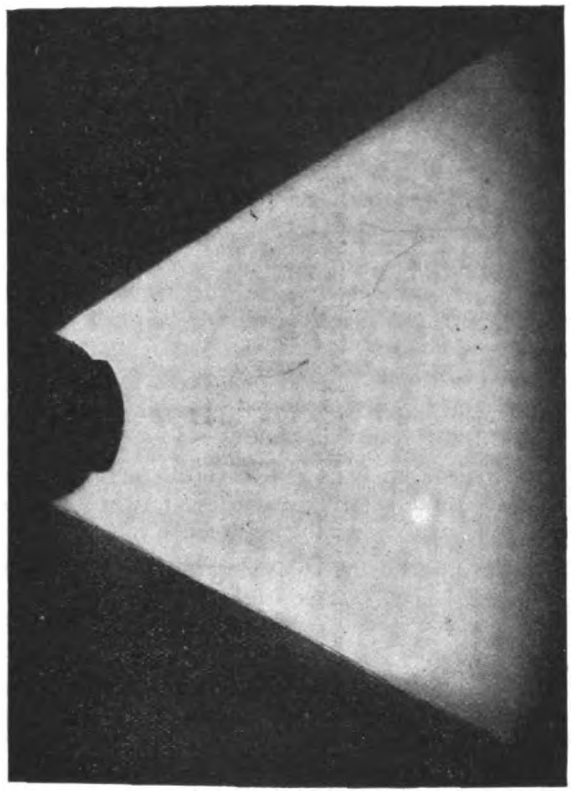

FIG. 1.—DISPERSED BEAM WITH WIDE-ANGLE LENS.

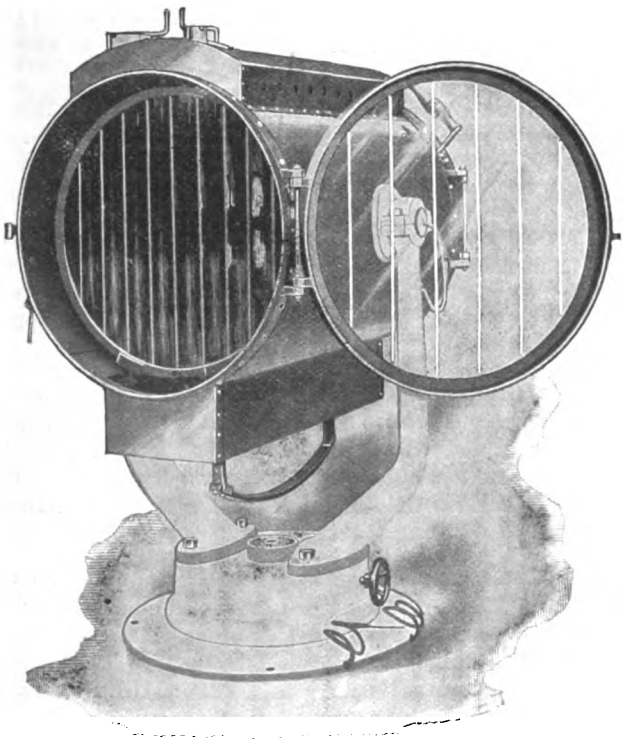

FIG. 2.—COMBINATION APPARATUS FOR CONCENTRATED BEAM AND DISPERSED LIGHT PROJECTION.

These lenses are made of strips of heavy plate-glass, one side of which is ground to a convex curve and highly polished. When the light passes through these strips it is first converged or brought together, and then as the rays cross they spread out again, and continue to spread indefinitely. The light is spread out flat or horizontally, as shown in Fig. 1, but not vertically and hence lights up objects on a flat surface much better than the ordinary straight beam. When the light is spread out as in Fig. 1, it is incapable of penetrating very far and for this reason the ordinary lens, which throws a straight beam, capable of penetrating to a considerable distance, is essential to a searchlight. The apparatus, as shown in Fig. 2 with the door swung open, which the company is now placing on the market, embodies both of these features.

The "Dispersion" lens is arranged on two semi-circular brass rings so pivoted that it can be swung around on the vertical axis as shown in illustration, and does not interfere with the light when an ordinary lens is being used. Fig. 3 shows the lamp with the "Dispersion" lens in place. On the top of each searchlight cylinder are two brass handles by means of which either lens may be swung into or out of place.

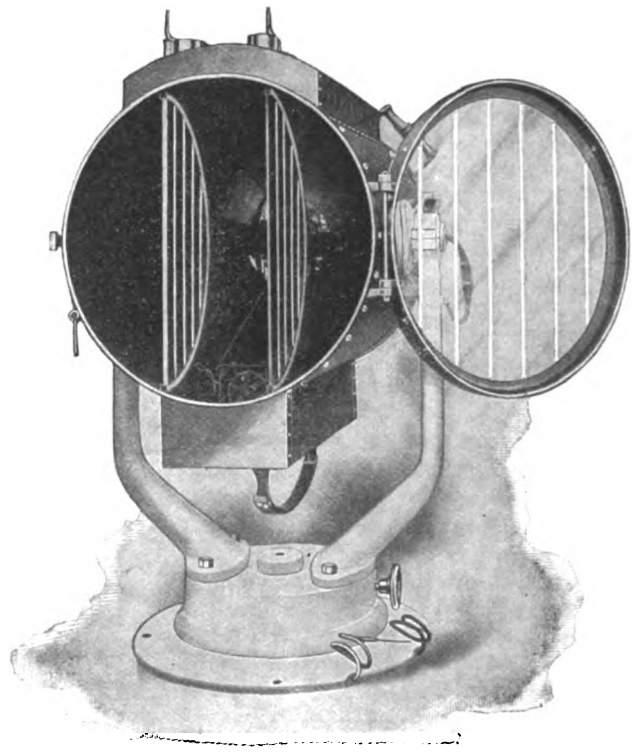

FIG. 2.—WIDE-ANGLE LENS, MANIPULATED BY BRASS HANDLES ON TOP OF PROJECTOR.

Automobile Cars for Railways.

The use of automobile cars—that is, light cars equipped with a small engine—is receiving a good deal of attention in England, in connection with lines where traffic is light. Two types of car are described in the October issue of the *Tramway and Railway World.* The first was constructed for the Southwestern and the Brighton Railway companies, and is being run between Fratton and Southsea. It has a first and a third-class section. The two may be separated by a sliding door. The total seating capacity is forty-two. The carriage body is fifty-six feet long overall and is carried on two four-wheel trucks. The motive power is steam, the engine cylinders having a stroke of ten inches and being seven inches in diameter. The rate of acceleration gives the coach a velocity of thirty miles an hour in thirty seconds.

The other type of car was designed by the Wolseley Tool and Motor Car Company, of Birmingham. The coach does not differ much from that just described, but the car is driven by motors, the power being supplied from a generator on the car which itself is driven by an oil engine. This method was adopted to secure the advantages of electrical control. The oil engine is rated at eighty horse-power. It has four cylinders and runs at 420 revolutions per minute. The generator is rated at sixty kilowatts, 500 volts, and is separately excited. A fifty-horse-power railway motor is mounted on each of the two trucks. A battery of forty cells, with a ninety-ampere discharge rate, is carried beneath the car and furnishes power for the lights and assists in starting the engine.

Gasoline Automobile Handbook.

The A. L. Dyke Automobile Supply Company, St. Louis, Mo., has published a gasoline automobile handbook, entitled "Diseases of a Gasoline Automobile and How to Cure Them." This book is written by Messrs. A. L. Dyke and G. P. Dorris, and takes up in detail the miscellaneous accidents and troubles which are experienced in the handling of gasoline automobiles, delineating the parts and their different functions, and giving ready means for getting over these difficulties.

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CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

SHOSHONE FALLS POWER PLANT—It is stated that Senator William A. Clark, of Montana, has under way a proposition to utilize the power of Shoshone falls, Idaho. This will require an outlay of $2,000,000. An electric power plant which will generate 48,000 horse-power and distribute this power to towns within a radius of 200 miles is said to be the ultimate object of the present plans.

NEW SPEED RECORD ON THE BERLIN-ZOSSEN EXPERIMENTAL LINE—Despatches from Berlin, dated October 23, state that during another speed test on the experimental electric railroad from Marienfeld to Zossen, Germany, a rate of 131 miles an hour was achieved. The test was observed from the Dahlwitz station by a number of military officers, civilians and other persons interested.

WATER POWER COMPANY FORMED AT VALPARAISO, CHILI—A company with a capital of $1,190,000 has been organized at Valparaiso, Chili, for the purpose of securing control of water power, erecting an electric light and power station, and taking over the horse-car lines. According to a report to the state department from United States Consul Warner, stationed at Liepsic, Germany, in this company are German firms, including the Siemens-Schuckert Company, the Allegemeine Elektricitäts Gesellschaft, the Union Elektricitäts Gesellschaft, and several of the banking houses in Berlin.

MEXICAN LIGHT AND POWER COMPANY—Preparatory work has been practically completed and actual construction operations are to be begun shortly by the Mexican Light and Power Company, Limited, on the transmission line which is to be erected between the company's large power plant at Necaxa and El Oro, Mexico. The length of the line will be about 100 miles. The company has let contracts for various equipments for the Necaxa plant, which is to have an initial capacity of 45,000 horse-power. The turbines will be built by Escher, Wyss & Company, of Zurich, Switzerland. A transmission line will also be built from Necaxa to Mexico City, a distance of ninety miles. It is stated that about 50,000 horse-power will be required for the purpose of operating all the mines in and around El Oro and for working various railway lines under construction. The Necaxa plant will be increased in capacity up to 80,000 horse-power. Mr. Hugh L. Cooper is engineer in charge of the construction of the Mexican company's system, and is now in Mexico, and Mr. F. S. Pearson is vice-president and chief electrical expert.

FATAL ACCIDENT IN THE NEW YORK RAPID TRANSIT SUBWAY—Following a slight blast in one of the tunnel excavations on the route of the rapid transit subway in New York city there was a cave-in which resulted fatally to a number of workmen. The loosening of a boulder in the rock formation above the roof of the tunnel resulted in the collapse of about 100 feet at 195th street on Saturday evening, October 24. Of the persons caught in the accident, six were killed instantly, three lingering for some time pinioned down by heavy masses of rock. Another man who was released from the débris and conveyed to the hospital died shortly after reaching there. All of the dead men, except Timothy Sullivan, the foreman, and William Scheutte, the electrician, were Italians. All possible precautions have been taken in conducting the work against an accident of this nature. At the point where the cave-in occurred the tunnel is about 110 feet below the surface. Only about 500 feet remain to be bored in order to make connection with the section of the tunnel which is being bored in a northerly direction. The night gang had entered the tunnel for the purpose of putting in the "wall plate," following the loosening of the rock by the blast, when, without warning, the ceiling of rock gave way. The man in charge was considered a very good and cautious workman, and it was his custom to sound the walls and roof after a blast to see if they were solid.

PERSONAL MENTION.

DR. ARTHUR W. SMITH has been appointed professor of physics at the University of Michigan.

PROFESSOR R. B. OWENS has been elected president of the electrical section of the Canadian Society of Civil Engineers.

MR. M. L. H. WILLIER, professor of physics at the Lyceum, at Nantes, France, has been appointed director of the Meteorological Observatory in that city.

MR. G. H. MARX, assistant professor of mechanical engineering at Stanford University, has received a year's leave of absence, which he will spend in Germany.

MR. FRANCIS GRANGER, 26 Cortlandt street, New York city, has been appointed the sole New York representative for the L. B. Allen Company, Incorporated, of Chicago, Ill.

MR. H. B. HEWITT, the Missouri representative of the Stromberg-Carlson Telephone Manufacturing Company, formerly located at Keithsburg, Ill., is now permanently located at Chillicothe, Mo.

MR. GEORGE W. COLLES, chief engineer of Marion & Marion, Montreal, Canada, has resigned this position and opened an office as consulting mechanical and electrical engineer in Milwaukee, Wis.

MR. BURCHAM HARDING, for several years with the Westinghouse Electric and Manufacturing Company, has resigned to become manager of the local office of a leading real estate company of Pittsburg, Pa.

MR. R. J. RUSSELL has severed his connection with the Wagner Electric Manufacturing Company, and has accepted a position as business and sales manager of the H. E. Lindsey Electrical Supply Company, of St. Louis, Mo.

DR. HENRY S. PRITCHETT, president of the Massachusetts Institute of Technology, sailed on October 5 from New York on the steamer Kronprinz for Germany. It is expected he will be absent from Boston about four weeks.

MR. J. P. CLARK, formerly manager of the Terre Haute electric system for Stone & Webster, Boston, and later representing their interests at Dallas, Tex., is to become manager of the Indiana Union Traction Company's lines at Fort Wayne, Ind.

MR. RAY TITUS WELLS, Ph. D., has been appointed assistant professor in charge of electrical engineering in the newly organized school of applied science of the State University of Iowa, at Iowa City. A new electrical laboratory is now being equipped under his direction.

MR. JAMES WILLIAMS has been appointed chief engineer of the Columbus, Delaware & Marion Electric Railroad Company, with headquarters at Prospect, Ohio. Mr. Williams succeeds Mr. Lee Fisher, who has been appointed to a similar position with the Joliet, Plainfield & Aurora Railway, of which his father, Mr. H. A. Fisher, is president.

MR. E. A. FISHER, city engineer, Rochester, N. Y., in an address on the morning of October 22, before the annual convention of the American Society of Municipal Improvements, in session at Indianapolis, Ind., stated that Rochester was one of the best lighted municipalities in the country and that Main street was better lighted than any other thoroughfare in the world. Mr. Fisher also made a report to the convention on "Improvements Made in Street Lighting," which covers the improvements made to lighting systems throughout the country.

MR. F. B. DUNCAN has been appointed manager of the Akron (Ohio) Electric Manufacturing Company. About two years ago Mr. Duncan resigned his position as general superintendent, which he had held for about five years with the Northern Electrical Manufacturing Company, of Madison, Wis., to accept a similar position

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with the Akron company, and his present promotion is an evidence of the company's appreciation of his services. During his connection with the Akron company, Mr. Duncan has redesigned its entire line of machines, and the growth of its business has been very marked.

MR. W. O. WOOD, formerly general superintendent of the Detroit, Mich., rapid transit system, has been appointed superintendent of the elevated division of the Brooklyn Rapid Transit Company, of Brooklyn, N. Y., succeeding Mr. George W. Edwards, resigned. Mr. Wood has had extensive experience in the operation of steam and electric railways, and the first move in his new position will be to perfect and apply to the elevated lines the merit system of discipline recently adopted by the company, and in working out for the elevated lines the system of train despatching recognized as standard by the leading steam roads.

MR. HORACE H. ESSELSTYN, engineer for Westinghouse, Church, Kerr & Company, who had charge of building the Grand Rapids, Grand Haven & Muskegon Company's line into Grand Haven, Mich., has gone to St. Louis to superintend the installation of the power plant in Machinery Hall of the Louisiana Purchase Exposition. The contract for this plant includes four 2,000-kilowatt units, besides various auxiliary engines, turbine pumps, etc., all of Westinghouse make. While in Michigan, in addition to building the interurban line to Grand Haven, Mr. Esselstyn built the new drawbridge across the Grand river at Grand Haven to accommodate both the interurban cars and the highway traffic, the contract for all of this work having been awarded to Westinghouse, Church, Kerr & Company.

NEW INCORPORATIONS.

HARRISBURG, PA.—Lancaster & Southern Street Railway Company. $84,000. Incorporators: James G. McSparran, of Furniss; C. H. Fondersmith, William Wohlsen, Frederick Shofl and T. K. Worthington, Lancaster.

ST. PAUL, MINN.—Farmers' Telephone Company. $12,500. Incorporators: C. B. L. Bohan, S. Greendahl, M. P. Mortenson, J. Elkof, J. A. Grundahl, A. Westlund, A. Salberg, O. L. Titrud, V. N. Millquist, G. A. Hohner, Stockholm; A. Hord and C. J. Carlson, Cokato.

MOLINE, ILL.—Dixon, Rock Falls & Southwestern Electric Railway Company. $50,000. Directors: O. E. Maxson, A. S. Goodell, A. J. McNeill, R. L. Leitsch and H. L. Sheldon, of Rock Falls. To build an electric railroad from Dixon, in Lee County, to Rock Island.

CHARLESTON, W. VA.—Paden City, Middlebourne & Salem Railway Company. $100,000. Incorporators: Thomas A. Watkins and George R. Wallace, of Pittsburg; Robert Miller, of Paden City; George E. Work, of Sisterville, W. Va., and E. L. Robinson, of New Martinsville, W. Va. To build and operate an interurban railway system through the cities named.

PITTSBURG, PA.—Irwin & McKeesport Railway Company; $45,000; directors, Charles Fritchman, Frank M. Fritchman, William W. George, John George, Irwin; Joseph C. Boyd, Pittsburg. The Lancaster & Southern Street Railway Company; $84,000; directors, C. A. Fondersmith, William Wohlsen, Thomas K. Worthington, Frederick Shoff, Lancaster; James G. McSparran, Furniss. California & Allen Port Street Railway Company; $50,000; directors, W. C. Smith, Edward C. Drum, C. H. Drum and A. T. Morgan, California. Bank & Broad Street Railway Company; $5,000. The Farmersville & Terre Hill Street Railway Company; $48,000; directors, E. H. Burkholder, A. E. Burkholder, S. M. Seldomridge, Farmersville; Dr. B. J. Reemsnyder, Hinkletown; John H. Fry, Lancaster. The Wilkesbarre Terminal Railroad Company; $35,000; directors, William H. Smith, Arthur P. Goedecke, F. Walk, Jeddo.

LEGAL NOTE.

THE BRADLEY-HALL ALUMINUM PATENTS LITIGATION —The United States Circuit Court of Appeals for the Second District has rendered a decision sustaining the Bradley patent No. 168,148, for electric smelting, instructing that a decree be entered in favor of the Electric Smelting and Aluminum Company for an injunction against the Pittsburg Reduction Company, and an accounting for profits, damages and savings on its manufacture of aluminum to date.

ELECTRICAL SECURITIES.

If there was one thing for which last week's market could be called remarkable it was for its resistance to the effects of bad news. The adverse decision in the Amalgamated Copper suit, with the consequent closing of large works and the throwing out of employment of some 20,000 men, was unfortunate; and, coupled to this, the failure of two Baltimore trust companies and the suspension of several Pittsburg institutions brought about a condition which would, no doubt, have proved disastrous earlier in the financial depression which has been witnessed for over a year. It is this market resiliency which lends constant hope to the optimistic side of the market. While it is conceded on every hand that there is in progress an industrial reaction, still the absolute lack of confidence and the abandonment of prices which the decline has brought forth strengthen the opinion in many quarters that these declines have more than offset the possible shrinkage in absolute value of stocks. As soon as a period of readjustment sets in there will, no doubt, be rallies in other industrials, a condition which has marked several naturally high-class securities within the last two weeks. This readjustment will, in all probability, show that, along with the general decline, there has been more than one stock pounded down to a great deal less than its normal value.

ELECTRICAL SECURITIES FOR THE WEEK ENDING OCTOBER 24.

New York:	*Closing.*
Brooklyn Rapid Transit	33½
Consolidated Gas	175
General Electric	148
Kings County Electric	150
Manhattan Elevated	133¼
Metropolitan Street Railway	107
New York & New Jersey Telephone	140
Westinghouse Manufacturing Company	160
Boston:	*Closing.*
American Telephone and Telegraph	123½
Edison Electric Illuminating	235
Massachusetts Electric	77½
New England Telephone	123
Western Telephone and Telegraph preferred	75

It is stated that the earnings of the New England Telephone Company for the past six months show an increase even larger than the average yearly growth for several years past. The gross business of the company in 1902 increased 14 per cent, while in 1901 the increase was 13 per cent.

Philadelphia:	*Closing.*
Electric Company of America	7⅞
Electric Storage Battery common	44
Electric Storage Battery preferred	48
Philadelphia Electric	5⅞
Union Traction	43½
United Gas Improvement	79
Chicago:	*Closing.*
Chicago Telephone	115
Chicago Edison Light	137
Metropolitan Elevated preferred	53
National Carbon common	15
National Carbon preferred	85
Union Traction common	4½
Union Traction preferred	25

The directors of the Chicago Edison Company have declared the regularly quarterly dividend of 2 per cent, payable November 2. Books close October 24 and reopen November 3.

The annual report of the Metropolitan Elevated Company for the year ended June 30, 1903, is as follows: Gross earnings, $2,094,008; expenses, $1,037,181; leaving net earnings of $1,056,827; other income, $10,462, giving a total income of $1,067,289. The amount paid for charges and dividends was $1,162,886, leaving a deficit for the year of $95,597, as compared with a deficit of $46,639 for 1902.

The National Carbon Company has declared the preferred regular quarterly dividend of 1¾ per cent, payable November 14. Books close November 4 and reopen November 16.

The present earnings of the Chicago Union Traction Company are said to be at the rate of $1,000,000 a year in excess of the last fiscal period.

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ELECTRIC LIGHTING.

RUSH CITY, MINN.—Grantsburg will install an electric light plant.

THOMPSONVILLE, CT.—The Enfield Electric Light and Power Company has a force of men at work making extensions to its system.

TOULON, ILL.—The new electric light system of Galva is expected to be in operation in about two months. The poles are now being set and the wiring will soon commence.

MURRAY, IOWA—The Osceola Electric Light Company, of Osceola, Iowa, purposes to furnish electric current to this city by means of an electrical transmission line from Osceola.

BOSTON, MASS.—A contract has been awarded for the building of an addition to the Gloucester Electric Lighting Company's plant. The building will be of brick and will cost $8,000.

SAN FRANCISCO, CAL.—A first mortgage has been filed for record covering a loan of $400,000 by the California Safe Deposit and Trust Company to the Mutual Electric Light Company, secured by a bond issue in the sum named. The lighting company mortgages all of its properties now owned or hereafter to be acquired by the corporation.

KANSAS CITY, MO.—The Leavenworth Light and Heating Company has been awarded a contract to furnish arc lights at Fort Leavenworth. The lamps are to run all night, and the company is to receive $80 a lamp a year. The company also agrees to furnish small electric lights to burn all night for 5.35 cents. The contract for lighting the fort is to run for ten years.

ALBION, N. Y.—The board of aldermen has made a new contract with the Albion Electric Light and Power Company for street light service. The price to be paid is $65 per lamp. The lights are to be turned on half an hour after sundown and burn until one o'clock the next morning on all nights except when the moon is actually shining. On one month's notice the board may, if it wishes, change to an all-night service on the basis of $85 per lamp.

FORT MADISON, IOWA—At a recent meeting of the council, a resolution was adopted, offering the Fort Madison Electric Light and Power Company a contract for the public lighting of the streets on a monthly basis, at the rate of $60 per lamp per year. The proposition is refused by the company on the ground that to do the necessary work would entail an expense which would not be justified without a contract of at least one year's duration.

SALT LAKE CITY, UTAH—A deal has been concluded whereby the Utah Light and Power Company will acquire 2,000 horse-power which will be generated at the Garland sugar factory and transmitted to Ogden and Salt Lake over transmission lines to be constructed from the factory to the company's transmission line at Ogden. The sugar company will have a power plant in connection with the factory, but will require the power only about three months of the year, and during the remaining nine months the Utah company will have the use of the power generated.

ST. PAUL, NEB.—At a meeting of the city council a franchise was granted the Loup Valley Electric Company for the installation of an electric lighting system in St. Paul. The term of the franchise is twenty-five years. A maximum limit of seventeen cents per 1,000 watts, meter rate, or seventy-five cents a month for sixteen-candle-power lamps, $1.50 for thirty-two-candle-power and $8 for 1,200-candle-power, flat rate, is fixed. The company is given ninety days from the date of the franchise to commence work on the plant and six months thereafter for its completion.

GRAND RAPIDS, MICH.—General Superintendent Meyer, of the municipal lighting station, in his annual report for last year, informs the board of public works that the circuits are now carrying their maximum load and that no new lamps can be added without increasing the capacity. He recommends that two new complete circuits be constructed, one on the east and the other on the west side. The cost of operation of the lighting plant and system has increased this last year to $43.40 per lamp, as compared with $40.99 during the year previous. It is claimed that the increase in the cost of coal is responsible for this condition. The total income of the lighting department was $36,040.15, and the expenses were $31,290.26.

TELEPHONE AND TELEGRAPH.

OSHKOSH, WIS.—The Wisconsin Telephone Company will erect an exchange at Manitowoc.

DES MOINES, IOWA—At Cedar Falls the Iowa Telephone Company will rebuild its exchange throughout.

CONCORD, N. H.—The Citizens' Telephone Company, of Laconia, has increased its capital stock to $70,000.

DES MOINES, IOWA—The Jasper County Telephone Company has increased its capital stock from $100,000 to $150,000.

LOS ANGELES, CAL.—The new Home Telephone Company will erect a new building in San Bernardino, to cost $16,000.

CHATTANOOGA, TENN.—The Bristol & Washington County Telephone Company has secured an entrance into Greenville.

MINNEAPOLIS, MINN.—The Northwestern Telephone Company will build a $12,000 addition for toll lines to its east side exchange.

WASHINGTON, D. C.—The Frost Telephone Company has been incorporated by E. F. Frost, C. W. Van der Hoogt and D. G. Clark.

DUBUQUE, IOWA—It is stated that the Iowa Telephone Company will within the next year expend $150,000 in improvements in this city.

CAIRO, ILL.—A franchise was granted recently to the Central Union Telephone Company to erect and operate a telephone exchange in Thebes.

GUTHRIE, OKLAHOMA—The Lamont & Eddy Rural Telephone Company, of Lamont, has been incorporated by John Cowen, Art Hollopeter and Swan Olson.

CINCINNATI, OHIO—The Cincinnati Telephone Company has let the contract for the erection of a new exchange at Court and Race streets to Griffith & Sons.

MONTGOMERY, ALA.—The Southern Bell Telephone Company has established a long-distance line connecting Huntsville with New Market and Deposit, Ala.

SPRINGFIELD, ILL.—The Alexis Telephone Company, Alexis, has been incorporated with a capital of $2,000. The incorporators are Charles Rogers, J. W. Standley and W. A. McKnight.

MADISON, WIS.—The Port Wing Telephone Company, Port Wing, Bayfield County, has been incorporated with a capital stock of $5,000. The incorporators are Axel Johnson, Carl Hogfeldt and Swanson Odgen.

MOUNT MORRIS, N. Y.—The Rural Telephone Company, of Dalton, has been granted a franchise by the Nunda village trustees for the use of the streets for the erection of poles and the stringing of wires.

DOWNS, KAN.—The Downs Western Telephone Company has been incorporated with a capital stock of $50,000. C. W. Baldwin is president; M. F. Hudson, vice-president; R. Broderick, secretary, and J. R. Loomis, treasurer.

RICHMOND, VA.—The Albemarle Mutual Telephone Company has been granted permission to change its corporate name to the Farmers' Mutual Telephone Company. T. F. Powell is president and Charles Miller, secretary.

READING, PA.—At a recent meeting of the Conestoga Valley Telephone Company, held at Morgantown, plans were made for an extension of the company's line to Birdsboro, and also for connections with Reading and other points.

JAMAICA, N. Y.—The New York & Long Island Telephone Company has bought the franchise and privileges of the Knickerbocker Telephone Company in New York, Brooklyn and Queens Borough, and has consolidated with the South Shore company.

TROY, N. Y.—The Champlain Telephone Company has been incorporated to connect the village of Champlain with Perry's Mill, Coopersville and Chazy. The capital stock is $2,000 and W. O Clark, James Burroughs, T. Dickinson, William Fraser, Hiram Briggs, W. H. Dunn and others are the directors.

NASHVILLE, TENN.—The Lauderdale Telephone Company, of Lauderdale County, has been granted a charter with a capital stock of $1,500. The purpose is to manufacture electricity for telephone and general purposes and to construct, equip and operate a line from Ripley to Durhamville. Orpa W. Rice, J. Holmes and others are the incorporators.

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ELECTRIC RAILWAYS.

READING, PA.—Operations have been begun on the construction of the Pottstown & Reading trolley line, the completion of which will afford trolley communication all the way to Philadelphia. It is proposed to have the road finished before March 1.

OXFORD, PA.—The town council has granted the right to lay tracks to the Wilmington, Kennett & West Chester trolley road. The tracks are laid from Wilmington to within about twelve miles of the town, and the projectors promise to have the road in operation by the new year.

HEMPSTEAD, L. I.—The New York & Long Island Traction Company has accepted the franchise granted by the town highway commissioners to build a trolley line from Freeport east to the town line at Seaford, on town roads and a private right of way. The line to be built will be the first link in the proposed route to Babylon.

ASHTABULA, OHIO—It is reported that the Conneaut & Erie Traction Company will extend its line from Girard, Pa., south to Conneaut Lake. It was formerly intended to run the line to Albion, but it is now stated on good authority that the line will run from Girard to Lockport, thence to Cranesville, Albion, Conneautville and Conneaut Lake.

MUNCIE, IND.—The Muncie City council has given the Indiana Union Traction Company a fifty-year franchise which permits the laying of double tracks as suggested by the company. Rights were given which will permit a loop surrounding the site recently bought for a terminal station. A station to cost $100,000 will be erected by the traction company.

SPRINGFIELD, ILL.—Articles of incorporation have been filed by the Charleston, Champaign & Northern Interurban Railway Company. The principal offices will be at Charleston and the capital is $10,000. The road is to be constructed from Charleston, Coles County, to Homer, Champaign County. The incorporators and first board of directors are W. R. Patten, W. F. Jenkins, J. B. Mitchell, C. L. Lee and J. L. Shisland, all of Charleston.

STAUNTON, VA.—There has been filed in the Corporation Court a charter for the Virginia Power Corporation, with a capital of from $500 to $50,000, the home office of same to be in Staunton. Mr. C. Russell Caldwell is president and Mr. Lawrence H. Peyton, Herbert J. Taylor, of Staunton; J. J. Nicholas, of Port Republic; John Fulton, of Mt. Meridian, constitute the board of directors. The company is empowered to use power for manufacturing, mining and the like.

MONONGAHELA, PA.—Donora capitalists have organized a new street car company, to be called the Monongahela & Clairton Street Railway Company. At Clairton the route will connect with the Frick line and make a complete service from Pittsburg to Donora. At Monongahela the line will make connections to Monessen, Bellevernon and Fayette City. The directors and officers are: President, J. M. Mullen; secretary, Oliver S. Scott; treasurer, Herbert Ailes.

PHILADELPHIA, PA.—The General Traction Company, which has filed articles of incorporation in the county clerk's office, Camden, N. J., with a capital stock of $100,000, is formed for the purpose of building and operating trolley lines between Camden and seashore resorts. One of the lines, it is said, will run to Atlantic City and another to Cape May, tapping other resorts along the South Jersey coast. The president of the General Traction Company is W. W. Benson, of Philadelphia.

JERSEY CITY, N. J.—The North Jersey Street Railway Company recently absorbed by the Public Service Corporation of New Jersey, has bought a tract of land on the Hackensack river at Jersey City for which it paid $12,500. The river frontage is 300 feet, the plot being 1,140 feet deep at the north end and 935 feet at the south end. It will be used for a new power-house in connection with an extension of lines on the west side of Jersey City Heights contemplated by the Public Service Corporation.

PHILADELPHIA, PA.—The Burlington County Traction Company has entered into a contract with the Interstate Construction Company to complete the electric road from Moorestown to Mount Holly, N. J., which has been under construction for a year past, and upon which work was temporarily suspended. The completion of the road will give Camden direct trolley lines to Mount Holly and Burlington. The line will be ten miles long and equipped for high-speed service, and it is hoped to have it completed in six months.

HARRISBURG, PA.—The Philadelphia Rapid Transit Company has obtained a charter at Harrisburg to build the first link in the short line which the company intends to construct from the centre of Philadelphia to Willow Grove. The company is called the Glenside & Willow Grove Street Railway Company. The capital is $25,000, and the charter permits of a line from Keswick avenue, Philadelphia, to Willow Grove Park. The president is C. P. Weaver, special agent of the Philadelphia Rapid Transit Company.

ALLENTOWN, PA.—Representatives have been seeking the right of way of landowners between Macungie and East Texas for a trolley line to connect with the Allentown-Reading line with Macungie. The Reading Traction Company is endeavoring to extend its line along the East Penn Railroad, where its road is not yet built. The traffic is to include freight business, and the run from Allentown to Macungie is to be made in thirty-eight minutes. As soon as the rights are granted work is to begin on the branch.

WASHINGTON, IOWA—The articles of incorporation for the new interurban line to be known as the Iowa City, Kelloma & Washington Railway were filed here recently, with an authorized capital stock of $50,000 and the right to increase the amount of stock at any time, and the work of surveying and buying the right of way will begin at once. This is the first interurban in this part of the state. The officers of the corporation are George Rodman, president; W. P. Coast, vice-president; W. J. Welsh, secretary; C. M. Keck, treasurer. The board of directors includes the officers and the following: L. G. Smith, G. S. Carson, Amos Alberson and S. W. Brookhart.

WATERVILLE, ME.—A. F. Gerald, of Fairfield, has purchased the water power at Fowler's rip on the Sebasticook river, one and one-half miles above Benton Falls, and will improve it at once. He buys the charter of the Sebasticook Manufacturing and Power Company, which has been running some six years. Mr. Gerald expects to have a dam completed by January 1, getting a head of twenty-three feet and some 1,000 horse-power. He will establish electric generators, and, running a line of wire to the Kennebec river, expects to sell power to people in Waterville and Fairfield. It is five and one-half miles to Waterville and two and one-half miles to Fairfield. The whole plant which Mr. Gerald proposes to have will cost some $50,000.

PROVIDENCE, R. I.—The Providence & Burrillville Street Railway Company, which is planning to build a double-track electric railway for passenger and freight service between Woonsocket and this city, connecting with the Rhode Island Company's system to the south, and Woonsocket Street Railway Company to the north, has organized and elected as directors Edgar K. Ray, of Franklin, Mass.; Edward H. Rathbun and Frank E. Holden, of Woonsocket; F. E. Bartlett and Francis Fagan, of Burrillville; E. B. A. D. Thayer, of Franklin, and Thomas Martin, of Chelsea. The following named officers have been elected: President, E. H. Rathbun; general manager and treasurer, E. K. Ray; secretary, Frank E. Holden. The company has an authorized capital of $200,000, and will apply for franchises in Lincoln and North Smithfield. Construction work is to begin in the spring, surveys and estimates of cost, etc., having already been made.

WATERBURY, CT.—Rapid progress is being made on the project of the New Milford Power Company to supply various divisions of the Connecticut Railway and Lighting Company with power generated along the Housatonic river in the towns of New Milford and Kent and transmitted over long distances. The large plants of the power company at Boardman's bridge and Bull's bridge on the Housatonic are nearly completed. The work of constructing the distributing power plants at Waterbury, New Britain and Cheshire is being pushed. The needed rights of way for the poles and wires along the entire distance have all been secured, with a few exceptions. The few property-owners who have not yet deeded the desired rights of way will do so shortly. The New Milford company will supply power for both trolley and lighting purposes for the Waterbury, New Britain, Southington and Cheshire divisions of the street railway combine. The electric power line from New Milford to Waterbury will be in duplicate, with two sets of poles and wires, and for the remainder of the distance there will be a single set of poles, carrying six wires.

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INDUSTRIAL ITEMS.

THE EMPIRE ELECTRIC SUPPLY COMPANY, 57 West Jackson Boulevard, Chicago, Ill., has added a full line of electric lighting and telephone supplies and is now prepared to quote prices and make prompt shipments.

THE ELECTRIC GAS LIGHTING COMPANY, Boston, Mass., is sending out bulletin No. 1, entitled "The Specializing of Interior Telephone Apparatus." This describes the details of the Samson telephone apparatus which this company is placing on the market.

STANLEY & PATTERSON, 93 Liberty street, New York city, manufacturers of general electrical supplies, operate a department devoted exclusively to electrical engineering and electrical construction and repair work. This department is operated in connection with their manufacturing and supply department.

THE JOSEPH DIXON CRUCIBLE COMPANY, Jersey City, N. J., is mailing a description and price list of Dixon graphite lubricants. This booklet illustrates the form in which the special graphite compositions are put up, and details the special work for which each is designed. The booklet will be sent upon request.

THE DAYTON MANUFACTURING COMPANY, Dayton, Ohio, is distributing its catalogue No. 110. This is a handsome production, printed on heavy cut paper, and shows the applications of the "Silvey" electric light for railway cars and appliances pertaining thereto, "Silvey" storage batteries, dynamos, motors, etc., and every description of car furnishings.

THE PAIRPOINT CORPORATION, New Bedford, Mass., is the headquarters for the celebrated "McCreary" shades. These are made in Empire or green finish, silver finish, and Colonial or white finish. These shades are made in seven, eight, nine and twelve-inch sizes, and they are also made for sixteen and thirty-two-candle-power lamps.

THE CLEVELAND CAR AND CRANE COMPANY, Wickliffe, Ohio, is distributing a series of booklets describing Cleveland cranes of the electric traveling type, hand and electric jib post and car types, hand power traveling cranes, and Armington electric hoists built by the Cleveland company. This covers a line of hoisting apparatus of a wide range, and the bulletins are worth writing for.

THE CROCKER-WHEELER COMPANY, Ampere, N. J., will be pleased to send to any one interested, upon request, bulletin No. 38. This describes a line of form L motors, which are adapted for either wall or ceiling suspension. The line includes machines of from one-quarter to three horse-power, and the design of these motors is such that they can be used with equal effectiveness for direct, belt or gear driving.

THE F. BISSELL COMPANY, Toledo, Ohio, is distributing throughout the electrical field a mailing card having attached to it a spider wire cleat for cable pole work and construction. This is of tough maple, held by screws or nails, and drilled for five wires for the full end of the cross-arm. When used with bridle rings this makes a holder for spider wires between the pole-houses and the insulators. The sample sent is for a small wire.

PASS & SEYMOUR, Solvay, N. Y., are meeting with a brisk demand for their decorative and wiring specialties. The city of Allentown, Pa., was elaborately decorated during the week of the State Firemen's convention, held there recently. The illuminations were equal to those seen in larger cities, and the work reflects great credit on the electrician, Mr. H. H. C. Smith, of Allentown. Pass & Seymour's goods were greatly in evidence on this occasion.

THE STANDARD PAINT COMPANY, 100 William street, New York city, is distributing an attractive mailing card advertising its "Ruberoid" roofing. This is a durable roofing, to take the place of tin, iron and shingles. It is built upon modern scientific principles, containing a water-proof, acid-proof and fire-resisting saturation, and does not dry out from long exposure nor melt away from heat, remaining elastic and pliable. This roofing has been on the market for twelve years and has given constant satisfaction.

THE H. T. PAISTE COMPANY, Philadelphia, Pa., reports gratifying sales for its three-screw fixture socket. This fixture socket, the manufacturer states, possesses many advantages in its holding together under all sorts of strains in places such as trolley and railway cars, where an extra fastening is necessary. The company has just completed a shipment of its large order for the United States Government printing office, Washington, D. C. This contract particularly specified that the sockets must be able to stand the vibration of the building, due to the running of the large printing presses.

JAMES T. PEARSON, Burnley, Lancashire, England, electrical and mechanical engineer and manufacturer, will be pleased to send to any one interested illustrated literature detailing his safety apparatus and automatic blocking and braking devices for tramway systems. Other recent additions to the literature produced by Mr. Pearson are short treatises on "The Destruction of Gas and Water Pipes by the Leakage of Current from Tramways, and Remedies Therefor," and a description of the system which he has invented for operating tramways without a third rail or without a trolley equipment.

THE KINSMAN ELECTRIC AND RAILWAY SUPPLY COMPANY, 91 Liberty street, New York city, is meeting with great success in marketing its improved "Daylight" desk lamp. This electric desk lamp is constructed upon scientific principles and is of great value to those who are compelled to do desk work. The light is soft and abundant, and so distributed as to leave no dark shadows or corners on the desk. At the same time, the lamp itself is entirely shaded from the eyes. This lamp has an ornamental appearance and is adjustable in six directions. It in no way interferes with the opening and closing of a roll-top desk, and requires no electric wires in the desk.

THE AMERICAN SCHOOL OF CORRESPONDENCE at the Armour Institute of Technology, Chicago, Ill., announces the following incident, as exemplifying the value of correspondence instruction: "Mr. George B. Tinkham, for a number of years engineer of the Upson Nut Company, Cleveland, Ohio, through native skill and knowledge gained by correspondence study, invented and patented a hydrocarbon device for increasing the efficiency of a brick furnace. On the suggestion of the American School of Correspondence, Mr. Carl S. Dow, chief of the department of mechanical engineering, was selected as best fitted to give an impartial judgment on the value of the apparatus, both from the viewpoint of the manufacturer and the inventor. The apparatus is practical and is, no doubt, of much value, and credit is due to Mr. Tinkham as an inventor. According to his own statement, Mr. Tinkham owes nearly all his knowledge of the theory of engineering to his courses with the American School of Correspondence."

THE FORT WAYNE ELECTRIC WORKS, Fort Wayne, Ind., manufacturer of the "Wood" systems, in bulletin No. 1048 describes and illustrates belted direct-current generators, types MP, LB and MPL. The small generators are built in sizes from three-quarters to thirty kilowatts, and are two-bearing machines. The medium size line consists of six-pole generators having separate field frame, laminated pole-pieces and two bearings. These vary in capacity from twenty to ninety kilowatts. The larger generators are three-bearing machines and range from 100 to 400 kilowatts. This bulletin gives a list of plants in the United States where from one to four machines of this type are in operation. Other literature which the Fort Wayne company is now distributing is a blotter bearing an illustration of a side wall with a bracket hanger carrying a Fort Wayne type A transformer. Catalogue No. 2007 details the parts of direct-current series form C "Wood" arc lamps, and there is also a reprint of an article by Mr. Edward A. Wagner, on transformer insulation. An interesting letter from Mr. R. Dean, the superintendent of the East Chicago lighting station, relates the successful operation of a thirty-kilowatt, 6,600-volt type A transformer during a severe lightning discharge on the evening of July 9. In this case the lightning discharge leaped from the connection clips to the iron strap supporting the porcelain block, a distance of about three inches, blackening the inside of the case and burning the connections away. The connection block was replaced and the transformer connected into circuit and tested for weak insulation. The transformer windings were found to be absolutely uninjured.

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CHARLES W. PRICE . . . . . PRESIDENT AND EDITOR
STEPHEN H. GODDARD . . . . . SECRETARY AND MANAGER
WM. HAND BROWNE, JR. . . . . TECHNICAL EDITOR
AINSLIE A. GRAY . . . . . ASSISTANT EDITOR

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CONTENTS

EDITORIALS 645
Shop Testing of Motors and Generators for Commercial Service 645
Temperature Rise of Railway Motors 645
Some Phases of Technical Education 646
Practical Standards for Electrical Measurements 646
Shop Testing of Dynamos and Motors for Commercial Service, by Bertrand B. Abry 647
Experiments for Improving the Condition of Practical Standards for Electrical Measurements—I 649
1,600-Horse-Power Gas Engine and Three-Phase Alternator at Laar Power Plant, and Other High-Power Blast Furnace Gas Engines, by Frank C. Perkins 651
Dielectric Hysteresis 652
Underground Telegraphs 653
A Heavy Electromobile Tractor 653
Motor Cars for Railways 653
Track Construction and Maintenance, by T. W. Wilson 654
Fire Protection at St. Louis World's Fair 655
The Condition Governing the Rise of Temperature of Electric Railway Motors in Service, by Cary T. Hutchinson 656
American Institute of Electrical Engineers 659
Administration Building, World's Fair 660
High-Speed Railway Trials 662
Underground Electric Railways Company, of London 662
An Electric Sleigh 662
The American Society of Mechanical Engineers 662
Single-Phase Repulsion Motors 663
Road Traction by Electric Vehicles Using the Trolley Automobile 663
New Winding for Induction Coils 663
A Sliding Railway 663
Canadian Society of Civil Engineers 663
Index of the Technical Press 663
Some Notes on the Commercial Features of European Lighting Practice 664
Tribute to Volta 666
Electrical Patents 666
REVIEWS OF CURRENT ENGINEERING AND SCIENTIFIC LITERATURE 668
INDUSTRIAL SECTION:
A Turret Lathe, Motor-Driven 670
The Vulcan Ammeter 670
New Types of Incandescent Lamps 671
The Power-House of the Valley Counties Power Company 671
Results of the Application of Electrical Traction to the Wannseebahn, Berlin 671
A New Coherer for Wireless Signaling 672
A Small Arc Lamp 672
An Electromagnetic Railway Coupling 672
Motor Starters 673
Statement from Mr. Milo G. Kellogg 673
CURRENT ELECTRICAL NEWS 674

It was most unfortunately true a few years ago that many pretended medical cures were described as electric treatments, with the idea of deceiving the unfortunate patients. This is not as serious to-day as it was some years ago, and on the other hand there has been a profitable study of the use of electrical effects in a legitimate way for treating disease. An instructive instance of this kind is described in a recent issue of the *Lancet* in which the practitioner describes his successful use of high-frequency alternating currents to cause electric osmose by means of which drugs were introduced into the tissues of the diseased part. In twenty-two per cent of the cases of cancer treated, the treatment was successful, and he has come to the conclusion that a radioactive salt of strontium induced into the tissues by cataphoresis by high frequency currents would prove the desired panacea for all forms of malignant disease.

SHOP TESTING OF MOTORS AND GENERATORS FOR COMMERCIAL SERVICE.

The series of articles on shop testing of motors and generators appearing in the ELECTRICAL REVIEW should be of interest to the man actually engaged in this work, and particularly so to the student of electrical engineering. The difference between laboratory tests and shop tests is not always made clear. In the factory two classes of work are recognized—the research work which is carried out on a new type of apparatus, and the commercial test through which all apparatus is put to show that it will meet its specifications. The first may be considered a test of design; the latter, a test of workmanship. These points, as well as the proper method of carrying out the tests, the care which must be observed in each case, and the allowable approximations, are all clearly explained in these articles. Mr. Abry is a technical graduate, and has also worked his way up through the testing department of one of our large electrical manufacturing companies. He is thus well fitted to present the subject clearly and instructively.

TEMPERATURE RISE IN RAILWAY MOTORS.

In a paper presented by Dr. Cary T. Hutchinson at the last meeting of the American Institute of Electrical Engineers, a method is described for determining the rise of temperature of railway motors in service, so that for any particular class of service a suitable motor and gearing can be selected. The problem is quite complex, and for this reason various assumptions in regard to operating conditions were necessary, but the results obtained by the method are in satisfactory agreement with those given by actual tests.

Analytical Studies Helpful.

Such studies of electrical machinery are valuable in so far as they enable us to use our machines most effectively. Electrical machinery differs from other machinery in that its capacity is limited, not by the applied voltage or the mechanical strength of the materials, but by the heat which can be dissipated. If a steam engine or other prime mover is overloaded it simply works less efficiently. An electric motor is usually designed to work most efficiently at its normal rating. If it is overloaded it not only operates less efficiently, but its temperature will rise. Such rise may do no damage, unless excessive or prolonged, and for this reason the specifications for electrical machinery frequently call for a machine that will stand a certain overload for a specified time. It is therefore important in laying out the equipment for any particular service that a motor should be selected which is in all respects the best one for that service. It is for this purpose that Dr. Hutchinson has developed his method. This can not be described here, but his paper will be found elsewhere in this issue.

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SOME PHASES OF TECHNICAL EDUCATION.

The education of engineers is still receiving a good deal of attention from the technical papers and associations. In England a good deal of uneasiness has been caused by the sharp criticisms made by practising engineers of the English method of furnishing technical instruction. That this agitation is bearing fruit is shown by several reports on technical education which have recently been presented to various bodies. One of these, presented by Principal R. Mullineux Walmsley, to the governing body of the Northampton Institute, is of interest to us because it gives the results of a tour made by Mr. Walmsley with the particular object of investigating the condition of technical education in the United States. An abstract of this report was given in the ELECTRICAL REVIEW of October 31.

Report Favorable to American Schools.

On the whole, the report was favorable to our methods, and decidedly unfavorable to the British lack of method. Some phases of our methods were criticised—perhaps not unjustly. One of these is overloading the student with work of all kinds. In the last two years of the usual four-year courses particularly, the student is forced to take courses in many special branches of his subject, and, from the limited time which can be given, such courses can not be thorough. On the other hand, a good deal of time in the first two years is given to manual training, although the student does not intend to become a mechanician.

Manual Training and Trade Schools Criticised.

The report takes an unfavorable view of our manual training schools and trade schools. The former are thought to attempt too much, endeavoring to compete with the technical college, with the result that they turn out men who do not make good foremen and who are not well prepared to take an engineering course at college.

Objectional Features of Our System.

In an excellent article on technical education in the November issue of the *Engineering Magazine,* Dr. Louis Duncan also criticises our system. He lays stress upon the evil effects of attempting to instruct the student too much, leaving too little to the man himself. He believes too much time is given to lectures and the study of text-books. It does not seem to be considered that information, as such, is not of great importance. What should be attempted is to make the men mental factories, and not mental storehouses. For this reason Dr. Duncan does not think that the most elaborately equipped institutions can point to a seemingly proper proportion of really successful graduates. Such institutions attract large classes, with the result that the instructor is not able to give as much personal attention to the individual members as is desirable. In handling such large classes much of the work becomes mere routine. On the other hand, these elaborate equipments bring the student into contact with practical machines, and not mere toys. There is, however, one possible drawback to elaborate equipments: Technical schools can not afford to scrap their machinery as soon as it is out of date, and if electrical machinery develops as rapidly within the next ten years as it has in the past ten years, it will not be long before many laboratory equipments which are excellent to-day will be antiquated. These machines will still have an educational value, but will no longer conform to the practice of the day.

Training of the Imagination Neglected.

Another point upon which Dr. Duncan lays particular stress is the cultivation of the imagination. This is a matter which is seriously neglected in our present school systems. The student insists upon having a machine or a drawing to assist him in the simplest problems, and he does not develop the faculty of picturing to himself the conditions of the problem. The trouble probably starts in the primary school, or even in the kindergarten. The child is taught not to count, but to count blocks, and the teacher will not venture to talk about a cat unless she can show one to the class, and the same system is used too much throughout all the schools. This is wrong, for training the imagination is important in all education, but particularly so in developing an engineer. Real engineering work consists in solving new problems, in devising and perfecting new machinery and methods, and in this work a well-trained imagination is essential for success.

PRACTICAL STANDARDS FOR ELECTRICAL MEASUREMENTS.

Next in importance to the fixing of electrical units is the construction of practical standards of such form and material that they will be permanent and can be tested and used conveniently. Specifications for such standards are usually drawn up by some authoritative body after mature thought and painstaking study of such data as is obtainable and which in any way bears upon the construction and behavior of the proposed standard. When a decision of this kind has been reached, the standard must then be considered on probation. Several such standards are constructed with the greatest care, and these are preserved and a record of each is carefully kept. Upon this record much depends, and it is not sufficient that the standard should be watched for a few months or a few years, but for a long period of time. And, at the same time, other suggested standards and methods of construction should be examined with reference to the accepted standard, with a view of determining whether the proposed standard can be constructed more accurately than the old, whether it would be less liable to change, and, as a minor consideration, whether it would be more convenient.

The Standard of Electromotive Force.

To illustrate this point, it may be mentioned that at the International Electrical Congress, which will be held at St. Louis next year, the question will probably be brought up of replacing the Clark cell—which is the legal standard of electromotive force to-day—by the cadmium cell. The objections to the Clark cell are that it is troublesome to construct, it is seriously affected by impurities in the materials used; it has an odd value and a high temperature coefficient, and, most serious of all, the accuracy of its legal value is in question. The cadmium cell which is proposed in place of the Clark is not so troublesome to construct,

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has a value near unity and an almost negligible temperature coefficient, advantages worth consideration, though they may not be sufficient to cause the Clark cell to be discarded. Whatever the outcome of this attempt to change the legal standard, it should be remembered that it is not the absolute value of the volt which is in doubt, but the actual electromotive force developed in the Clark cell and the question to be decided is whether the cadmium cell is not the more convenient form of apparatus.

Record of the British Association Standards of Resistance.

Of equal importance with the selection of a standard of electromotive force is that of selecting a standard of resistance. In 1898 independent determinations of the value of an ohm were made in this country, in England and in Germany. From the average of the three values it was decided that a column of mercury one square millimetre in section and 106.3 centimetres in length, would have a resistance of one ohm at 0 degree centigrade, and the resistance of such a column of mercury has been defined as the international ohm. The construction in this way of a resistance is difficult, and the apparatus is of such a character that it can not be used conveniently. For this reason, standards of resistance are usually constructed of some metal or alloy supposed to be little subject to change. Such standards must be watched carefully during their existence with a view to detecting any change. An instructive study of such resistances is given in a report of a committee to the British association, which was presented at the annual meeting of the association at Southport, in September, and which gives a record of the standards preserved at the British National Physical Laboratory. It appears from this report that changes have shown themselves in all the original silver-platinum coils. The relative values of these coils have been discussed in previous reports to the British association, the 1888 report containing a very complete comparison of all the earlier coils. It was shown then that they agreed with the values assigned to them by Fleming in 1881. The conclusion was therefore drawn that, with the exception of the platinum-iridium coils, no really certain variations could be traced in the other coils. In reports made in 1890 and 1892, however, changes in three of the standards had been recorded. One standard remained unchanged in value until 1901.

Reasons for Changes.

The reasons for these changes are difficult to trace. In some cases the change may be due to a removing of the coil to another place for making new determinations of its value. Changes in certain coils appeared after the coils had been subjected to a very low temperature, which may have started strains. It appears from the report that the new platinum-silver standards have retained their values since 1898, practically unchanged.

Comparison of Various Standards.

The present report also gives a comparison of the British standards and those of the Reichsanstalt, the results indicating that the unit of the British association is less than that of the Reichsanstalt by 0.000105. This result is deduced from a series of experimental concordant measurements on coils of six different values—one-tenth, one, ten, 100, 1,000 and 10,000 ohms. Both the unit and the multiple coils agree in giving the same difference in the Reichsanstalt and British standards.

Accuracy of the International Ohm Questioned.

From a study of the records, the committee has come to the conclusion that the length of the mercury column constituting the international ohm—which has been defined as 106.3 centimetres—does not give the absolute value. The absolute unit, as deduced from the coils of the association, has a length of 106.291 centimetres, and thus the absolute unit is thought to be smaller than the international ohm by 0.009 per cent. The report concludes that the British Board of Trade unit of resistance is too small by 0.015 per cent. Should further investigations, now in progress, confirm the deductions drawn in this report, would it not be well for the International Electrical Congress, in addition to the consideration of a new standard of electromotive force by it, to consider the appointment of a committee to redetermine the absolute value of the ohm and to make investigations with a view of deciding upon suitable methods of constructing working standards?

SHOP TESTING OF MOTORS AND GENERATORS FOR COMMERCIAL SERVICE—V.

BY BERTRAND B. ABRY.

3—SPEED TEST.

Before beginning this test the cold resistance should be measured if not already obtained. This is done by the fall of potential method as explained earlier. These resistances are reduced to a basis of twenty-five degrees centigrade on the assumption that two and one-half degrees centigrade is equivalent to a change of one per cent in the resistance. This resistance at twenty-five degrees centigrade is then increased a certain amount corresponding to the average temperature at which the motor will probably run when in service. This was fully explained under direct-current generators.

To conveniently make this test the motor should be direct-connected to a similar machine driven as a generator and feeding into a rack. In this way the load may be readily varied.

During the test make the following motor observations:

Speed.	Main Volts	Amperes.	Field Volts.

Throughout the test keep the main voltage constant. After the test has been completed correct the speed observed, to correspond to the above average temperature at which the motor will probably run in service. This correction is made on the following basis:

It is assumed that the total drop in voltage (*i. e.*, across armature and field) is to drop across the field alone, as the total resistance of the motor is to the resistance of the field alone. That is, the current being constant the voltage varies directly as the resistance. For convenience tabulate and designate the calculation, as follows:

Amperes. (*a*)	Main Volts. (*b*)	Field Volts. (*c*)	Total Observed Drop. (*d*)	Total Calculated Drop. (*d'*)	Observed Effective Volts. (*e*)	Calculated Effective Volts. (*e'*)	Observed Speed. (*s*)	Calculated Speed. (*s'*)

Then according to the above assumption,

$$(d) : (c) :: (R_a + R_f) : R_f$$

or,

$$(d) = (c) \times (R_a + R_f) / R_f$$

but

$(R_a + R_f / R_f$ is a constant at any given temperature, such as the average temperature of the motor in service as referred to above.

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Therefore

$$(d) = (c) \times K$$

Also

$$(d') = (a) \times (R_a + R_f)$$

$$(e) = (b) - (d)$$

and $$(e') = (b) - (d')$$

Then since the speed varies with the voltage, the following relation holds:

$$(s') : (s) :: (e') : (e)$$

that is,

$$(s') = (s) \times (e') / (e)$$

In this manner the corrected speed is obtained for the increased temperature at which the motor will probably run in service. Seventy-five degrees centigrade is generally taken as a safe working limit for railway motors.

Having thus corrected the speed for different loads, plot it, using revolutions per minute and ampere as co-ordinates of the curve. A curve of the general shape shown in Fig. 13 will result, and should be marked "Speed at, say, seventy-five degrees centigrade."

4—BRAKE TEST.

The brake test on a series motor is made in very much the same way as in the case of shunt and compound motors. The torque may be conveniently measured by means of a Prony brake. It is difficult to get accurate speed readings during a brake test and it is not necessary to observe the speed if a speed test has already been made and the results corrected and plotted as in Fig. 13.

Make the following observations:

Volts.	Amperes.	Torque.	Calculated Speed (as Obtained from Speed Test).

Hold the voltage constant throughout the test and vary the current, that is, the load. After the test has been made, obtain from the speed curve the corresponding speed values, and reduce the torque to pounds at one-foot radius.

Make a careful preliminary plot of this speed and torque on an ampere base. From these preliminary curves choose even values of the amperes for convenience, and read corresponding values of the speed and torque. Tabulate the results as follows:

Amperes.	Corresponding Speeds.	Torque.	Brake H.-P.	Electric H.-P.	Efficiency.

Knowing the speed and torque, the brake horse-power may be computed from the formula:

B. H.-P. = speed × torque × $2\pi/33{,}000$

= speed × torque × 0.0001904

where torque equals pounds pull at 1′ radius.

The

E. H.-P. = amperes × volts / 746.

Lastly, the efficiency is computed from

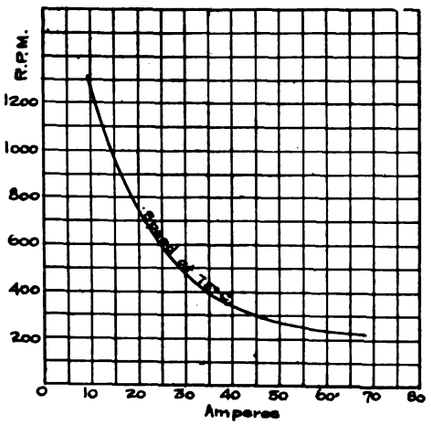

FIG. 13.—SPEED CURVES—SERIES MOTOR.

the ratio of the brake horse-power to the electrical horse-power. After these calculations have been made the characteristic curves may be plotted altogether, as shown in Fig. 14. These curves are plotted on an ampere-input base; consequently at zero amperes, we have zero electrical horse-power. In other words, when the voltage is held constant, the electrical horse-power varies as the current and we get a straight line curve through the origin.

The torque and brake horse-power

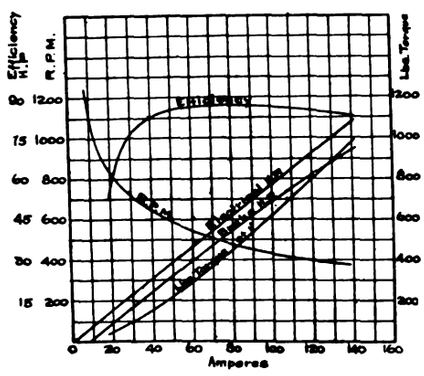

FIG. 14.—CHARACTERISTIC CURVES—SERIES MOTOR.

curves start a little above zero amperes, because the losses must first be supplied before power can be obtained from the motor. Notice also that the general shape of the brake horse-power curve is convex, and that it tends to fall away from the electrical horse-power curve, the heavier the load. The difference of the ordinates of these two curves represents, of course, the loss in the motor at any given load. This greater difference, the larger the current, is due chiefly to the fact that the copper loss on heavy loads increases very fast, and is a large percentage of the total loss.

The curves in Fig. 14 are not drawn to exact scale, but when accurately plotted it will be noted that the torque increases much faster than the current, and approximately in this ratio three times the torque at double the current.

The efficiency curve is in all cases convex in general form. The downward tendency of the curve at overloads is due to the rapidly increasing losses. It is customary to plot only that portion of the curve as shown, but when drawn in full it crosses the X axis at zero brake horse-power.

As a check upon the efficiency obtained from the brake test, the efficiency may be calculated from the losses in a manner similar to that explained under shunt and compound motors. In the case of a series motor, however, the same current goes through the armature and field, hence the C^2R loss in armature and field may be calculated as one loss. The iron, friction and windage loss may be obtained from the iron loss and friction curve for the different current values taken. With these exceptions the method of calculating the efficiency from the losses for a series motor is similar to that used for the shunt motor.

These characteristic curves of a railway motor obtained from a shop test give all the information desired in connection with the application of the motor to actual service, when the armature speed has been reduced to miles per hour, and the torque at one-foot radius to tractive effort at the rim of the car wheel.

In figuring the size of motor required for any particular railway service, it is more convenient to know what pounds pull the motor will exert at the rim of the car wheel, that is, the tractive effort. This tractive effort at the rim of the wheel varies directly as the torque at one-foot radius, directly as the ratio of the gear to the pinion, directly as the efficiency of the gears, and inversely as the radius of the car wheel. We may write this in the form of an equation, as follows:

Tractive effort =

Torque (at 1′ radius) × gear / pinion × 1′ / radius wheel × efficiency of gears.

With the aid of this formula we may calculate the tractive effort curve for any size wheel and any gear ratio. It is then customary to plot the characteristic curves, replacing the torque by the tractive effort curve, which is of the same general shape.

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EXPERIMENTS FOR IMPROVING THE CONSTRUCTION OF PRACTICAL STANDARDS FOR ELECTRICAL MEASUREMENTS—I.[1]

During the year a very complete comparison of the resistance standards belonging to the association has been carried out, and the standards have been compared with those of the Reichsanstalt and of the Board of Trade. The various units discussed in the report are: (1) The "ohm" 10^9 C. G. S. units of resistance; (2) the international ohm—*viz.*, the resistance at 0 degree C. of a column of mercury of uniform section 106.3 cm. in length and 14.4521 grammes in mass; (3) the original B. A. unit; (4) the Board of Trade unit, supposed to represent the international ohm, but constructed in 1891 so as to be equal to 1.01358 B. A. units; (5) the N. P. L. unit defined as No. 4, as deduced from the wire standards of the association; (6) the Reichsanstalt unit, constructed at the Reichsanstalt to represent the international ohm; (7) the mercury tubes, constructed at the National Physical Laboratory to represent the international ohm.

A full account of this comparison is given in Appendix I to the report, by Mr. F. E. Smith, of the National Physical Laboratory. It appears from this that changes have shown themselves in all the original platinum-silver coils. The relative values of these coils are discussed in the reports of the committee for 1888, 1890 and 1892. The 1888 report contains a very complete comparison of all the coils, not merely those of platinum-silver; and it is there shown that they then agreed with the values assigned to them by Fleming in 1881. The conclusion is also drawn in the same report that, with the exception of the platinum-iridium coils A and B, no really certain variations could be traced in the other coils between the results of Matthiessen and Hockins comparisons in 1864 and 1867, those of Chrystal in 1876, Fleming in 1881, and the present secretary[2] in 1888. A postscript to the report for 1888 recorded, however, an appreciable change in the coil F in the autumn of that year. In Appendix I Mr. Smith starts with the values given in the 1888 report, which are, as nearly as we can tell, the original values of the coils.

[1] Report of a committee of the British Association, consisting of Lord Rayleigh (chairman), Dr. R. T. Glazebrook (secretary), Lord Kelvin, Professors W. E. Ayrton, J. Perry, W. G. Adams and G. Carey Foster, Sir Oliver Lodge, Dr. A. Muirhead, Sir W. H. Preece, Professors J. D. Everett, A. Schuster, J. A. Fleming and J. J. Thomson, Dr. W. N. Shaw, Dr. J. T. Bottomley, Rev. T. C. Fitzpatrick, Dr. G. Johnstone Stoney, Professor S. P. Thompson, Mr. J. Rennie, Dr. E. H. Griffiths, Sir A. W. Rucker, Professor H. L. Callendar and Mr. George Matthey. Presented at the annual meeting of the British Association at Southport.

[2] It is possible that coil F is an exception to this statement.

Changes in the three standards F, G, H have already been recorded in previous reports (1890 and 1892). The standard coil Flat remained unchanged in value until 1901-1902. Between the observations recorded in these years it increased in resistance by 17×10^{-5} B. A. U., and has not varied since. The alterations in the other coils, since the comparisons in 1888, have been as follows: (F) $+ 97 \times 10^{-5}$ B. A. U.; (G) $+ 33 \times 10^{-5}$ B. A. U.; (H) $+ 18 \times 10^{-5}$ B. A. U. It should, however, be noted that while between 1888 and 1890 the change in F was $+ 64 \times 10^{-5}$ B. A. U., that in G was $- 27 \times 10^{-5}$, and in H $- 13 \times 10^{-5}$. Since 1890 the same coils changed by $+ 33 \times 10^{-5}$, $+ 54 \times 10^{-5}$ and 31×10^{-5} B. A. U., respectively, while between 1901 and 1902 Flat, as has already been stated, rose by 17×10^{-5} B. A. U. It is not easy to trace the causes of these changes. In the case of Flat the observations in 1901 were made at Kew, those in 1902 at Bushy House, and the change may in some way be connected with the removal of the coils. The changes in F, G, H first showed themselves after the coils had been subject to a very low temperature, and may have been started by strains due to this. Appendix I gives the details on which these various statements are based. It appears also from the same appendix that the new platinum-silver ohm standards of the association have retained their values since 1898 practically unchanged.

The comparison between the standards of the association and those of the Reichsanstalt leads to the result that the unit of the association (No. 5 of those defined above) is less than that of the Reichsanstalt (No. 6) by 0.000105 ohm. This result is deduced (table IX of Appendix I) from a series of extremely concordant measures on coils of value 0.1, 1, 10, 100, 1,000 and 10,000 ohms; thus both the unit and the multiple coils agree in giving the same difference between the Reichsanstalt and ourselves.

By the kindness of Mr. Trotter a comparison has been made between the Board of Trade unit and those of the association, with the result that, as deduced from the unit coils, the Board of Trade unit is less than that of the association by 0.00006 ohm. This result, however, is not confirmed by a comparison of a 1,000-ohm coil belonging to the association with one of those of the Board of Trade;[1] these coils show no difference.

The above statements are made on the assumption that the various changes in the coils which have undoubtedly occurred have been rightly interpreted, so that we can now recover the absolute C. G. S. value of the coil Flat, and hence of the standard ohm as originally determined at the Cavendish Laboratory, and defined by the committee in the Edinburgh Report, 1892. That this is the case is borne out by the results of the experiments on the specific resistance of mercury, a summary of which is given in Appendix II. These are not yet complete. Mr. Smith has, however, constructed and calibrated eleven mercury tubes. The mean cross-section of each of these has been determined by at least four different sets of measurements. In nine cases the greatest difference between any measurement and the mean is not more than 0.001 per cent. The values found for the resistance of each tube do not differ by more than 0.001 per cent.

If we assume as above that the values of the wire standards of resistance of the association are known in terms of the absolute C. G. S. unit, then it follows that the length of the column of mercury, 1 sq. mm. in section, which would have a resistance of 10^9 C. G. S. units, would be 106.291 cm. The value found for this same quantity by the secretary (Mr. Glazebrook) and Mr. Fitzpatrick in 1888,[1] was 106.29 cm. We infer then that we still can recover from our standard coils the absolute C. G. S. unit of resistance. Again, the length of the mercury column constituting the international ohm has been defined as 106.3 cm. But we have seen that the absolute C. G. S. unit, as deduced from the wire coils of the association, has a resistance equal to that of 106.291 cm. Thus the absolute unit[2] is smaller than the international ohm by 0.009 per cent. Again, it has been stated above that the unit deduced from the standards of the association is smaller than that of the Reichsanstalt by 0.0105 per cent. Thus the mercury standards of the Reichsanstalt, constructed to represent the international ohm, exceed those just made for the association by Mr. Smith by 0.0011_5 per cent, or 1.5_5 parts in 100,000.

Again, if these results be accepted, since the Board of Trade unit as derived from the wire standards is less than that of the association by 0.006 per cent, and the association unit is too small by 0.009 per cent, it follows that the Board of Trade unit is too small by 0.015

[1] If the view be accepted that the laboratory unit is the same as in 1891, the Board of Trade standard has fallen since that date by 0.00006 ohm.

[1] *Phil. Trans.*, 1888.

[2] The resistance taken for a column of mercury 1 sq. mm. in section, 100 cm. in length at 0 degree C. at the Edinburgh meeting in 1892 was 0.9407×10^9 C. G. S. units. Mr. Smith's experiments give, assuming the values of the wire coils known, the result 0.9408×10^9 C. G. S. units.

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per cent. This difference arises in part from the fact that the standards of the association, from which the Board of Trade standard was copied by the secretary in 1891, are too low; in part from the fact that the Board of Trade standard has diverged slightly from that of the association since 1891.

Thus, to sum up this part of the report, it may be stated that:

(*a*) The original B. A. unit and the standard ohm based on it (Nos. 3 and 5 of the units concerned) can be recovered from the wire coils of the association.

(*b*) The Board of Trade unit (No. 4) is now less than the laboratory unit (No. 5) by 0.006 per cent.

(*c*) The laboratory unit (No. 5) is less than the international ohm (No. 2) by 0.009 per cent.

(*d*) The Board of Trade unit is less than the international ohm by 0.015 per cent.

(*e*) The mercury tubes made at the National Physical Laboratory to represent the international ohm are less than those made at the Reichsanstalt by 0.0015 per cent.

This last result must be considered as provisional pending the completion of Mr. Smith's work, but it is clearly highly satisfactory.

Mr. Smith has also made progress during the year with his investigations into certain of the anomalies shown by Clark cells, but the results of that enquiry are not yet ready for publication.

The standard condensers of the association have been frequently in use during the year; about 15 condensers have been compared with them. They retain their value in a satisfactory manner, and are convenient to work with, though possibly some improvement in the insulation might be desirable. A chronograph, purchased with part of the grant made last year, will enable the time measurements required in the measurements of capacity to be made with greater accuracy, and hence will permit of greater rigidity in the enquiry as to the permanence of the standards.

The platinum thermometers made from the stock of wire purchased from Messrs. Johnson and Matthey, which at the time of last report were in course of construction, have been completed, and the behavior of some of them investigated throughout the past year. The resistance box available was the old Callendar-Griffiths box used in the work of Dr. Chree at Kew Observatory, having coils of platinum-silver on the binary system. The contacts are an old form of the Cambridge Instrument Company's type of plug contact, the cheeks being made of a special white alloy held in round Doulton-ware cups. In measurements with this box not much significance attaches to the third figure of decimals representing hundred-thousandths of an ohm, though the settings could be made to this amount at the lower temperatures. The box resistance coils were intended for use with platinum thermometers of 1 ohm fundamental interval only, and therefore the two high-resistance thermometers, of 5 ohms fundamental interval, could not be measured at the sulphur-point; their systematic investigation has, therefore, been temporarily postponed. The want of a better box for this work is seriously felt.

Of the original six thermometers made in August, 1902, Nos. 1 to 4 are of 1 ohm fundamental interval, Nos. 1 and 2 being in porcelain and 3 and 4 in specially thin Jena glass tubes of internal diameter 8 mm. to 9 mm. and 38 cm. to 40 cm. long. Nos. 5 and 6 are of 5 ohms fundamental interval and in somewhat wider tubes of specially thin glass, through which the four leads are hermetically sealed. The heads of all these thermometers are of the design used by Chappuis and Harker, the contacts to the solid ends of the copper flexibles being made by fusible metal cups. With reasonable care these contacts prove very satisfactory, both as regards the constancy of their resistance and their mechanical strength. In the construction of all these thermometers special care was devoted to adjusting their fundamental intervals to be very close to their nominal values, and after completing this adjustment all were subjected to repeated annealing in air at a bright-red heat, thermometers Nos. 3 and 4 being temporarily placed in porcelain tubes for the purpose.

The remaining four constructed last summer, and one of later date, all of 1 ohm fundamental interval, have had their constants determined from time to time during the year. One of them—B. A.$_2$—was selected as a representative platinum thermometer for use in an investigation made to determine the relation between the platinum scale and that of the gas thermometer of the National Physical Laboratory at temperatures up to 1,000 degrees C. During the time occupied by two sets of experiments with this instrument, extending over about three months in all, its constants altered by an amount only just greater than their probable error, showing that it is quite possible to use properly constructed platinum thermometers up to temperatures slightly over 1,000 degrees C. for long periods without fear of serious changes.

The summary of the life history of the different thermometers is given in Appendix III. The chief fact apparent is that there seems to be a small but real difference between the δ of thermometers 1 and 3 on the one hand, and 2, 4 and 7 on the other, the maximum divergence being about 0.02. Prolonged electrical heating in air of the wire of one of the thermometers was not found to sensibly change the value of the δ. The cause of the small differences found is not obvious, and further investigation is being made on this point. A change in δ from 1.50 to 1.51 would make at the sulphur-point a difference of 0.153 degree C., and at 1,000 degrees C. one of 0.9 degree.

The question of the resistance of copper has been raised lately by the work of one of the subcommittees of the Engineering Standards Committee. For commercial purposes the resistance of copper is defined at a temperature of 60 degrees F. (15.55 degrees C.). A table in Appendix IV gives the values that have been found by various experimenters. It is clear that copper is now prepared of a higher degree of purity than in the time of Matthiessen. Taking the mean of the figures in the table for modern electrolytic copper, we have as the value of the resistance of 1 metre of copper wire weighing 1 gramme at 15.55 degrees C. the value 0.1485_5 ohm, but the figures of which this is a mean range from 1,475 to 1,492. The value found by Matthiessen, as deduced from his paper in the *Phil. Trans.* for 1860, is 0.1500 ohm. Thus the conductivity of modern pure electrolytic copper is 1 per cent better than Matthiessen's. The committee on copper conductors, which investigated the question in 1899, adopted the number of 0.1508 ohm as the resistance of a metre-gramme of commercial annealed high-conductivity copper. This figure has been accepted by the Engineering Standards Committee.

Mr. H. A. Taylor has recently placed in the hands of the secretary two resistances of gold-silver wire made by Mattheissen himself, to represent the resistance at 15.5 degrees C. of 100 in. of pure annealed copper, having the weight of 100 grains. The resistances of these coils have been determined by Mr. Smith, and the results are given in the following table:

	Coil No. 1.	Coil No. 2.
Resistance of 100 in. of copper weighing 100 gr., as given by Matthiessen in B. A. units at 15.5 degrees C.	0.1516	0.1514
Resistance found in 1903 in B. A. units at 15.5 degrees C.	0.1513_5	0.1513_2
Resistance found reduced to ohms at 15.5 degrees C.	0.1493_9	0.1492_6
Resistance deduced of a metregramme in ohms at 15.5 degrees C.	0.1499_6	0.1499_4

Thus Matthiessen's value for the resistance of annealed copper at 15.55 degrees C. (60 degrees F.) as deduced from these coils, agrees very closely with the value calculated by the secretary from the figures in his 1860 paper.

(To be continued.)

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1,600-Horse-Power Gas Engine and Three-Phase Alternator at Laar Power Plant, and Other High-Power Blast Furnace Gas Engines.

By Frank C. Perkins.

THE progress in the development of the high-power gas engine has been most rapid during the past two or three years, especially on the continent of Europe, where thousands of horse-power are developed at the present time in the electrical power stations of foreign iron and steel plants; utilizing the waste blast furnace gas, which has heretofore been a total loss, although in some instances it has been employed for fuel for boilers which have supplied steam engines, driving blowers and electrical generators.

Until recently single-acting four-cycle engines have been more extensively used for this purpose, ranging in capacity up to 1,000 horse-power for single cylinders and 2,000 horse-power for double cylinders, arranged one on either side of the flywheel or in tandem on the same side of the flywheel or generator. In some cases higher output has been obtained by double-tandem arrangement, using a single-acting tandem engine on each side of the alternator. Such an arrangement is illustrated in Fig. 1, showing two 800-horse-power tandem engines, both directly coupled to a three-phase alternator, which, when operating at full capacity, absorbs fully 1,600 horse-power. This is one of the gas engine units at the power station at Laar, near Ruhrort, and is operated by the Phœnix Actiengesellschaft Für Bergbau Und Huettenbetrieb. This double-tandem gas engine has four cylinders and was built by the Vereinigte Maschinenfabrik Augsburg Und Maschinenbau-Gesellschaft Nurnberg.

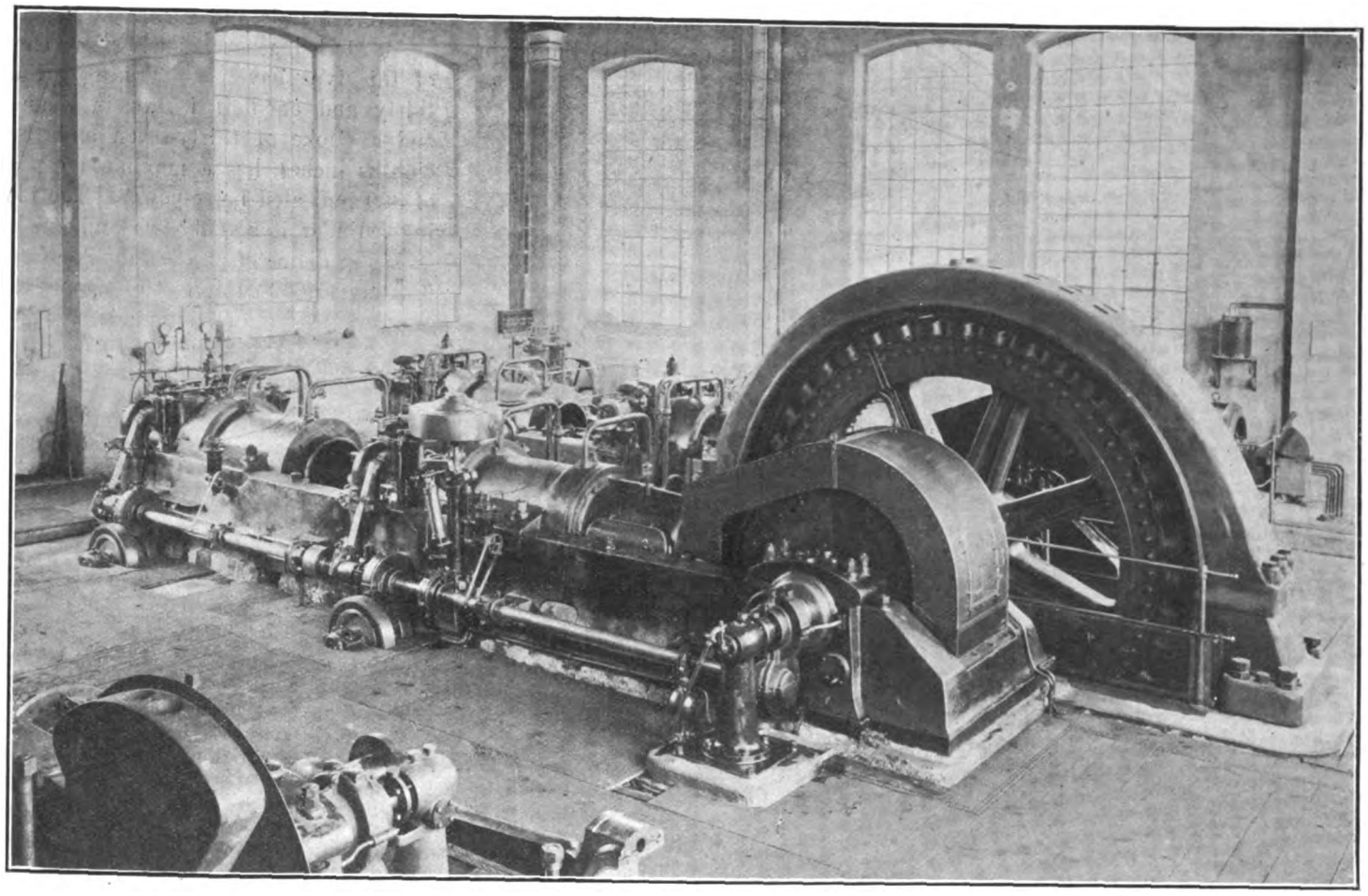

FIG. 1.—THREE-PHASE GAS ENGINE, POWER PLANT OF PHŒNIX ACTIENGESELLSCHAFT FÜR BERGBAU UND HUTTENBETRIEB AT LAAR, NEAR RUHRORT. 1,600 HORSE-POWER, 4-CYLINDER GAS ENGINE, DIRECT-CONNECTED TO A THREE-PHASE ALTERNATOR.

Another double-cylinder gas engine of high power directly connected to a three-phase alternator is shown in the drawings, Figs. 2 and 3. These engines operate on the Oechelhaeuser system of two stage motors and have two plunger pistons working toward each other in a single cylinder which is open at both ends. These pistons shortly before reaching their dead points open successively the different ports, the exhaust port first, then the port for rinsing the cylinder with fresh air and finally the gas inlet port.

The large double-cylinder gas engine of the Oechelhaeuser type, noted in diagram Figs. 2 and 3, has a capacity of 1,000 horse-power and is in operation at the power plant of the Ilsedes-Hütte in Grossilsede, near Hanover, Germany.

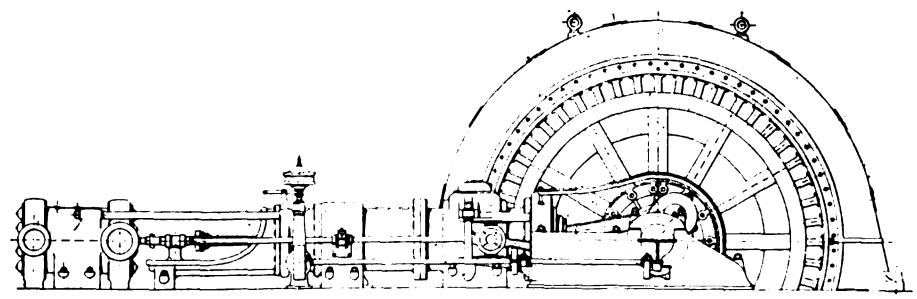

FIG. 2.—DOUBLE-CYLINDER GAS ENGINE, DIRECT-CONNECTED TO THREE-PHASE ALTERNATOR.

Besides the tandem types of single-act-

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ing gas engines, one of which is seen in Fig. 4 having a capacity of 600 horse-power and arranged for direct-connection to an electrical generator, there are also double-acting gas engines now constructed which give most excellent regulation for driving alternators in parallel. This is largely true on account of the fact that there is an impulse at every stroke and at each end of the cylinder. Double-acting gas engines are now constructed abroad using both the four-cycle or Otto cycle and the two-cycle or Clerk cycle. The double-acting engines of Koerting Brothers are now constructed in this country as well as in Europe in capacities up to 2,000 horse-power with a thermal efficiency of thirty-eight per cent.

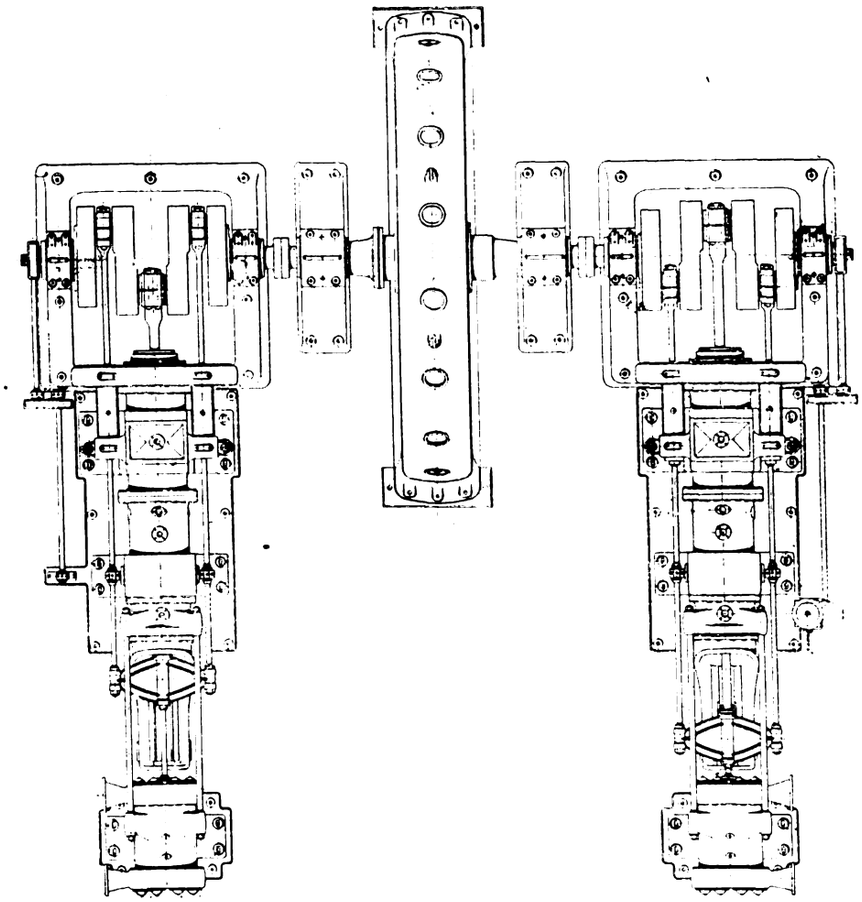

FIG. 3.—DOUBLE-CYLINDER GAS ENGINE, DIRECT-CONNECTED TO THREE-PHASE ALTERNATOR.

Double-acting four-cycle engines are now being constructed by John Cockerill, of Seraing, Belgium, of 3,000-horse-power capacity, and double-tandem double-acting engines of the same type have been designed by this firm for a capacity of 6,000 horse-power.

The Oechelhaeuser gas engine has two plunger pistons working toward each other in a simple cylinder. After the explosion of the compressed and mixed gases, such a large quantity of the burned gases escapes that the pressure in the cylinder sinks as low as the atmosphere and then the entering fresh air blows out the remainder of these gases through the exhaust pipe. A yielding cushion is thus formed between the hot exhaust gases and the fresh ones before the fresh supply of gas enters and mixes with the air entering and forming with the latter the explosive mixture. The explosive mixture is then compressed by the two pistons nearing each other and the ignition takes place just before the end of the compression. This drives the pistons from each other and the entire cycle is again repeated and so on indefinitely.

A feed pump is attached to the engine which supplies the air and fresh gas which are compressed in the receivers arranged around the ports to such an extent that there is effected a sufficient rinsing of the cylinder as well as a good mixing of air and gas. The pistons shortly before reaching their dead points open successively the different ports, the exhaust port, the port for rinsing the cylinder by fresh air, and the gas inlet. The power is regulated in a similar manner as is done in steam engines by the throttle valve, a single admission valve regulating the gas supply to the pump and therefore the number of revolutions.

It will be observed that the cylinder itself has no valve operating during the piston stroke and the engine is thus very favorable to the exacting conditions of work in using blast furnace waste gases. The oiling of the working cylinder is so arranged that in no position of the pistons are the oil holes left free by the latter, and the pistons as well as the cylinder walls are continually supplied with an abundance of lubricant. The working cylinder is fastened in the cooling chamber in such a way that its free expanding by the heat is effectually secured, the cooling spaces also being brought close to the receivers for air and gas.

An Oechelhaeuser blowing gas engine of this type having a working cylinder thirty and one-half inches in diameter and a stroke of thirty-seven and three-eighths inches, has a maximum capacity of 800 indicated horse-power. The blowing cylinder is seventy-two and one-half inches in diameter and is capable of compressing 17,662 cubic feet of air per minute to a pressure of 7.7 pounds per square inch, at the normal speed of 100 revolutions per minute.

Dielectric Hysteresis.

Work has recently been carried out at the laboratory of the Elektricitäts Actien-Gesellschaftvorm W. Lahmeyer und Compagnie by Mr. P. Holitscher in studying dielectric hysteresis and the heating of high-tension cables. With a view to obtaining these losses, independent of the volume of the materials, experiments were made on high-tension machines. One of the difficulties of the work was the designing of a measuring method which would give accurate determinations of the small power involved. Mr. Holitscher's work has shown that a relatively accurate and convenient method for determining great losses by dielectric hysteresis, as is the case with the great strain of the dielectric, is obtained by applying to the capacity to be tested the high potential of a transformer, the loss of the transformer being deducted from the input supplied to it. With smaller losses, measurements are made direct in the high-tension circuit by means of a wattmeter, the low and high-tension coils of which are interchanged, and incandescent lamps inserted as a shunt resistance in the pressure circuit. The losses met with are practically proportional to the number of periods, a loss by leakage of current being practically negligible as compared with dielectric hysteresis. The capacity, and therefore the dielectric constant, was by no means a constant quantity with the material tested—micanite. It was altered within appreciable limits according to the elec-

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trostatic strain. As the variation of the capacity was an unknown quantity, it was impossible to determine in anticipation the increase of the dielectric hysteresis with the increase of the pressures. In high-tension machines with micanite tubes, the dielectric hysteresis loss with higher strains on the micanite is approximately proportional to the third power of the tension. In determining the efficiency of a high-tension machine, the loss by dielectric hysteresis is negligible, as comparatively thick material is generally chosen to provide against piercing.

Underground Telegraphs.

The British Post Office will complete the putting underground of the telegraph system between Warrington and Carlisle, and Manchester and Leeds. The cost of the work, together with a twenty-mile extension to Beattock Rise, is estimated at $675,000. The three new sections referred to cover about 120 miles, and the cost is considerably less than a few years ago, as the 113 miles from London to Birmingham cost $800,000. Practically all the exposed parts of England will be dealt with in this manner before the end of the year. The authorities are urging on the contractors to complete the new pipes along the northwest route to Glasgow and Edinburgh, and it is probable that the underground system will be extended in the direction of Portsmouth, Bristol and Land's End, as recent storms have shown the susceptibility of the wires in the south of England.

A Heavy Electromobile Tractor.

A heavy electromobile tractor is now in use at Grevenbruck, Westphalia, for hauling heavy loads, and has proved quite successful. This tractor, or road locomotive, has the advantage of not requiring a regular track, but is built to run over the ordinary roads. It is used for hauling loads of material from a large brick factory over the main road to the nearest railroad station, which is about half a mile distant. The tractor is equipped with two motors of twenty-five to thirty horse-power each. The current is taken to the motors from a double overhead wire by a special form of trolley which is supported on the roof of the tractor. This trolley, which is the invention of M. Schiemann, is constructed so that it can shift from side to side upon its base so as to cover a distance of ten feet or more, while still keeping a contact with the overhead wire. By the use of this device the train composed of the locomotive and its trailers can easily pass around a curve of twenty-two-foot radius, such as occur frequently in the present case. The tractor usually draws a train of two freight cars which carry a load of five tons each. The gross weight of a loaded train is about twenty tons, of which one-half represents the net load. In some cases the tractor draws a train of four freight cars. The average speed of such a train is four miles an hour. As to the energy required for the locomotive, it is found that with the best conditions of road surface it requires about 350 volts and thirty amperes.

Motor Cars for Railways.

The use of self-propelled or so-called motor cars on railways is still attracting a good deal of attention in England. The current issue of the *Railway News* describes two cars just put in service on the Great Western Railway, running between Chalford and Brinscombe. The cars are fifty-seven feet long, eight feet six and three-quarter inches wide, and eight feet two inches high inside. The total wheel base is forty-five feet six inches. The wheel base of each truck is eight feet. The car is divided into a compartment thirty-nine feet long for passengers, one for the motor, twelve feet nine inches long, and a vestibule four feet long. The car is handsomely finished inside and out, comparing in this respect to the best type of electric car, and will accommodate fifty-two passengers. It is propelled by means of a steam motor, with cylinders twelve inches by sixteen inches, fixed horizontally on the frame of the truck. The diameter of the driving wheels is three feet eight inches. The tractive force is 8,483 pounds. Steam is supplied by a vertical boiler burning coal. The working pressure is 180 pounds. This car has been put in service to meet competition with the electric lines and to build up local traffic. It stops at road crossings, as well as the fixed stations. The cost of the cars is given as $12,500 each.

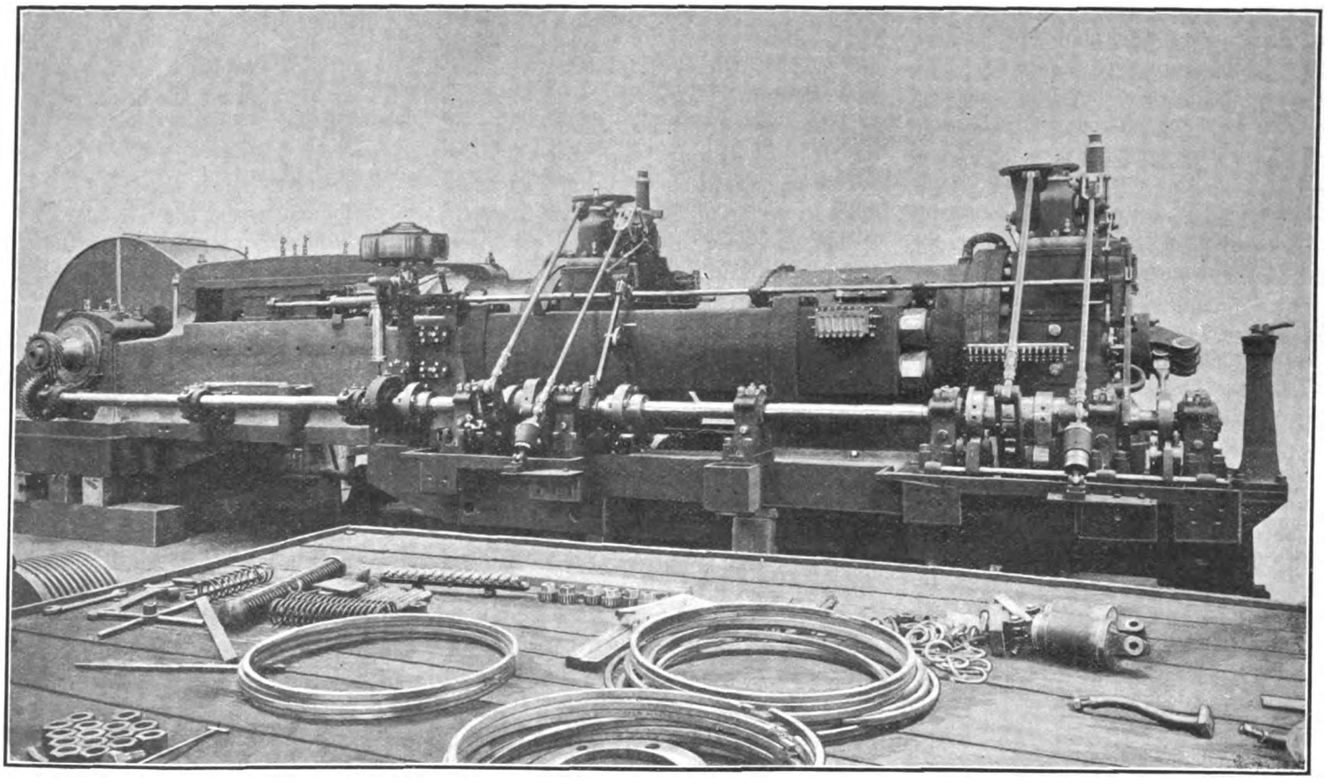

FIG. 4.—600-HORSE-POWER TANDEM BLAST FURNACE GAS ENGINE, DIRECT-CONNECTED TO ELECTRICAL GENERATOR.

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TRACK CONSTRUCTION AND MAINTENANCE.[1]

BY T. W. WILSON.

The close relationship of the terms "construction" and "maintenance" does not seem to be fully appreciated. The track upon which all the traffic has to be carried is one of the most essential parts of a railway, and yet the importance of the track and track work in relation to the operation of the railway, and the portion which the maintenance of track bears to the total operating expenses do not seem to be fully recognized by street railway officials. This proportion is usually high and due to a great extent to the fact that the majority of our street railways were originally built by promoters with regard to immediate cheapness of construction. While this was justified in many cases by the tracks being constructed in advance of the prospective travel, still in too many instances the mistake has been made of adhering to the original types and standards of construction long after they were inadequate to the greatly increased traffic and the heavier equipment. The result of this is seen on the auditor's books, the road having to sustain an undue continual charge for maintenance. If those who originally built street railways had to maintain them they might have been built differently. This rebuilding of old track to take care of increased travel and heavier equipment makes necessary the construction account of which has been aptly said: "The construction account can never be closed until our railways are built. To attempt it involves a destruction account of fearful magnitude. Under our present system we are perpetually rebuilding our railways, not reaching the life of our works, and thus running capital to waste. A better system will strike at the root of the evil by correcting, not nursing, the defects of our permanent way."

It behooves us, therefore, to carefully review our standards of construction in order to be certain that we are building for the future.

On October 9, 1901, the Committee on Standards of the American Street Railway Association reported in favor of a tee rail for use in city streets whether paved or unpaved, their recommendation being: "We recommend a tee rail as the most desirable under any conditions."

This is the generally accepted solution of the rail question, the familiar arguments of the tee rail being small resistance to tractive force, ease of installation and the keeping of vehicular traffic away from the tracks. And yet it would seem that we lose sight of the most important point, *viz.*, the maintenance of the pavement along the gauge line side of rail. On "Archer avenue," in Chicago, a mile of Trilby girder rail and a mile of tee rail were laid side by side about two years ago in order to convince the municipal authorities that the tee rail was the best. The writer inspected this stretch of track lately and found that while the girder rail track was practically as good as new, the paving along the inside of the tee rail had been rutted out badly by the teams, in some places the ruts being four inches deep. That track looks as if it would have to be entirely repaved within a short time, and meanwhile is a constant menace to the wheels of all vehicular traffic, with a consequent liability for accident. Again, the track on North Main street, Buffalo, was relaid four years ago with a semi-groove girder with block stone paving in the tracks. Within a year afterward the paving stone next to the gauge had worn down to the lip of the rail but no further. It has remained in the same condition four years and will apparently outlive the rail. If this track had been built of tee rail, repaving would now be in order.

So it would seem that we can not afford to overlook the fact that the pavement along the tee rail is subjected to much greater wear than along the girder and may be a source of expensive maintenance on busy streets. As to the question of keeping the vehicular traffic away from the tracks, this might possibly be the case on wide, smoothly paved streets of cities of less than 200,000 population and where there is very little trucking. But in the narrow, busy thoroughfare of the larger cities, where there is not room enough in the street for the vehicular and car traffic, this would be impossible, and a rail must be installed which will provide for the trucking as well as for the cars, and afford the best protection to the paving adjacent to it.

These were the reasons which probably led up to the adoption of the "Crimmins" or "Trilby" shaped rail (so called on account of its resemblance to a foot when inverted), which has been laid in New York, Chicago, Washington, and many other cities, which finds its highest development to-day in a section weighing 137 pounds per yard, now being laid in Philadelphia. The extra weight of this rail has nearly all been placed in the lip, solely for the purpose of furnishing a runway for the tires of vehicles and keeping them off the pavement. Another argument against the tee rail is that nearly all the municipal authorities of our larger eastern cities, and the public, are against its adoption on account of the aforesaid ruttings, and the city ordinances usually prohibit it. As public carriers, we can scarcely afford to ignore their point of view.

A practical solution of the rail question would seem to be to use the nine-inch Trilby type in the busiest thoroughfares of our larger cities, where the trucking is heavy and the traffic congested; the semi-grooved girder in the quieter streets and those districts which by reason of architecture and location have become fixed as resident districts; and the tee rail in the smaller towns and cities, and in the suburbs of the large cities.

Besides the shape of the lip of the girder rail, which has already been mentioned, there are two other important points to be carefully considered, *viz.*, the width of base and the depth of groove. The base on a nine-inch girder should not be less than six inches. This makes a firm support when superimposed upon concrete, and lessens the tendency of wide gauge, due to tipping. Too little attention is paid to this point by street railway engineers. When the track and all its fillings are new a narrow base does not matter so much, but after eight or ten years of continuous service, with the pavement loosened and the ties rotten, the six-inch base should do its work well.

The depth of groove should not be less than one and one-quarter inches. With the use of a concrete roadbed the wear upon the head of the rail is undoubtedly greater than with a flexible roadbed, and every one-thirty-second of an inch of increased depth means a longer life for the track, depending of course upon depth of wheel flange and condition of traffic.

Very careful measurements in Buffalo have resulted in determining that the average wear of head for four years on the busiest street has been one-thirty-second inch per year. The largest tread operating over this track being three-quarter inch and the original depth of groove being one and one-quarter inches, a very simple computation gives sixteen years as the life of this track. In this connection it will appear strange to the old trackman to speak of the life of the rail being fixed by the wear of the head rather than the joint, but this is one of the results the welded joint has achieved. To be paradoxical, after the joint is welded it ceases to be a joint.

With the advent of the welded joints came a great decrease in maintenance. The

[1] Paper read at eleventh annual meeting of Street Railway Association of the State of New York, Syracuse, N. Y., October 6-7.

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cost of welding of joints has been carried on for some eight years, especially in the West, with varying success. The percentage of breakage never seems to have been less than two and one-half. The electric weld we are all familiar with and it seems to be the highest type of joint to-day. The per cent of breaks during the last year has been kept down to the astonishing figure of one-tenth of one per cent. The only objection to this joint is in its method of application, a train of four cars being necessary which occupies the track and interferes with the regular traffic. Another drawback is, that it is not possible to contract for a small number of joints on account of expense attached to shipping the equipment from place to place. This puts it beyond the reach of all roads that have less than 2,000 joints to weld.

Among the best of the mechanical joints is the riveted splice bars of the Philadelphia Rapid Transit Company. It consists of the regular splice bar, with rivets substituted for bolts, and the space between the rail and the bar is filled solid with molten zinc.

With the introduction of concrete roadbed came the necessity for a steel tie, as with a track whose life is estimated at from fifteen to twenty years, it would hardly be economy to install ties with a life of from ten to twelve years. These steel ties should be secured to the rail by means of brackets which fit up well under the head of the rail, and which accomplish the same purpose as a brace tie plate or a tie rod. Old rail can be very readily used as a tie when cut up into proper lengths.

Where wood ties are used on interurban work, they should be white, rock or burr oak, or long leaf southern pine. Cedar, while being long-lived, is too soft, especially with heavy interurban passenger and freight service, and will not hold a spike.

While on the question of ties, it may be of interest to note that the steam and electric railways of the United States are using over one hundred million wood cross-ties per annum. The prices are constantly advancing and it is evident that we will be forced to turn to the steel tie as a substitute for wood. As a starter, the entire roadbed of the Pittsburg, Bessemer & Lake Erie Railroad is being equipped with steel ties.

One of the greatest, if not the greatest source of expense for track maintenance is on account of no ballast, loose track, and consequent failure of pavement. Miles upon miles of track in which the rail was good, the joint perfect, and the tie sound, have been torn up and relaid because the ties had been laid in the mud, concrete placed on top of them and around them, in fact any place but underneath them, and the whole surmounted by a three-inch veneering of asphalt laid right against the rail. Could anything be more criminal? Such a track will last from three to six years, depending upon traffic, and then suddenly the pavement will go all to pieces.

"Never lay asphalt against a steel rail" has come to be a street railway axiom.

Brick, sandstone, granite, all make a very acceptable pavement, but in order to preserve the pavement it is necessary to have a foundation of concrete, and this means concrete under the rail and ties.

The concrete roadbed consequently, either of the beam or solid type, has come to be a recognized standard, and although some objection is made to this construction on account of the rigidity of the track and the wearing of the rail, yet a railroad can better afford to have the head of the rail wear for a certain period for no maintenance, than to have it wear a little longer time with constant repairs to pavement.

Owing to different prices of material at various places, estimates of cost must necessarily vary with the locality. The following may be of interest, however:

CONSTRUCTION.

1. Replacing old six-inch track in asphalt pavement with new nine-inch ninety-four-pound girder rail, Portland cement, concrete base, steel ties at ten-foot, welded joints, No. 1 Medina sandstone block paving with grouted joints, toothing and asphalt in two-foot strip, including cleaning up street, and allowing salvage on old six-inch rail. Per foot of single track, about $4.30.

2. Relaying and welding rail already in street, concrete base, steel ties, pavement, etc., as above, except that there is no salvage. Per foot of single track, $3.30.

The cost of maintenance of track and roadway of nine railways, per mile of single track, per year, for 1901, is given in table below. It will be seen that the cost varies from $215 to $733 per mile. It is interesting to note that the larger the mileage the higher the cost of maintenance seems to be. Not much can be gleaned, however, from these comparative figures as the conditions are so diverse; for instance, the Brooklyn Heights is mostly on elevated structure and of course is more costly to maintain. The cost per car mile of maintenance of track and roadway for International Railway Company for 1903 was 0.008.

COST OF MAINTENANCE PER MILE OF SINGLE TRACK FOR YEAR 1901.

Railway Company.	Mileage.	Tracks and Roadway.	Remarks.
B'klyn Heights R. R. Co..	401	$733	6 mo. end. Dec. 31
Cleveland Elec. R. R. Co..	....	630	All city
Montreal Street Ry.....	103	469	All city
Rochester Ry. Co.....	100	378	City and sub.
Denver City Tramway....	144	298	All city
International Ry., 1901....	330	290	City and sub.
International Ry., 1903....	457	258	City and sub.
Milwaukee, 1900.....	225	250	City and sub.
Scranton Ry. Co	76	321	City only
Schenectady Ry.....	82	215	City and sub.

As potent a factor as any in the economical construction and maintenance of track is the organization not alone of the track department, but of every individual job undertaken. All work should be carefully laid out and planned beforehand and the plans rigidly followed. As little initiative as possible should be left to the subforeman. Cheap tools, cheap material and cheap foreman are not necessarily economical, and are usually the reverse. And above all, a close watch must be kept on details, with a view to turn aside all the undirected and misdirected tendencies which might lead to extravagance, inefficiency, or whatever in the end might operate depressingly upon dividends, which after all constitute the ultimate aim of our friends the directors.

Fire Protection at the St. Louis World's Fair.

The authorities of the Louisiana Purchase Exposition are making adequate provision for water supply by putting in one of the largest installations of fire pumps in the world. The exposition authorities are doing everything possible to prevent a recurrence at St. Louis of any disastrous conflagration such as has marked previous expositions in other parts of the country. These pumps have been purchased from Henry R. Worthington Company, New York city, and comprise twelve 1,000-gallon standard "Underwriter" fire pumps, each capable of supplying four fire streams, making it possible to have forty-eight fire streams in operation at one time. The pumps are of the duplex double-acting type, and are supplied with air and vacuum chambers of large capacity. The fittings are of composition metal, and the piston and valve rods are of bronze. Every measure has been taken in designing these pumps to ensure their starting at a moment's notice at any time after having been idle for a long period.

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THE CONDITIONS GOVERNING THE RISE OF TEMPERATURE OF ELECTRIC RAILWAY MOTORS IN SERVICE.[1]

BY CARY T. HUTCHINSON.

In a former paper read before the Institute (Transactions of the American Institute of Electrical Engineers, vol. xix, p. 129), I described a method for determining the motor capacity and energy required to make any schedule speed for a run of any distance, with electric motors. Since that time I have extended the method to include the predetermination of the rise of temperature of the motor when those constants of the motor are known, upon which the rise of temperature depends.

In that investigation the time required for each of the three periods of the "type-run," shown in Fig. 1, was first determined; this was an algebraical problem, the solution of which involved the initial acceleration (a), the coasting retardation (b), the retardation after braking (c), the length of the run and the average speed from start to stop. These equations are:

$$x/T = A_0/a - K_1 (A_0 - A)^{\frac{1}{2}}$$
$$y/T = K_2 (A_0 - A)^{\frac{1}{2}}$$
$$z/T = 2\ A_0/c\ K_3 (A_0 - A)^{\frac{1}{2}}$$

in which K_1, K_2, K_3, and A_0 are simple functions of (a), (b) *and* (c) only; x, y and z are respectively the times of initial acceleration, coasting and braking, and T the total time, as shown in Fig. 1. The only quantity occurring in these equations other than the three accelerations, (a), (b) and (c), then, is

$$A = V/T = 0.682\ L/T^2$$

T being the time and V the average speed from start to stop; the form of the equation shows that all runs having the same values of (a), (b), (c) and A will be made in the same proportionate time for the different periods, *i. e.*, the same fraction of the total time will be required for accelerating, coasting and braking. In other words, all runs having the same value of the accelerations and of $A = V/T$ are represented by the same figure, with merely a change in scale for the different lengths of run, the ordinates and abscissæ being proportional to $L^{\frac{1}{2}}$.

This quantity A reduces the variables from three—V, L and T—to two—A and L. A is a convenient quantity to use as independent variable for the curve-sheets; it simplifies the presentation, since all runs having the same values of A, (a), (b) and (c) require the same energy per ton-mile, independent of the length of run or the average velocity, and require a motor capacity directly proportional to the square root of the length of run—that is, directly proportional to the time from start to stop.

Moreover, all values of A occurring in practice can be included between the values of 0.15 and 0.35—a relatively small variation, whereas variations in V, L and T cover a much wider range.

It is to be remembered that the previous investigation, as well as this one, assumes a straight, level track, constant train friction and constant braking force. These assumptions are necessary to any general treatment, since curvature and gradients are arbitrary. I have, however, in part, developed a method for making the necessary allowances for curves, grades and variable train friction in the form of corrections to the values found for the corresponding simple case.

These equations involve four quantities, of which, two—(b) and (c)—are assumed to be constants and two—(a) and A—the variables. The solution of the equations is best given by curve-sheets, with x/T, y/T and z/T as ordinates, and A as abscissæ; a separate curve is required for each value (a). Curve-sheet 1 is plotted with

(b) = 0.15 mph/sec. = 13.6 lbs. per ton

and

(c) = 2 mph/sec. = 182 lbs. per ton;

(c) is the total retardation after braking, including train friction. This curve-sheet is similar to curve-sheet 2 of the first paper, save that there the values, (b) = 0.2 and (c) = 3 mph/sec., were used.

Fig. 1 shows the type case, with three constant accelerations; Fig. 2 the actual case, in which acceleration on the motor curve is added to the constant initial acceleration; Fig. 2 then involves the characteristics of the motor used. Curve-sheet 5 of the first paper gave the average speed and torque curves of a number of tramway motors in common use; I have since added other motor curves, and in curve-sheet 2 show average motor curves, which represent with practical accuracy the torque and speed relations of any General Electric or Westinghouse motor, throughout the range of ordinary operation. The extreme difference between the speed of any motor of either company and the speed on this curve-sheet for a given torque is greatest at the high speeds, but within the range of ordinary operation this variation is less than five per cent.

It is necessary to assume the same motor performance in order that the variation in energy consumption and motor capacity required by the different schedules when made with various initial and motor accelerations may be shown independently of variations in characteristics of the motor. If one assumes other motor curves, the methods outlined here can be applied by making certain corrections; but, as a matter of fact, the small variations in the shape of the motor curve are of comparatively slight consequence in the final results.

The efficiency of different motors varies through a much wider range than do the speed and torque; but the efficiency is used only in connecting the input and output, and not in determining heat losses, which are the subject of a separate consideration; hence considerable differences in efficiency curves are of minor consequence.

Here, as in the first paper, the datum points for these motor curves is the load determined by the "hour rating"—that is, the load the motor will carry for one hour with a temperature rise of seventy-five degrees centigrade when tested on the stand, with covers off; this value is assumed to be the commutation limit of the motor capacity and all the results of the investigation are expressed in terms of the input donated by the datum point; therefore it only remains to determine the conditions of a run which will give the limiting temperature elevation when the motor is used at this particular input. The hour rating for the maximum input is not unduly conservative, it leaves a margin for greater power on curves, grades and for emergencies.

Curve-sheet 3 and curve-sheet 4 give energy and motor capacity in terms of through acceleration A; they are the same as curve-sheet 13 and curve-sheet 14 on the first paper, except that here the abscissæ are through acceleration with the motor curve instead of the corresponding through acceleration with the type curve; that is, the quantity A_m of the first paper is used as abscissa instead of the A of that paper, but is designated A; and that the motor capacity is given for a run of one mile. This change simplifies the use of the curves, in that it makes it unnecessary to add corrections to the value of A calculated from the data given for the run. Curve-sheet 3 then gives directly the energy per ton-mile for any run and for initial accelerations from 0.6 to 3 mph/sec., and for a train friction of 13.6 pounds per ton, equivalent to (b) = 0.15, a retardation after braking equivalent to two mph/sec., and all for an acceleration on the motor curve to a speed

[1] A paper presented at the 180th meeting of the American Institute of Electrical Engineers, New York, October 28, 1903.

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fifty per cent greater than the speed with all resistance out.

Curve-sheet 4 gives the horse-power per ton for the same conditions; in the first paper, motor capacity was given in kilowatt input; here it is reduced to horse-power output. These curves give the motor capacity per ton required for any run expressed in terms of the maximum

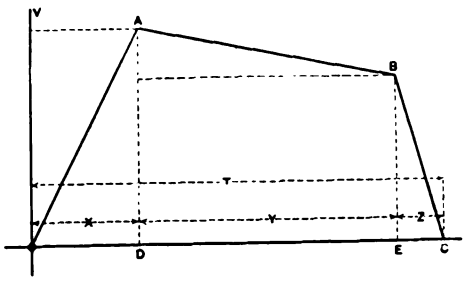


FIG. 1.

power input at the end of the initial acceleration.

An example will best explain their use: suppose

Schedule speed = 30 mph.
Distance = 7,000 feet.
Time of stop = 25 secs.

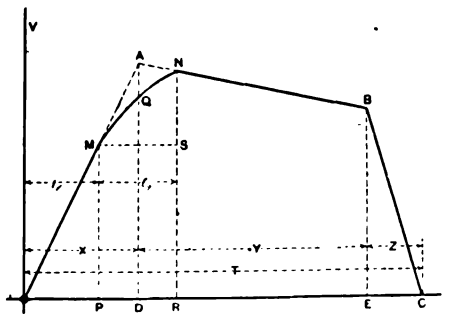


FIG. 2.

Then

Time from start to start = 159 secs.
" " " " stop — T = 134 "

Average velocity = 30×159/134 = 35.6 mph.

Through acceleration, A = 35.6/134 = 0.266.

Suppose further that the speed, energy

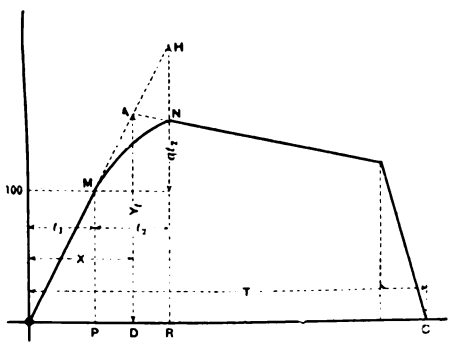


FIG. 3.

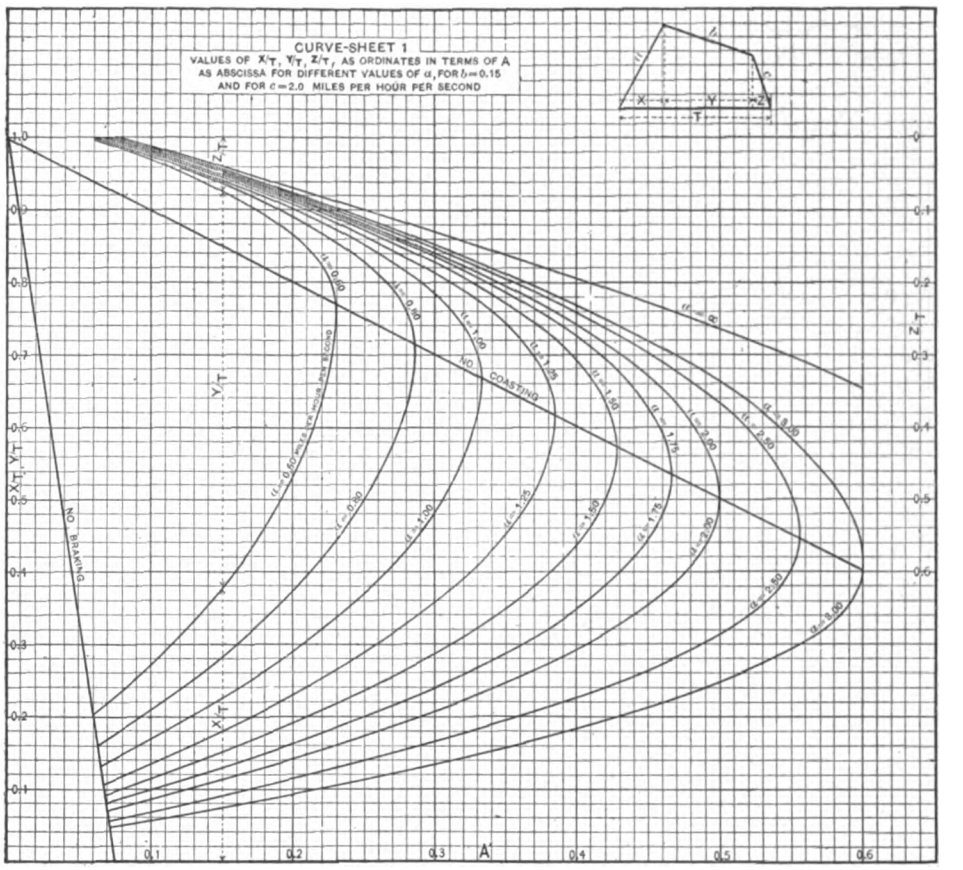
and motor capacity are to be determined for

(a) = 1.25 mph/sec.,

and a velocity on the motor curve of 150. Then,

Relative maximum velocity on type curve = 160 (curve-sheet 5).

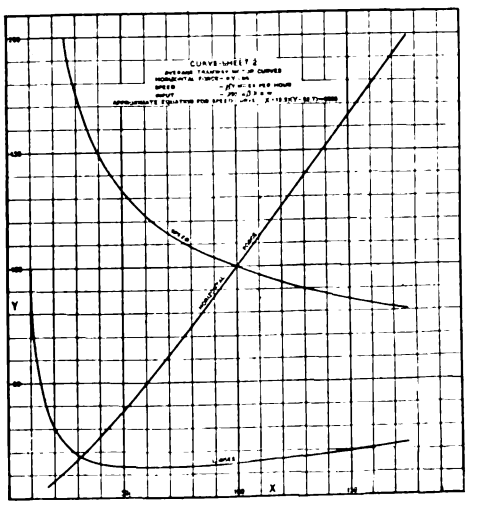
(Curve-sheet 5 is plotted from the velocity time curves for the various initial accelerations.)


CURVE-SHEET 1
VALUES OF X/T, Y/T, Z/T, AS ORDINATES IN TERMS OF A AS ABSCISSA FOR DIFFERENT VALUES OF a, FOR b=0.15 AND FOR c=2.0 MILES PER HOUR PER SECOND
X/T
Y/T
Z/T
NO BRAKING
COASTING
A

CURVE-SHEET 1.

$x/T = 0.306$ (curve-sheet 1)
Hence, $a\,x/T = 0.306 \times 1.25 = 0.382$
and $a\,x = 0.382 \times 134 = 51.2$ mph.

This is the maximum velocity on the type curve.



CURVE-SHEET 2.

Hence,

Maximum velocity on motor curve = 150/160×51.2 = 48 mph.

and

Velocity at resistance out = 100/150×48 = 32 mph.

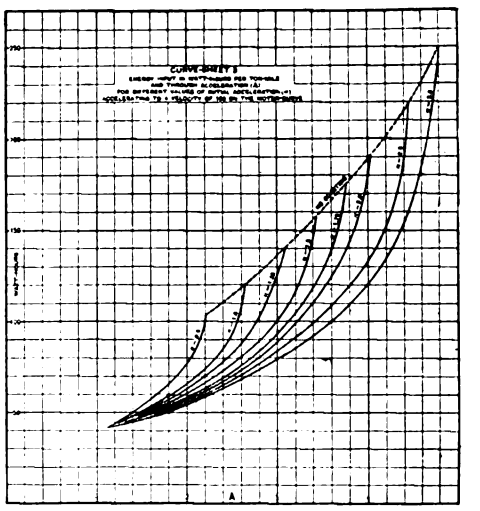
hence,

Velocity coefficient = 0.32

(Velocities are uniformly expressed in terms of the velocity at maximum power, as 100; the actual velocities are then equal to β 100, where β is a coefficient determined as indicated here, or in the manner explained in the first paper.)

Time of initial acceleration = 32/1.25 = 25.6 secs.

Usually it will not be necessary to de-



CURVE SHEET 3.

termine the times required by the various parts of the run, but this can be done as follows:

$x/T = 0.306$ (curve-sheet 1)
$y/T = 0.545$ (curve-sheet 1)
$z/T = 0.149$ (curve-sheet 1)
1.000

Hence

x/T = 41 secs.
y/T = 73 "
z/T = 20 "
T = 134 secs.

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Referring to Fig. 2:

Time of initial acceleration (OP) = 25.6 secs.

Time of acceleration on motor curve (PR) = $\beta \times 112 = 0.32 \times 112$ (curve-sheet 6) = 35.8 secs.

(Curve-sheet 6 is taken from the separate velocity time curves.)

It is noteworthy that this total, made up from readings taken directly or indirectly from half a dozen curve-sheets, should check exactly; of course such accuracy is partly accidental, but it shows how well graphical work of this character can be done.

The distance passed over for the various portions of the run can be calculated in a similar manner from other curve-sheets which are not given here.

Further, from curve-sheet 4.

$$\text{Motor capacity} = 10.8 \left(\frac{7,000}{5,280}\right)^{\frac{1}{2}} = 12.5 \text{ hp/ton.}$$

Energy per ton-mile = 92 wh (curve-sheet 3).

The results of the assumption of any other initial acceleration are obtained in the same manner.

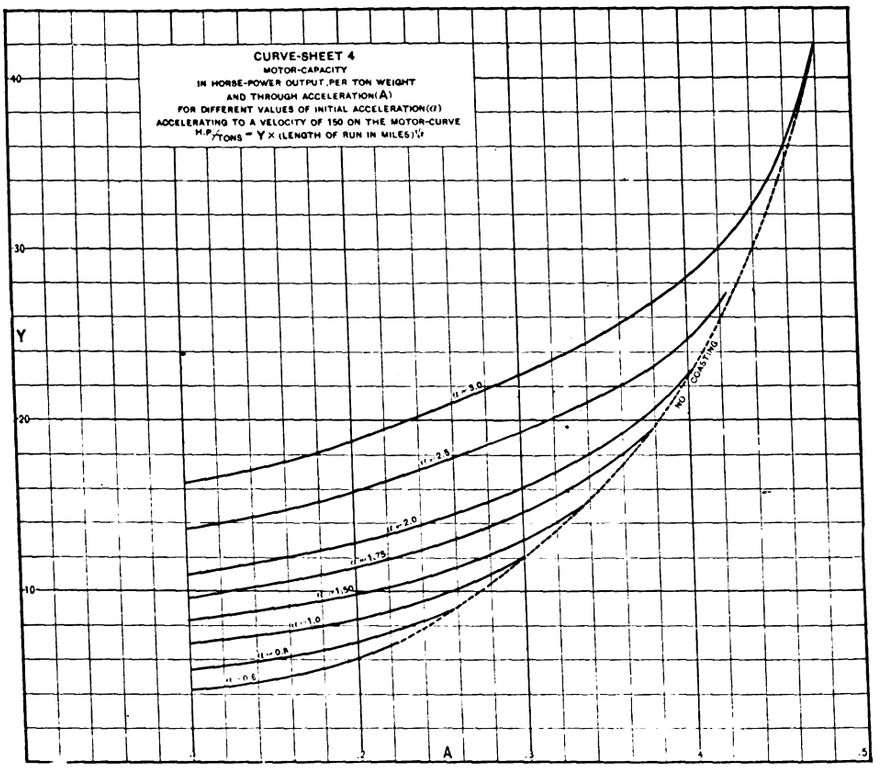
These calculations show that the energy consumption and motor capacity can be determined when the "through acceleration," the initial acceleration and the amount of use of the motor curve are given. As I show below, the initial and motor accelerations are fixed by considerations of heating; hence the conditions are entirely determinate.

The input and output of the motor when accelerating to any maximum velocity at any rate can both be obtained by integrating the appropriate power and velocity curves. A comparison of these figures shows that the efficiency for constant maximum velocity is practically independent of the initial acceleration. Both the input and output vary, but their ratio varies slightly; for instance, for a maximum velocity of 125, the input of the motor varies from 804 to 653 wh when the initial acceleration is varied from 0.6 to 3 mph/sec.; for the same range the output varies from 517 to 415; hence the efficiency then varies only from 64.3 to 63.5 per cent, a total variation of only 0.8 per cent for a variation from 0.6 to 3 mph/sec. in the initial acceleration. Sixty-four per cent may be considered the efficiency for a maximum velocity of 125, regardless of the initial acceleration. This is for the motor shown on curve-sheet 2, of which the efficiency at rated load is eighty-five per cent. For a maximum velocity of 175, the efficiency varies from seventy-one to seventy-three per cent.

Curve-sheet 7 gives the efficiency of this motor equipment in terms of the maximum velocity. The values of efficiency from this curve-sheet can be used with small error to determine the input from the output.

A deduction from the fact that the efficiency is independent of the initial acceleration is that the average heat loss is independent of the initial acceleration, which is also deduced directly. It is true that in the losses, friction loss is included, but the average friction loss from zero to a fixed maximum velocity will not vary with the initial acceleration; hence the difference, representing the heat loss, must be constant to the same degree of approximation that the efficiency is constant.

The formula following gives the work done at the car axle per ton-mile for various schedules, in terms of the through acceleration and the proportional part of the total time used in braking. This for-



CURVE-SHEET 4.

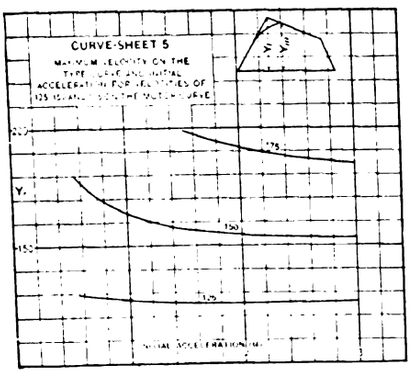
Time of total acceleration (OR) = 61.4 secs.

Time of total acceleration on type run (OD) = 41 secs.

Difference (DR) = 20.4 secs.

Time coasting on type run (DE) = 73 secs.

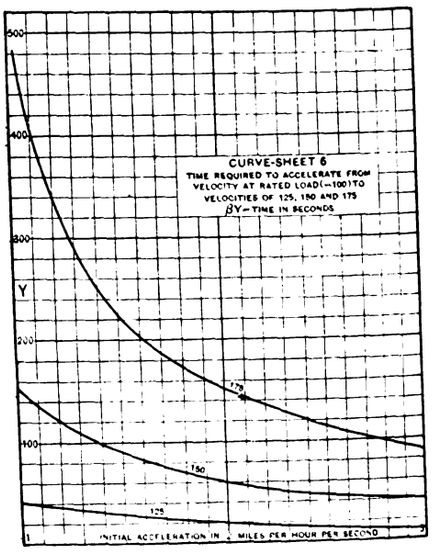
Difference, time coasting on motor-run (RE) = 52.6 secs.



CURVE-SHEET 5.

The various times are then,

Initial acceleration	(OP)	= 25.6 secs.
Motor acceleration	(PR)	= 35.8 "
Coasting	(RE)	= 52.6 "
Braking	(EC)	= 20 "
Total	(OC)	= 134.0 secs.



CURVE-SHEET 6.

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mula and the efficiency from curve-sheet 7 permit the easy determination of the energy input per ton-mile.

The formula for work per ton at the car axle is deduced by calculating the work of friction for the entire distance, and the kinetic energy at braking; by the substitution of

$$L = 0.682\ AT^2$$

the through acceleration is included, and hence the schedule. The formula is:

Work per ton-mile at car axle $= 180\,b + 90\left(c - b\right)\frac{c}{A}\left(\frac{z}{T}\right)^2$ wh

The first term, 180 b, gives the work of friction per ton-mile; the other term, the energy wasted in brakes per ton-mile. z/T is a function of the three accelerations, (a), (b) and (c), as well as of the through acceleration. Hence the values of z/T to be used in this formula must be obtained from curve-sheets plotted for the particular values of (b) and (c) that are substituted in the formula. Curve-sheet 1 is calculated for $(b) = 0.15$ and $(c) = 2$. Substituting these values in the above formula, it becomes,

$$\text{Work} = 27 + 333/A \times \left(\frac{z}{T}\right)^2 \text{wh}$$

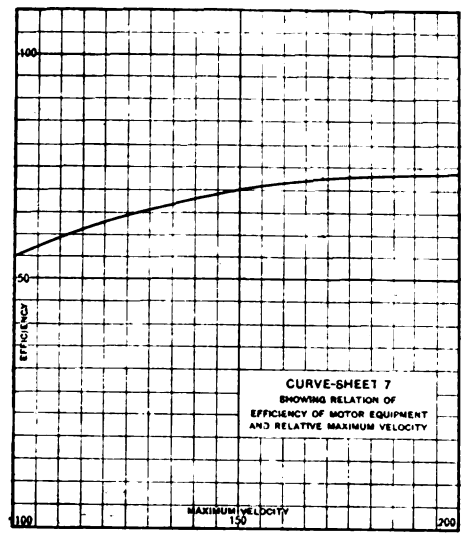
To apply this formula, find first the value of the through acceleration on the type curve corresponding to the through acceleration A on the motor curve, given by the data of the problem. Curve-sheet 8 gives this relation for a maximum velocity of 150. Having this value of A^1, the through acceleration of the type curve, select from curve-sheet 1 the value of z/T corresponding to that value of A^1 and of the initial acceleration in question. For example,

For A = 0.266
and velocity = 1.0

Curve-sheet 8 shows that A^1 equals 0.275. The value of z/T for this value of A^1 and for an acceleration of 1.5 mph/sec., from curve-sheet 1 is 0.15, substituting in the above formula the work per ton-mile at the car axle is found to be equal to fifty-six wh; the efficiency, from curve-sheet 7 is seventy per cent; hence the energy input is eighty wh. Curve-sheet 3 shows for the same conditions; *i. e.*, for $A = 0.266$ and $(a) = 1.5$, an energy input equal to eighty-three wh, an agreement sufficiently close.

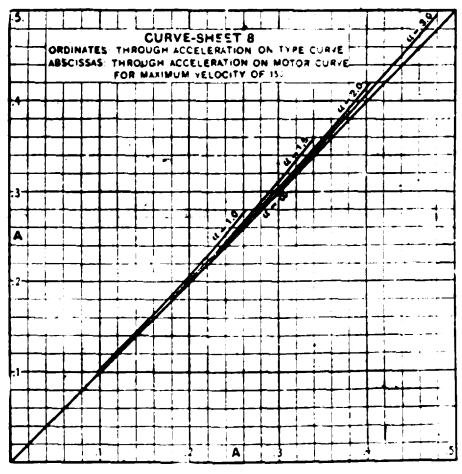
In the first paper, I assumed that an electric tramway motor in service will carry, on an average, a heat loss of three per cent of its "hour-load," with a temperature elevation of seventy-five degrees centigrade. This is a fair average figure, but individual motors differ greatly in their heating characteristics; hence I have elaborated the method so that it may be used for motors having any copper loss and any core loss, for any schedule with any initial acceleration.

For this purpose I determine the ratio of average loss to loss at rated load for the copper and core loss separately, and for the several initial accelerations; knowing then the ratio of average loss during



CURVE-SHEET 7.

acceleration to loss at rapid load, the average loss for any particular motor is found by multiplying the proper value of this ratio by the loss at rated load, separately for copper and core loss; the results added will give the total average loss during acceleration. These ratios of average to maximum loss were determined for velocities of 125, 150 and 175 on the motor-curve; that is, for maximum velocities twenty-five, fifty and seventy-five per cent greater than the velocity



CURVE-SHEET 8.

with resistance out. In describing this method further, it is to be understood that this procedure was followed in all cases; in other words, three separate sets of curves were carried through for the three maximum velocities, for the heat losses, for ratio of distribution, for motor capacity, for energy curves, and for the various other intermediate curves which were used as steps to the final results.

The rise of temperature of the parts of a motor, as determined by tests, depends upon the ratio of the distribution of the total heat loss between the armature and field; to apply such test results correctly this ratio must then be known for the various conditions; hence the ratio of distribution was calculated for the several initial accelerations and maximum velocities; the average loss during acceleration and its distribution having been determined in this manner, the average loss during the run will be known when the ratio of time of acceleration to time of run, for the various initial accelerations, maximum velocities and for all values of the through acceleration is known.

Having then the average loss during the run and its distribution between armature and field, the rise of temperature of a motor, used under the conditions of service fixed by any particular ratio of distribution, can be determined by comparing this calculated average loss with the rise of temperature per watt lost, for the same ratio of distribution, as determined by tests in service.

These steps required the preparation of nearly a hundred curve-sheets and some four hundred curves—the matter is too voluminous to present here in detail; I shall therefore give only the results and call attention to a few of the principal steps.

The ratio of average to maximum copper loss is definite and was determined in the usual manner by plotting values for the current and integrating.

(To be continued.)

American Institute Electrical Engineers.

ASSOCIATES ELECTED AT DIRECTORS' MEETING, NEW YORK, FRIDAY, OCTOBER 23, 1903.

Roy Harmon Adams, New Orleans, La.
Paul Lewis Anderson, East Orange, N. J.
Charles Fowler Baldwin, Antwerp, Belgium.
E. G. C. Barton, Brisbane, Queensland.
Elmer E. Beam, Ashtabula, Ohio.
Leon Beauchamp, Montreal, Quebec.
Ralph Bennett, Los Angeles, Cal.
James Dillon Brooke, New York city.
A. J. Byington, Santos, Brazil, South America.
William G. Chace, St. Catharines, Ontario.
Frank Ross Chambers, Jr., Seattle, Wash.
George Percy Cole, St. Louis, Mo.
J. H. Davies, Johannesburg, South Africa.
Ferdinand John Foote, Norwood, Ohio.
Hugo Fuchs, Chicago, Ill.
George Adam Fuchs, Erie, Pa.
Louis Brounell Hastings, Pittsfield, Mass.
Clarence Freer Hill, Philadelphia, Pa.
William Levi Hoffman, Wilkinsburg, Pa.
Samuel Huston, Kaukanhalli, Mysore State, India.
Gustav Adolf Juhlin, Preston, England.
Gaylord B. Kirker, Le Havre, France.
George Spangler Loutey, Philadelphia, Pa.
Irving Loveridge, Antwerp, Belgium.
Newitt Jackson Neall, Edgewood Park, Pa.
Will Harold Oldham, Johnstown, Pa.
Coleman Clyde Parks, Munhall, Pa.
Frederick Welles Prince, Hartford, Ct.
Yasuo Riko, Tokyo, Japan.
Robert Sibley, Berkeley, Cal.
Thomas O'C. Sloane, South Orange, N. J.
Worrall E. S. Temple, Pocahontas, Va.
Radley Mott Trille, Cienfuegos, Cuba.
F. T. Wright, Kensington, London, England.

TRANSFERRED FROM ASSOCIATE TO THE GRADE OF MEMBER.

William Howard Cole, Singapore.
Walter Atwood Hall, Lynn, Mass.
William Weedon Cole, Elmira, N. Y.
Walter I. Slichter, Schenectady, N. Y.

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The Administration Buildings at the St. Louis Exposition.

FROM its inception, the plans of the St. Louis Exposition have grown greater, the funds augmented and of necessity the area has been increased from time to time. When the Forest Park grant was found inadequate, the exposition turned to Washington University and secured a lease of the new campus. This tract has a frontage of 1,600 feet on the west side of Forest Park and contains 110 acres. A few of the buildings were completed and others in the process of erection, making eleven in all. The university buildings are of uniform Tudor-Gothic architecture and built of pink granite at a cost of $1,300,000. A complete system of lighting, ventilation and heating was installed so that in every way the buildings are adapted to the needs of the exposition. So complete were these facilities for housing the officials and carrying on the administrative business of the exposition that it has been a great help in expediting the work up to date.

The structure which is shown in the foreground became the Administration Building, and contains the offices of the president, director of exhibits, chief of the department of electricity and other officials. The building embraces fifty rooms and cost $225,000.

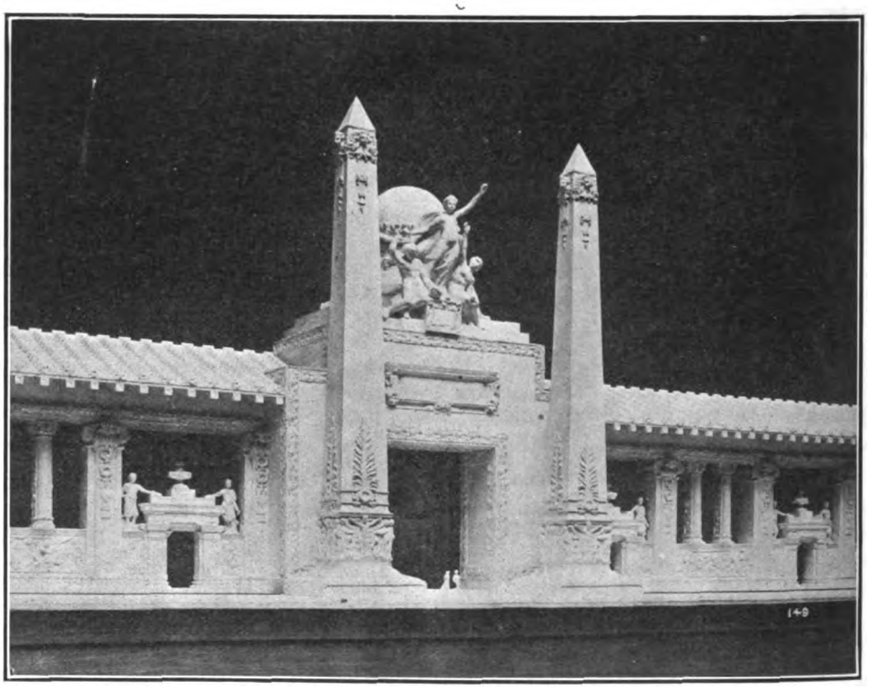
Perhaps the most beautiful building is the university library, which is to be the hall of international congresses during the exposition. It is situated directly west of the Administration Building and has a length of 257 feet and a depth of forty-six feet. There is also a structure in the rear of the centre of the library 110 feet long by forty-one feet wide. Four large assembly halls are available in the group, three 110 feet by forty-six feet, the fourth 100 feet by forty feet. The largest sections of the congresses will be held in this building. The smaller sections will be in the assembly and lecture halls and other buildings surrounding the quadrangle. In the library the international electrical congress will be held from September 12 to 17, 1904. From the interest already manifested the accommodations will be taxed to the utmost to take care of the foreign engineers of prominence who are expecting to visit the exposition at that time.

Cupples Hall No. 1, a structure 263 feet by 113 feet, erected at a cost of $150,000, will be occupied by the department of anthropology and ethnology. The south side of the quadrangle is formed by Cupples Hall No. 2, similar in form and dimensions to No. 1. This building is now occupied by the division of works.

West of the first quadrangle is the Physics Building, a granite structure, 178 by 69 feet and two stories high. Two projecting bays located at equal distances from the ends of the building surmounted by ornamental gables contain the entrances. This building is now being used by the board of lady managers. At the extreme west end of the campus is the gymnasium, 182 feet by ninety-four feet, erected at a cost of $150,000. Adjoining the gymnasium is the athletic field, 760 feet long, which will contain one of the finest tracks in the world, and an arena with a seating capacity of 25,000. Here the Olympian games will be held. These facilities will be available for the department of physical culture during the fair.

The other buildings are occupied as dormatories by the Jefferson Guards who police the grounds and buildings. On the extreme north side of the campus is the power-house, which contains seven 150-horse-power Wangler boilers supplying steam for power and heating. Three 150-horse-power, two-phase, 550-volt generators furnish current for light and motor power about the premises. From the power-house extend tunnels containing steam, water and electric mains running to the principal buildings. The main tunnel is six by eight feet in cross-section and 1,182 feet in length, from which run two branch tunnels, one 106 feet and the other seventy feet long.

Beauty, utility, comfort and convenience have been combined in the construction of these buildings, and when they are all completed Washington University will be as well housed as any college in the country. Both the exposition and the university have been mutually favored by this lease; the exposition by the splendid facilities already prepared, and the university by the addition of several hundred thousand dollars to its building fund.



DETAILS OF ENTRANCE. MINES AND METALLURGY BUILDING.

The Mines and Metallurgy Building at the Lousiana Purchase Exposition is unique in that from an architectural standpoint it is not approached by any of the other exhibition palaces. In fact, it has been spoken of by Mr. T. C. Link, architect of the building, as a type of "secession architecture," meaning by this a breaking away from conventionality in design, making the architecture of the building feelingly express the use for which it was built, rather than a construction along conventional lines and formulæ. The outside dimensions, 525 feet by 750 feet, confine an area considerable in excess of that provided by any other exposition for similar exhibits, and the arrangement of glass-covered arcades is such that the eight

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rectangular divisions of exhibit area are equally well lighted.

A striking feature of the building is the ornate façade surrounding it on all sides which will constitute one of the most attractive bits of sculpture on the grounds. This façade consists of great sculptured panels illustrating in bold relief mining and metallurgical operations in symbolical representations, the background being of a rough golden-colored glass. At night these panels will be illuminated from behind, causing the figures to stand out prominently. Above these panels ornate columns rise supporting the cornice. The main entrance is flanked by two gigantic obelisks, 150 feet high, and above each of the four major entrances rises a great sphere of gold.

The low pitch of the roof and the use of monster tiles add strength to the architectural scheme and create an impression of stability.

In the department of mines and metallurgy the particular feature that is being incorporated in the exhibits is the exhaustive display of processes and products. Raw materials, with forms of metallic ores, clays, coals, building stone, etc., will as usual have a conspicuous space, but the elaboration and exploitation of mining and metallurgical methods showing the means of producing the finished materials will be emphasized in a large degree. The following display might be mentioned as illustrating this feature of the exhibits:

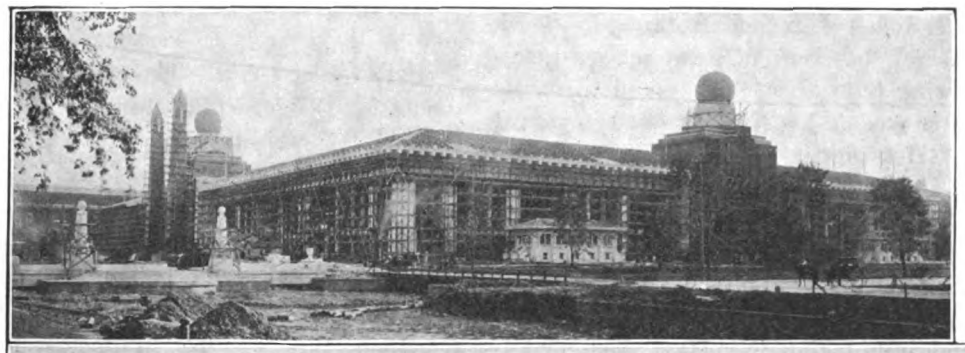
Operating exhibits of artesian and oil drills with the methods of using same, conducted on the open space southeast of the mines building. Here will also be located working mines and shafts, tunnels, etc., supplied with both electric and steam hoist operated so as to show the more modern methods of wire and rope transmission. These mines will have the advantage of operating on some of the well-known clay and coal strata underlying the exposition grounds and annexed territory, and the products will be conveyed by transmitters to tile and brick presses and there worked up into commercial forms by the most improved methods.

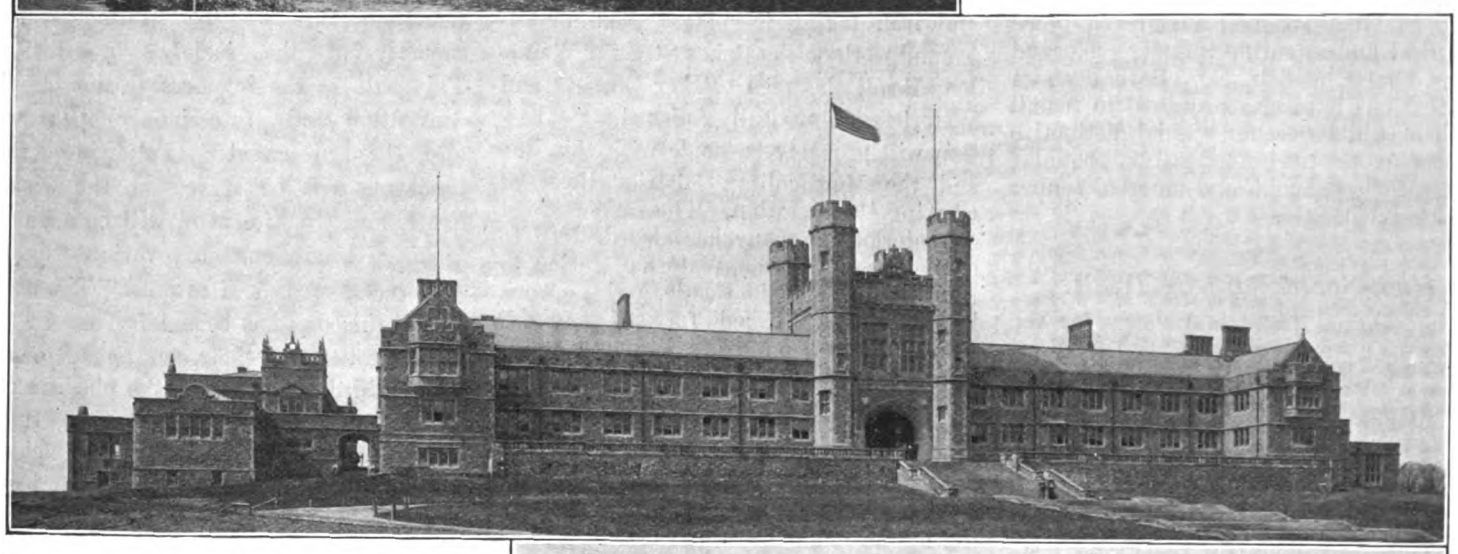
On this space will also be shown a full sized operating mill especially designed to crush and concentrate Missouri lead and zinc ores. This will be constructed with special reference to handling gold, silver and lead ores, such as constitute the more important mineral wealth of Colorado, Utah, California and the Rocky Mountain and Pacific Coast areas.

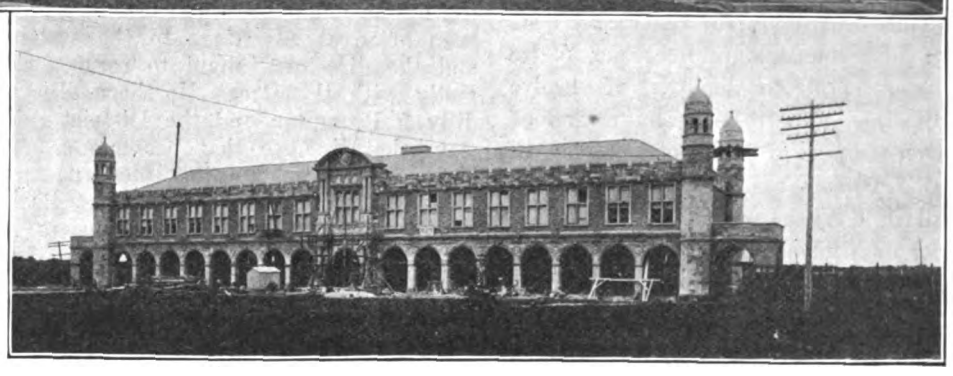
In order to meet the more popular demand there will be installed in contrast to the improved mills, ancient forms of the arastras and other primitive metallurgical devices. In this connection, after the metal has been extracted it will be made up by natives into the shapes utilized so long in their household economies.

In the main building covering an area of more than nine acres, under one roof, will be collected the best and most valuable natural mineral resources, together with many mechanical appliances designed for their utilization. These will include mills, rolls, crushers and concentrators of many designs and air and electric drills. Here also special care has been given to meet the full demands of the official classification and to display the best and most important in modern mining and metallurgical research.

Another special feature of the indoor display is the grouping of collective exhibits. Each of the states and foreign







1.—Mines and Metallurgy Building, St. Louis Exposition.
2.—Administration Building.
3.—Hall of Congresses.

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countries will display under its own control and direction what is best of its minerals, but there will also be collective exhibits in the following classification: clay and clay products; coal in many varieties with exhaustive analyses; iron ores and finished products with numerous forms of steel, with descriptive maps and models; petroleum and mineral oils, precious stones with the cut and polished gems, and the more recently discovered metals, with a specimen of radium and its compound.

In the foreign department such countries as France, Germany, Russia, Great Britain, Japan and China and the smaller principalities and republics have all applied for and have been granted liberal space, with the assurance that no effort will be spared to make their exhibits worthy of the opportunity offered.

The more technical and educational features will be represented by a fully equipped assay office, conducted by students and experts, and a fully equipped technical and scientific library, geological maps, charts, models, etc. Several states and nations have also promised to install in their exhibits certain special distinctive objects more likely to attract popular favor, such as gold and quartz, copper ores, telluride, etc.

High-Speed Railway Trials.

The original track laid down for the Marienfeld-Zossen experimental railway did not seem safe for speeds exceeding 160 kilometres per hour, because at those speeds the cars ran very joltingly, the rail showed signs of bending, and cracks were observed in the iron sleepers. The new rails since put down for the recent tests weigh forty-one kilogrammes per metre and were laid in lengths of twelve metres, the support being by means of eighteen sleepers of pine wood per length of rail. Broken basalt was employed as a ballast. As a preventative measure against derailment, a guide rail was laid along each rail, the slot being fifty millimetres wide; but so far these rails do not seem to have come into actual use. It is said that the cars now run as quietly at 200 kilometres per hour as formerly at from 130 to 140 kilometres per hour, and that it is possible for the passengers to write notes when either standing or sitting in the moving car, at its highest speeds. The primary voltage during the successful runs was 14,000 volts. Trouble had been experienced previously from vibration of the line conductors and poles, but since the collecting bows had been made lighter and were better sprung, no further trouble had been experienced in this direction. The wheel base of the trucks was increased from three and one-half to five metres, and the central pivot was allowed some lateral movement.

Underground Electric Railways Company, of London.

At a recent meeting of the Underground Electric Railways Company, of London, Mr. Charles T. Yerkes gave an encouraging account of the progress of the work. Mr. Yerkes said that the company's power-house would be the largest of its kind in existence, and that the work on this was going on most satisfactorily. The electrification of the Metropolitan District Railway is progressing rapidly. The line put in and working to South Harrow has been of great service in allowing tests of machinery and materials to be made. Experiments tried in regard to safety devices have been very exhaustive, and to guard against fire, nothing with which the current comes in contact will be inflammable. The use of wood in the company's stations, for platforms and stores, will be done away with, cement and iron taking its place. The underground work on the Baker Street & Waterloo Road, between Baker street and Waterloo, is practically finished. Connection will probably be made with this line and the Metropolitan District Road at Charing Cross station. The Baker Street & Waterloo Company has also decided to extend its lines from Waterloo station to the Elephant and the Castle, and the work is now being pushed forward rapidly, while the extension from Baker street to Edgeware road is about to be commenced. After completion, this line will be carried on to Paddington. Great progress is being made on the Great Northern, Piccadilly & Brompton and the Charing Cross, Euston & Hampstead lines. The acquiring of the London United Tramways has been of great advantage to the system, and the directors intend to connect directly with the Great Northern, Piccadilly & Brompton and the District railways that line, so that passengers may have an almost uninterrupted passage from Bow, and also from Finsbury Park.

An Electric Sleigh.

During the coming winter the Allgemeine Elektricitäts Gesellschaft will conduct trials with an electrically operated sleigh on what is known as the Haidebahn, a trackless trolley on the line between Dresden and Klotzsche on which electrically propelled carriages are run for passenger transport. The vehicle will be similar to the electric carriage, but with the difference that the hind pair of wheels will be replaced by a pair of sleigh runners, and the driving wheels will be fitted with tires specially designed for taking hold on slippery surfaces. Experiments were made with a vehicle of this type last winter, and they were sufficiently successful for further trials to be made this year.

The American Society of Mechanical Engineers.

Owing to numerous delays in the receipt of papers for the December meeting of the American Society of Mechanical Engineers, the issue of the programme of the meeting will be a little late. For this reason a brief outline of the programme will be of interest.

The headquarters of the society will be as usual at the society house, 12 West Thirty-first street, where the opening session will occur on Tuesday evening, December 1, at 9 P. M. The president Mr. James M. Dodge, will deliver the annual address, the subject being "The Value of an Engineering Education to a Young Man."

The second session will occur on Wednesday morning, at the hall of the Mendelssohn Glee Club, 113 West Fortieth street, because of the limited seating capacity of the society's auditorium. This will be the business session of the convention and professional papers will also be presented. Following this, luncheon will be served at the society house, and the afternoon will be spent in making excursions to various power stations and points of interest. The evening of this day has been left free for the members to make their own engagements.

The third session will take place in the Carnegie Laboratory of Stevens Institute on Thursday morning at 10 o'clock. Luncheon will be served at the institute, and will be followed by visits to various points of interest in and about the grounds.

The usual reception for guests and friends will be at Sherry's on Thursday evening, at 9 o'clock, and will be followed by dancing and supper.

The closing session will be at the society house on Friday morning, December 4, at 10 o'clock.

The following nominations for officers of this society for the coming year have been announced by the nominating committee.

For president—Mr. Ambrose Swasey, of Cleveland, Ohio.

For vice-presidents—Professor D. S. Jacobus, of Hoboken, N. J.; Mr. M. L. Holman, of St. Louis, Mo.; Mr. William J. Keep, of Detroit, Mich.

For managers—Mr. George I. Rockwood, of Worcester, Mass.; Mr. John W. Lieb, Jr.; of New York city; Mr. Asa M. Mattice, of Pittsburg, Pa.

For treasurer—Mr. William H. Wiley, of New York city.

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Single-Phase Repulsion Motors.

To the Editor of the Electrical Review:

Mr. William Cramp in his paper on single-phase repulsion motors read before the British Association and published in the Electrical Review, October 17, mentions two main difficulties in the way of the introduction of this type of motor. These are sparking at the commutator and the low power-factor. It would be interesting to know whether Mr. Cramp has tried either of the methods suggested by Mr. Alexander Heyland for overcoming these troubles in the operation of commutating alternating-current motors. The first of these is the use of a spark-absorbing resistance between the commutator segments to reduce the sparking, and the second, connecting the brushes to the secondary terminals of a small auxiliary transformer whose primary is in series with an adjustable resistance across the mains that supply the motor stator. The writer found that the latter method brought the power-factor of a two-horse-power motor completely into control, but in order to get exactly unity of power-factor, adjustment was necessary after each change of load. However, by adjusting for light loads, the motor took a slightly leading current for heavier loads, which ordinarily is not objectionable. Motors thus equipped behave very similarly to compound-wound direct-current motors. R. M. Gaston.

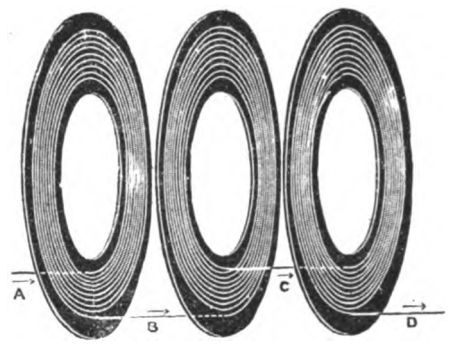
Chicago, October 27.

Road Traction by Electric Vehicles Using the Trolley Automobile.

At a recent automobile congress held in Paris, M. René Koechlin reported upon the utility of the trackless trolley, that is, an electric road vehicle drawing its supply from an overhead line. The different systems were first explained and the performance of these vehicles described. They possess many of the advantages of the electric car, climbing grades easily and turning within a very short radius. The practical speed of running is fourteen kilometres an hour. The supply is generally continuous current at 550 volts. Contrary to what might be supposed, the consumption of energy by an electric carriage is practically the same as that of a car running on rails. This is explained by the fact that these vehicles, on an average, do not weigh more than four tons, and though the power required may be twice or three times that per ton-kilometre for the electric railroad car, it is practically the same per car-kilometre. Practical tests have shown that the consumption of energy for an electric carriage varies according to the condition of the road and the grades, but for a line with grades of not more than three per cent, it is between 450 and 800 watts per car-kilometre, or about 110 to 200 watts per ton-kilometre. In climbing grades the power required is less than for the electric car, because of the lighter weight of the carriage. The price of a completely equipped omnibus is given as $3,400. It is thought that such lines should find a very useful application where traffic is light; but where it is comparatively heavy, a railroad should be built.

New Winding for Induction Coils.

A new method of winding the secondaries of induction coils has been devised by Mr. Leslie Miller, of 93 Hatton Garden, E. C., London. In this system the secondary winding is made in vertical layers one turn deep, as shown in the accompanying illustration, the successive layers being insulated from each other by paper discs. The winding is done by a machine and is continuous, without joints or crossings, the successive layers being wound alternately from the inside and



New Winding for Induction Coil.

from the outside. The advantages given for this method of winding are that an internal breakdown, due to the coming together of wires between which a high potential exists, can not possibly occur; the secondary winding can be compressed to any extent; there is a low ohmic resistance of the secondary, and the coils will stand any climate. A twelve-inch coil, when constructed by this method and worked with twenty-four volts and an ordinary mercury break, will fully light up five or six X-ray tubes at one time when connected in parallel. By a slight modification of the winding machine it can also be used for producing non-inductive resistances.

The Vienna Academy of Sciences has appointed a committee to study pitchblende, the mineral from which radium is derived. Baron Auer von Welsbach has placed his laboratories at the service of the committee during its researches.

A Sliding Railway.

The novelty of the railway system as described in the *Revue Technique* by M. G. Sautereau consists in doing away with the running wheels of the cars and replacing them with slippers or skates. The cars are raised on a thin film of water, which is forced under the skates through a jet. In the earlier plans the propelling force contemplated was a horizontal jet of water, which was directed against suitable vanes on the bottom of the cars. The valves of these jets were opened by the leading car and closed by the rear one. In the plan as at present proposed, a third rail is laid between the two gliding rails, and a friction wheel, driven by electric motors, runs on this and furnishes the propelling force. The advantages claimed for this system of traction are a great reduction in the track resistance and in the power required by a car, a much smoother running of the cars, and hence a smaller depreciation, both of track and car. There is no danger of derailment, and high speeds can be attained. By cutting off the water supplied under the skates, a great braking effect is secured. Figures are given to show the economy of the system over electric traction on wheels.

Canadian Society of Civil Engineers.

An electrical section of the Canadian Society of Civil Engineers has been formed. It will hold monthly meetings from October to April. The schedule of subjects for discussion at the various meetings of the current season is as follows: October 15, "Electrical Equipment of Some Canadian Hydroelectric Power Plants;" November 19, "Alternating-Current Motors for Traction Purposes;" January 7, 1904, "The Relative Cost of Producing Power by Steam and by Water under Different Conditions;" February 11, "Recent Developments in Electric Illumination;" March 18, "The Use of Electricity on Canals;" April 17, "Power Station Design and Operation as Affected by Recent Advances in the Design of Turbo-Electric Machinery." Professor R. B. Owens is the president of this section of the society.

Index of the Technical Press.

The October issue of the *Index of the Technical Press,* a monthly index to the technical journals of the entire world, contains over 2,000 references to articles of interest and importance. These references give the title of the article, its length, and indicate its nature. The *Index* is published in Brussels, the New York office being at 220 Broadway.

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Some Notes on the Commercial Features of European Lighting Practice.

At the nineteenth annual convention of the Association of Edison Illuminating Companies, held at the Frontenac, Thousand Islands, N. Y., September 8, 9 and 10, 1903, Mr. Arthur Williams contributed an excellent paper on the subject of "Some Notes on the Commercial Features of European Lighting Practice." This paper has just been transmitted to the press for publication, and an abstract follows:

At the time of my arrival in London, the finishing touches were being placed upon the decorations erected in honor of the visit of the French President, and I was, therefore, given opportunity to make comparison between London methods and those of the larger American cities. In a general and well-designed display of banners and bunting, they were not materially different, but there was a marked absence of the use of electric light as a decorative or illuminating feature. Only a very few electrical installations were to be seen and they were on a small scale. The decorations included a great many painted signs and monograms, but none, as far as I am aware, having electrical treatment.

Likewise at the gala opera, given by command of the King, at Covent Garden in honor of the President, there were no electrical decorations, such as those in the Metropolitan Opera House in New York city for the reception of Prince Henry of Prussia. Seemingly the only additions to the permanent installation were the lamps at the temporary entrance enclosed for the royal visitors, and for the illumination of the royal box in which they sat. The auditorium was beautifully decorated with artificial flowers, but the possibilities of the decoration were not brought out as they would have been were decorative lighting freely used in addition.

There seems to have been a very great increase in arc lighting on London's streets. The prices paid by the municipality vary from $110 to $150 annually for an arc lamp of about the same size as our lamp rated at 2,000 candles. The practice is to place the lamps much nearer together, in many instances averaging not more than 100 feet apart, and the result is a degree of lighting which would offer a useful, impressive example to those in charge of that kind of service in most of our American municipalities. The city furnishes the posts and shades; the companies provide all else, giving the lamps the usual attention.

Enclosed arc lamps have made very little headway; the few to be seen are of a design less satisfactory than that with which we are familiar here, and for the most part they have not given satisfaction to the users. The reason the English engineers adhere so devotedly to the open lamps is that in London and other English and European cities, the price of labor and carbons is low, while the cost of current is high—the reverse being true in our American cities.

The Siemens-Halske company has placed upon the market a very small enclosed arc light, called the "Liliput;" in deference, I presume, to its lack of size. It is even shown in the conventional desk standard, in which heretofore the incandescent lamp has been supposed to find an exclusive field.

"Bremer" lamps are seen frequently on the streets. The outside of one hotel or restaurant on Piccadilly Circus is strikingly illuminated by them. The color of the light, however, is not pleasing, and I question whether, unless changed, the lamp will soon become very popular. It is said that about 150 are now used, with very great satisfaction, for lighting the streets of one district—that surrounding the East India docks. The lamp has recently been improved, and I understand that all now in use are to be replaced with the new type as soon as practicable. The object of the improvement is to do away with "fluttering," which heretofore has been a chronic defect. As all doubtless know, these lamps burn two in series, about fifty volts each, on a 110 to 120-volt circuit.

These lamps, as incandescent lamps and all other features of the installation, must be purchased by the consumer, but to ensure good service, the manufacturer, the Westinghouse company, arranges for their care at a cost of ten shillings, or $2.50, weekly, for two; the price including inspection, carbons and repairs, but not the current supply. The responsibility of the company supplying electric current ends at the meter, and so everybody seems to understood. This I think is not conducive to best service. It compels the customers to purchase incandescent lamps, without expert knowledge and at a price in excess of the cost of lamps to the supplying company, tending thus to prolong their use until breakage, however blackened or low the candle-power has fallen. The incandescent lighting standards are low, and as the service rendered by the companies is said to be very satisfactory—it is evident that they are carefully managed—the cause must be found in the lamps.

In the business sections one sees little gas lighting, and it is said that there is but one oil lamp installation in the city—and that that is going out. The "Lucas" lamp, comparing with the "Northern" here, is used, but apparently not to any great extent. Electric light seems to have little, if any, serious competition.

Nernst lamps, large and small, are to be seen frequently on the principal thoroughfares, and the light is of very satisfactory quality. A number of stores use them exclusively. Plain, ground or opalescent glass globes are used, with vertical spiral glowers—distinct from the horizontal straight glowers with which we are familiar in American practice. Large lamps, consuming about 250 watts, cost the retail consumer $5; small lamps, $1.25; large glowers cost fifty cents, the small, thirty-seven and one-half cents. They can be used with either alternating or direct current—those I saw using the direct current.

A Nernst projector lamp of 1,000 candle-power has been made. The lamp consists of three glowers, in parallel, placed on a white enamel disc of about two and one-half inches diameter. About 300 watts are consumed and hand control is substituted for the usual automatic control.

A representative of the manufacturers stated that 400,000 of these lamps, sixty per cent small, the remainder large in size, were sold in England during the last year. It should be remembered that the incandescent lighting standards are generally low, and therefore a greater relative growth than would be possible here should be expected.

There are thirty-six companies or vestries in London operating electric lighting plants. The aggregate of the installations, on the sixteen-candle basis, is 2,476,491 equivalents. This is largely incandescent lighting; the motor installations aggregate hardly more than 5,000 horse-power, and the arc lamps something less than that number.

It has been stated that thirteen of the companies or vestries use Wright meters, not exclusively, but in conjunction with their rates. The companies using these meters control about forty-five per cent of the total installations, but I have no data as to the number of meters used, or on the percentage of current sold through them. The manager of one of the largest companies stated that though he was reported as using this system of discount, he actually had only a few of the meters. The Shattner demand meter is also in use; one advantage being that it can be

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made fast or slow, as desired, by simply changing the medium through which the balls fall.

So much has been devised and said concerning electric lighting rates that it would seem as though nothing new were possible. Yet I had not previously heard of the rate recently adopted by the St. James & Pall Mall company for long hour, usually hidden lighting; by hidden I mean the lighting of hotel, apartment house and club cellars, kitchen and servants' quarters, shops below the sidewalk level, basements and the public conveniences, which the city of London has liberally provided at the large intersections. The retail rates of this company are twelve cents a kilowatt-hour for the first 4,000 kilowatt-hours of annual use and eight cents for all over, with a discount of eight per cent on all bills paid quickly—say, within thirty days. To meet the competition of gas in the places mentioned, the company has adopted a new schedule, under which all "below street level" lighting is supplied at exactly half the usual rates. That is to say, the first 4,000 kilowatt-hours are charged for at six cents instead of twelve cents, and the remainder at four cents instead of eight cents—and the additional discount of eight per cent is also allowed.

If the consumer's premises are half above and half below the street level, he is given the benefit of a liberal interpretation of the schedule, and charged altogether at the low rates. Separate meters are provided where necessary to separate other parts of the premises supplied at the higher rates. This schedule has been very successful in competing with gas service.

Reverting again, momentarily, to rates, it may be of interest to know that one company charges twelve cents a kilowatt-hour for service at 100 volts and ten cents where taken at 200 volts. This method has been adopted, I infer, to encourage a general change of installations to the higher voltage. Another company, or rather one of the borough councils, charges sixteen cents a kilowatt-hour for the first hour of the maximum demand, and two cents for all over—a schedule representing, I believe, the extreme views of Mr. Arthur Wright in connection with the Wright demand system. Another company has recently entered upon a large contract for lighting and power service, under which the consumer pays $75 annually for each kilowatt of maximum demand and two cents for each kilowatt-hour consumed. The demand rates of this company are also interesting: for the first quarter, ending with March, the charge is, for the first six kilowatt-hours consumed per eight-candle-power lamp, or equivalent, sixteen cents a kilowatt-hour, and for all excess, four cents; for the quarters ending with June and September only the first three kilowatt-hours of average use are charged for at the higher rate, the remainder being charged for at the lower rate; the quarter ending with December, filling out the year, is again increased to an average of six units at the higher rate, as with the first quarter. Power is sold at five cents a kilowatt-hour for the first 250 kilowatt-hours of annual consumption per kilowatt of installation and two cents for all consumed in excess.

It should not be forgotten, when considering English terms, that the consumer buys everything beyond the meter, and therefore, on any prices given, fully one and one-half cents a kilowatt-hour should be added to get an American comparison.

The Shoreditch destructor works, of which so much has been said, are still in operation. This plant, it will be remembered, was erected for the purpose of burning the garbage of the district, utilizing the heat for making steam, the live steam for operating an electric light plant, and the exhaust for heating the water of the municipal bath of the district, and in winter for heating the district library. These several departments are located contiguously in the same block, but front on different thoroughfares. A second lighting station, some distance from the first, has now been erected, the capacity of which is about 1,600 kilowatts, but it is operated entirely with coal fuel. The destructor works remain substantially as they were when first finished, though because of the larger demand for electric current and the somewhat lessened supply of débris, I believe more coal is now being consumed than formerly. The consumable débris of the district amounts to 25,000 tons annually and gives sufficient heat to produce 1,000,000 kilowatt-hours. It is estimated that garbage produces on the average one-tenth the heat of ordinary coal.

Curiously, the garbage supply is decreasing. This is because dwelling-houses are being gradually replaced, as the city pushes out, by factories and stores, which in proportion contribute less. The new inhabitants, however, demand more light and power service, so that the works can well afford to burn as much additional coal as may be required.

The figures showing the result of last year's operation seem to make it difficult to prove that the electrical are paying features of the plant. There was a balance of $20,000, after all charges were met, credited to the sinking fund, but this amounts to only 1.5 per cent of the cost, a rate of depreciation demanding an active life in excess of fifty years to equal the original cost of the plant.

The use af arc lamps for the street lighting of Paris, as in London, has increased largely in the last two years, the greatest change being in the centre of the city. Open burning lamps are used, again because of the low cost of carbons and labor and the high cost of current. The lamps are spaced apart on an average not exceeding 100 feet; in some places the distances are much less. There seems to be no desire on the part of the city officials to utilize the private window lighting for the illumination of the thoroughfares, and this is well, for there is little, if any, display lighting of that order that is worth mentioning.

Where electric light is not used, there are Welsbach burners, which, with the surrounding glass case, are maintained in excellent condition. This is true of the narrowest and least important as well as of the largest and most thickly traversed thoroughfares. On some of the streets, such as the Rue de la Paix, in the centre of the city and as yet untouched by the electrical invasion, posts, supporting three lanterns, each containing a large Welsbach mantle, line up on both sides of the street, and are not more than twenty-five feet apart.

Ordinary gas burners seem to have disappeared from the shops of the city. Either Welsbach mantles, which are most common, or some similar form of burner, much larger, are mostly to be found. Some of the larger theatres and concert halls still use gas for decorative lighting, though this is true to a less extent than formerly. The maximum price of gas is $1.80 a thousand cubic feet, which also must be the minimum price, as under the law a reduction made to one gas consumer must be made to every other consumer conducting a like kind of business.

The companies supplying electric current are limited in their franchise to a maximum price equaling thirty cents a kilowatt-hour, but there is no limitation upon the extent to which this price may be reduced. The average price obtained is about twenty-two cents a kilowatt-hour.

Companies making electric current inside the city's walls pay a tax of five per cent on their gross income, while those which generate outside the walls, thus

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avoiding the duty paid upon coal brought within the fortifications, pay one per cent additional, or six per cent

The cost of municipal arc lighting, where supplied by private companies, is at the rate of $240 annually, but the annual expenditure is in many cases lessened through the disconnection of the lamps at midnight or shortly thereafter. As the companies are taxed upon their gross income, this figure is reduced five per cent or six per cent, as the case may be, so that the net cost is not far from $225 a lamp annually.

At the end of 1901 the five private companies and the municipal plant of Paris had 68,267 kilowatts of installation, equaling 1,365,340 sixteen-candle equivalents. The capacity of all the stations was 38,000 kilowatts, or fifty-six per cent of the installations. 27,322,000 kilowatt-hours were sold, the consumption averaging about 400 hours per unit of installation.

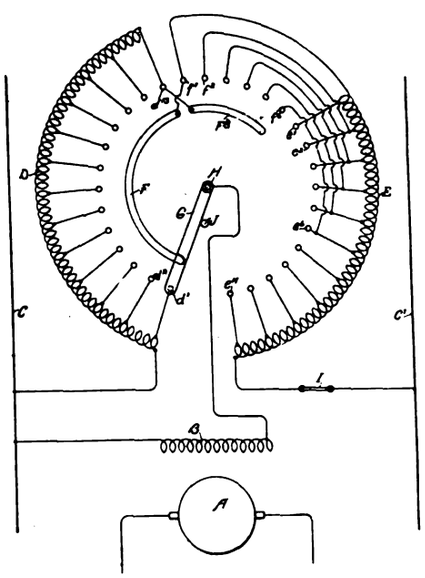
A very interesting map has been prepared by the engineer in charge of the municipal works, showing in each of eighty-three small sections, into which he divided the city, the installation capacity in kilowatts, the kilowatt-hours consumed annually, and the average use of each unit of installation. For example, one, a rich residential section, is shown where 3,387 kilowatts installation have an average use of only 161 hours annually; a second, next it, having 1,895 kilowatts, averages only 147 hours. The business and small shop sections appear better; in one 2,301 kilowatts were used an average of 585 hours; in another, 1,717 kilowatts an average of 887 hours, and in still another, 135 kilowatts averaged 734 hours. A section in which the installations are largely for city lighting, having 102 units averages 3,061 hours; another, also devoted to city lighting, having twenty-six units of installation, averages 2,284 hours. As stated previously, the average of all is 400 hours.

Tribute to Volta.

The secretary of the British Institution of Electrical Engineers reports: The bronze shield subscribed for by the students of the institution at the beginning of the present year has now been placed upon the tomb of Volta, at Camnago, Italy, near Como. The ceremony of fixing it in place was performed on Sunday, October 4, with many expressions of international good feeling, in the presence of Professor Count Alessandro Volta, Cav. Franchi, the Sindaco of Camnago, with several members of the Volta family and a number of other guests. The shield is mounted on a slab of green marble supported on granite in front of the tomb. The electotype reproduction, which was officially deposited on the tomb on the occasion of the visit of the institution in April last, has been transferred to the Civic Museum in Como, where it is placed in the collection of Volta relics.

Electrical Patents.

Mr. Leonard Wilson, of Pittsfield, Mass., has assigned to the Stanley Electric Manufacturing Company, Pittsfield, Mass., a patent recently granted to him on an electric rheostat. Referring to the illustration, A represents the armature and B the field of a separately excited generator. CC^1 are the exciter bus-bars. D and E are the resistances connected at suitable intervals to contact buttons d^1 d^2, etc., and e^1 e^2, etc., respectively. f^1 f^2, etc., are extra contact buttons connected to e^1 e^2, etc. F is a contact strip connected to f^1. F^3 is a contact strip connected to d^{13}. G is a rotary arm pivoted at H, connected to one end of field B and adapted to make contact with the contact buttons and with the contact strips F and F^1. I is a switch for opening the field and rheostat circuit. J is a stop for rheostat arm G. The operation will be



A New Type of Rheostat.

obvious: Assume, for example, that the voltage between exciter bus-bars CC^1 is one hundred and that the values of resistance of field B, of resistance D and of resistance E are twenty ohms each. Now starting with the arm G in the position shown, field B is short-circuited, and no current flows through it. As arm G is moved along contacts d^1 d^2, etc., and in contact with strip F the resistance shunting-field B is gradually increased and more and more current flows through field B until when arm G reaches d^{13} all of resistance D is in shunt or parallel circuit with field B and all of resistance E is in series with the parallel circuit. The resistance of the circuit between bus-bars CC^1 is now thirty ohms. The current is therefore three and one-third amperes, one-half of which, or one and two-thirds amperes, flows through field B. As arm G moves from d^{13} to f^1 and from F to F^3 no change in resistance takes place. Now as arm G is moved along contacts f^1 f^2, etc., part of resistance E is gradually cut out until when arm G is in contact with f^6 half of E is cut out. The resistance of the circuit between bus-bars CC^1 is now twenty ohms. The current is therefore five amperes, one-half of which, or two and one-half amperes, flows through field B. Now as arm G passes to e^1 the connection with contact strip F^3, and consequently with resistance D, is broken, while all of resistance E is placed in series with field B. The resistance between bus-bars CC^1 is now forty ohms. The current is therefore two and one-half amperes, all of which passes through field B, since field B is no longer shunted. Thus it is seen that the current through field B is not changed by moving arm G from f^6 to e^1. It will of course be understood that the step from f to e^1 may be so arranged as to produce a small change in the current passing through field B proportionate to the other steps. This could be accomplished by so arranging the contacts in relation to resistance E that a little less than half of resistance E would be cut out when arm G is in contact with f^6. Now as arm G is moved along e^1 e^2, etc., resistance E is gradually cut out until when arm G is in contact with e^{11} field B is connected directly across the exterior bus-bars. The current through field B is now five amperes, the maximum value.

General Electric Company, a corporation of New York, has purchased from James J. Wood, of Fort Wayne, Ind., a patent. The invention relates to means for preventing or reducing fluctuations occurring in rotary motor devices, such as steam engines, turbines, impact-wheels, or other prime movers, as well as secondary motor devices, such as dynamo-electric machines, electric motors, rotary converters, and the like. The invention is applicable whenever in such a rotary motor fluctuations from a uniform rotation are liable to occur by reason either of variations in the propulsive energy or variations in the work or load, which variations recur at frequent intervals, so that they tend to produce alternate accelerations and retardations of the motor, such as are known in the art as "hunting" or "pumping." Another application for patent still pending covers a device for preventing such fluctuations particularly with reference to synchronous dyna-

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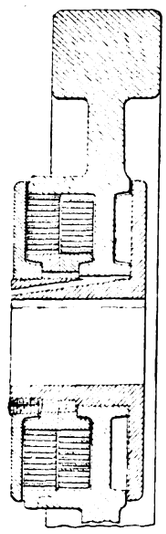
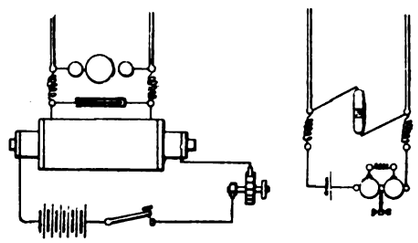
mo-electric machines, such as alternating motors or rotary converters. In operating such machines, the hunting or beating action is usually indicative of some irregularity in the circuit feeding the motor. This irregularity may consist of variations either in speed or in electromotive force. The variation in speed of the generator tends to cause a corresponding variation in the speed of a synchronous motor. The motor can not, however, assume instantly the speed required by the new speed of the generator. When the speed of the generator increases, the motor-armature begins to increase in speed; but by reason of its lagging the motor receives an increased current, because its armature is not in normal position for the new frequency and because additional current is required for supplying the energy necessary for increasing its speed. This additional current produces a difference of magnetism of the field, which must again be altered when the generator speed decreases below the aver-



SECTION OF FLYWHEEL AND SLEEVE, SHOWING ARRANGEMENT OF SPRINGS.

age. The motor is therefore undergoing a slight variation in speed, which seeks to approximate to, but does not exactly correspond with, that of the generator. As set forth in the application with particular reference to synchronous alternating motors, the inventor overcomes this defect and avoids interference with the line by applying to the shaft of the motor or a shaft rotating therewith a flywheel of suitable weight, which is yieldingly connected to the motor, preferably by being free to turn upon its driving-shaft, a spring connection being interposed between the flywheel and its shaft so as to oppose relative movements of the motor and flywheel in either direction. The degree of such relative movement preferably corresponds to the angular distance between two adjacent poles of the armature. The spring connection therein shown comprises a coiled spring or springs interposed endwise between abutments formed upon the flywheel and its shaft, said springs being compactly arranged between these parts and suitable stops being provided for limiting the strain upon the springs. While well adapted for use with motors in which the angle between the poles is not considerable, as is the case with motors having a relatively great number of poles, difficulties have been encountered in adapting such devices to motors having comparatively few poles. This is due to the fact that because of the relatively great angle between the poles springs of this character are not well adapted to permit the necessarily extensive rotary movement of the flywheel in a connection which provides the requisite compactness, durability and strength. In the later invention the aim is to provide a construction which is especially adapted for use with motors having two or more poles, while retaining the advantages of the construction just described. In its preferred form the invention which provides a connection between the flywheel and its shaft, which comprises a pair of spiral springs, preferably involute springs, each connected at its opposite ends to the flywheel and its shaft, respectively, and the springs reversely arranged so that relative movements of the flywheels and shaft in both directions are resisted by the tension or compression of the springs exerted in such manner as to tend to wind or unwind them. The springs preferably encircle the axis of rotation of the flywheel and are suitably housed or enclosed, preferably within the flywheel. Certain other features of improvement are provided in the construction and arrangement of the parts.

An English electrician, Mr. Sidney G. Brown, of Bournemouth, England, has patented in this country an improvement in a system of wireless telegraphy. Accordingly the transmitter apparatus is provided with two radiating wires coupled one to each terminal of the sparking device, and the receiving apparatus is provided with two receiving wires coupled one to each terminal of the coherer. These radiating and receiving wires are respectively placed at a distance apart which has a definite relation to the length of the signaling waves, that of half a wavelength or approximately half a wavelength being the most convenient distance. This placing of the wires half a wavelength apart causes the system to send its waves or to receive them from mainly one direction, which direction would seem to be that of the plane of the wires. If the vertical wires were not so carefully adjusted to the wave-length, they would transmit or receive the Hertzian waves from any direction. By arranging a condenser across the high-potential terminals of the spark coil and joining the terminals of this condenser to the spark-balls through highly inductive coils, the persistence of the waves can be increased, the conductor acting as a storage of power and maintaining the condenser at each side of the spark-gap. The highly inductive coils prevent the charge in the condenser from oscillating across the spark-gap. By thus increasing the persistence of the train of Hertzian waves due to each disruptive discharge the receiving circuit can be caused to be in tune or syntony with the transmitting circuit, thus rendering the system more sensitive and less likely to be interfered with by neighboring systems differently disposed. The wave-length that any system may generate is to a certain extent under command, and it is necessary if parabolic reflectors are to be used to keep the waves



SHOWING SENDING AND RECEIVING APPARATUS, WIRELESS TELEPHONE SYSTEM.

short. This can be done by suitably arranging the spark-gap, such as by employing suitably sized intermediate balls or by placing inductive coils in the arms of the radiating wires. By thus keeping the length of the waves short the use of parabolic mirrors behind the radiating and receiving wires and within a much shorter distance of said wires than that of their length or half their length is rendered possible. These mirrors which should be constructed of reticulated metal, such as fine wire netting or its equivalent, have the effect of reflecting the waves to or receiving them from one definite direction, and thereby restricting the wave or telegraphic effect to a given direction. The coherer preferably employed is electrically or magnetically controlled in such manner that immediately after a signal has been received the electric or magnetic controlling force decoheres or renders the coherer non-conductive without the intervention of a mechanical tapping device, thereby increasing the speed of signaling.

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Reviews of Current Engineering and Scientific Literature.

Locomotives or Motor Cars?

For the three classes of service—fast long-distance passenger and freight, local passenger, and slow freight—different classes of motive power seem suitable to Mr. B. Pontifex. For express traffic he believes a locomotive is safer and more satisfactory, as a train drawn from the head is less liable to derailment at crossings and switches than when propelled by motors distributed throughout the entire train. Although the latter method of equipping makes possible a higher rate of acceleration, on the whole, the running time of the train would not be increased, due to the necessity of slowing down at all switches and crossings. On the other hand, for local passenger traffic, quick acceleration is most important, and for this purpose the motor should be distributed throughout the train. Motors should be placed on the inner axles of each truck, as this arrangement gives an increased acceleration and results in a smoother running and decreased hammering at curves and at switches. For slow freight traffic locomotives alone meet all requirements. —*Abstracted from the Electrical Engineer (London), October* 16.

Iron Losses.

The curious result that the iron loss in dynamos is about two and one-half times what it is in transformers for the same maximum density has led Mr. A. Press to seek for an explanation. It is usual to assume that the flux wave in transformers is the sine function of the time, and that the flux distribution in a dynamo is of the nature of a flat top wave. The apparent discrepancy may be possibly explained by an increase in eddy loss due to the character of the distribution curve. Continuous-current machines are first examined, and it is found that this distribution having a minimum eddy loss for a given area included under the curve and a given base is the parabola which approximates closely to a sine wave. The conclusions reached are that the great difference between transformer losses and dynamo losses can be explained in greater part by taking into account the slope of the flux distribution wave; that the so-called full load increment in iron loss can be in a measure accounted for by the skewing of flux due to cross-magnetization, and that the ideal distribution curve is a parabola degenerating into a flat top with parabola sides, for a minimum total iron loss. For alternators the most efficient sort of flux distribution is found to be a sine function. For machines of low frequency, where the hysteretic constant is more important than that for eddy currents, a flat top wave should be aimed at; but where this constant is practically negligible compared with that for eddy current, the flux should spread to one and three-quarter times the width at the top. The degree of peakedness is determined by the amount of maximum density and effective electromotive force required. Arnold, as the result of his investigations, found that the sine wave was the best form of flux distribution, but his point of view is entirely one of effective electromotive force against a given flux.—*Abstracted from the Electrician (London), October* 16.

Tangental Traction.

This is a study by MM. L. Rosenfeld and C. Zelaney of a so-called tangental traction system. In this system three-phase currents are employed and the propelling force is produced by a method similar to that which causes rotation in induction motors. What corresponds to the primary of the motor is here buried in the street between the rails. The part corresponding to the secondary, here called the propeller, is suspended from trucks just above the stator. The reactions set up by polyphase current in the winding of the buried stator so react upon the propeller above it as to cause it to move in one direction or the other. The application of a system of this kind encounters a number of serious difficulties. One of these is the poor power-factor which under ordinary conditions would be caused by the necessarily large gap between the stator and the propeller. The power-factor here is brought up to a satisfactory figure by increasing the breadth of the air-gap, by means of polar extensions built up of plates lying at right angles to the plates of the cores of the primary and secondary. In this connection some interesting results of tests on motors constructed upon the same principle are given. Another objection is the large power which would be required if the potential were applied continuously to all coils at the stator. This difficulty is removed by grouping the stator sections and introducing an automatic switch for connecting these sections to the feeders as the car passes them. The automatic switch is a small three-phase induction motor, the stator being connected in circuit continuously. The rotor has a coil winding, the ends of which are connected to the two wheel rails which are insulating. This winding then remains open except when a car is on that section of the track. When the circuit is closed by a car, the rotor closes the switch throwing that section of the stator on the feeders. After the car passes, a counterweight opens the switch. The speed of the cars is controlled by means of resistance in the propeller circuit. An experimental track has been installed, the dimensions of the various parts being given, but no results of tests are yet available. — *Translated and abstracted from Bulletin No.* 6, 1903, *of the Association Des Ingeneurs Electriciens, Liege.*

Three-Phase Switch Gear.

This series of articles by Mr. A. C. Eborall criticises the so-called cellular type of switchboard for high voltages and discusses in detail the desirable features of switchboards for high-tension work. The whole of the high-pressure gear should be removed from the operating platform and isolated in fireproof compartments. All high-pressure fuses should be done away with. High-pressure bus-bars should be arranged in such a manner that any portion of them can be isolated. They should be provided with properly arranged pressure discharges and so arranged that the attendant has no excuse for getting confused. All high-pressure switches should be controlled from a distance, because in this way not only can one man control effectively all the switching gear without becoming nervous on account of the presence of conductors carrying high voltages, but the apparatus itself can be distributed without being crowded into too close quarters. Switches should be of the oil-break type, automatically operated. The following arrangement of protective devices is recommended: automatic non-overload switches with reverse-current attachments on the generator panels; automatic overload switches with time attachments on the feeder panels; automatic overload switches with reverse current and time attachments on the feeder panels; automatic overload switches with time attachments on the machine panels

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and the substation switchboards. The conclusions which the author draws from the study of the switch gear are: never break a circuit in air; arrange all circuits so that the voltages produced by the oscillations in opening a transmission line are moderate; and provide excess-pressure discharges at different points of the system. The best form of excess-pressure discharges is the horn type in series with a high non-inductive resistance. In many cases cable-charging apparatus will not be found necessary. If power-driven switch gear is necessary, electrical means, rather than pneumatic, are recommended. —*Abstracted from Engineering* (London), *September* 25, *October* 2, 9, 16, 1903.

Trial of the Diesel Oil Engine.

A trial was recently made on behalf of the Belper Rural District Council, England, at its Lee pumping station, to ascertain whether the guarantees given by the makers of the pumping plant had been fulfilled. The results of this trial are given in detail here by Mr. M. Longridge. The plant consists of two units for alternate use. Each unit comprises one thirty-horse-power Diesel oil engine and one horizontal Reidler pump, the two being coupled together by spur wheels keyed on the engine shaft and pump crank shaft, respectively. Each engine is an inverted vertical type with cylinder 11.8 inches in diameter by 18.12 inches stroke. The normal speed is 180 revolutions per minute. To make the trial, the pump was disconnected, a brake being put on the flywheel of the engine. It was found to run very readily. The pull was shown by a spring balance. The oil used was said to be Texas crude oil, the calorific value corresponding to chemical analysis being 18,735 British thermal units per pound. The same value, determined in a Berthelot-Mahler bomb calorimeter, gave 19,080 British thermal units; or, deducting the heat of evaporation which is not available in the engine, leaves 17,900 British thermal units. A number of trials were necessary before the proper conditions for testing were ascertained; but after all parts had been adjusted, a run was made which gave the following results: The test lasted sixty minutes; the speed of the engine was 177.7 revolutions per minute; pressure of the air in the receiver, 645 pounds; maximum pressure in the cylinder, as shown by the indicator, 498 pounds; temperature of the exhaust gases, 379 degrees Fahrenheit; the total oil used, 8.687 pounds; mean effect of pressure, 53.4 pounds per square inch; indicated horse-power, 23.75; brake horse-power, 14.76; mechanical efficiency of the engine, 62.2 per cent; horse-power expended in friction, 8.9; oil consumption per indicated horse-power-hour, 0.366 pound; per brake horse-power-hour, 0.585 pound. Tests made at other loads show that the consumption of oil per brake horse-power-hour was minimum at the normal rate of thirty horse-power.—*Abstracted from the Mechanical Engineer* (*London*), *October* 3.

The Central Station Auxiliary Plant.

The auxiliary plant of the power station is often the most inefficient part of the installation. Mr. F. H. Davies here considers this phase of station design, and points out what seems to him to be a desirable method. The most important auxiliaries are the pumps, and these are most often driven by steam. In many cases electrically driven pumps would be more efficient, but a rigid rule can not be laid down. If the pump is used intermittently, steam operation is very inefficient, and under such conditions electrical driving should, in general, be used. The average small steam pump efficiency is said to be about twenty-two per cent. Better efficiencies are obtained in large stations, but, under good conditions, it is only about half of that of an electrically driven pump. An objection to electrically driven pumps is the difficulty of regulating efficiently the supply of water. When a series resistance is used, the efficiency may be less than that of the steam-driven pump. Shunt resistance does not give a wide range of regulation and is apt to cause sparking. The use of a by-pass to the pump is wasteful and inefficient. Series parallel control is efficient and gives a wide range, but requires an expensive motor. When three-throw pumps are used, an efficient method of control is to cut out one or more plungers, but this does not give close regulation and is apt to cause dangerous water hammer and straining in the delivery pipes. Variable gear is noisy and inefficient, and does not give a wide range. The conclusion reached is that the series parallel control is the best system; but, to guard against breakdowns, it is advised that both steam and electrically driven pumps be installed. Injectors for boiler feeding are not satisfactory, as they are unreliable and inefficient. For stoking and economizer gear, electrical driving is to be recommended, as the service is continuous. The economizer scraping gear should be run from the stoking motor. For source of power, single-phase alternating current is not satisfactory, and while plants of this type in some cases run motors from the exciter bus-bars, this is strongly objected to, as the exciter service should be maintained for that work alone. The power should be distributed to the auxiliary motors in a systematic way, and should be measured and the circuits protected by automatic apparatus.—*Abstracted from the Electrical Review* (*London*), *September* 25.

BOOK REVIEW.

"Electrical Engineering Measuring Instruments." G. D. Aspinall Parr. New York. D. Van Nostrand Company. Cloth. 6¼ by 9 inches. 328 pages. 370 illustrations. Supplied by the ELECTRICAL REVIEW at $3.50.

This book treats of the construction and principles of operation of present types of ammeters, voltmeters, wattmeters, phase meters, frequency meters and electricity supply meters. There is an introductory chapter on the general classification of these instruments according to the methods of their operation and upon the controlling forces, sources of error, and compensating devices. The next three chapters treat of moving-needle, moving-coil, hot wire and electrostatic instruments. Then follow chapters on electromagnetic wattmeters, recording instruments, standard instruments, and supply meters. Over one hundred instruments of different manufacture are described and illustrated. Among these are but half a dozen of American make. The American reader can not fail to be impressed with the large number of low-grade instruments which appear to be worthy of the consideration of the author. The English engineer has more patience with gravity control, with non-uniform or parabolic scales, and with strings to be pulled than his brother Jonathan. The descriptions are in the main clear and the illustrations good. The book can not fail to be of great value to any one who is interested in the subject.

The Independent Telephone Association of Southern Indiana.

The following programme has been announced for the fourth annual convention of the Independent Telephone Association of Southern Indiana, which will be held at Evansville, November 10 and 11:

Tuesday, November 10, 2 P. M., address of welcome by the Mayor of Evansville. Response by the president of the association, Mr. G. A. Kienle. Paper on "The Situation in Evansville," by the Hon. A. W. Funkhauser, followed by general discussion and the appointment of committees.

Wednesday, November 11, 9.30 A. M., paper on "Long-Distance Lines," by the Hon. Charles D. Knoefel, New Albany, Ind. Paper on "The Bell People as Antagonists," by Mr. A. J. Payton, of Rockford, followed by discussion.

The discussion of these papers will be followed by the reports of committees and the election of officers.

On Tuesday evening a special entertainment will be arranged for by the citizens of Evansville and the Evansville Telephone Company.

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INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

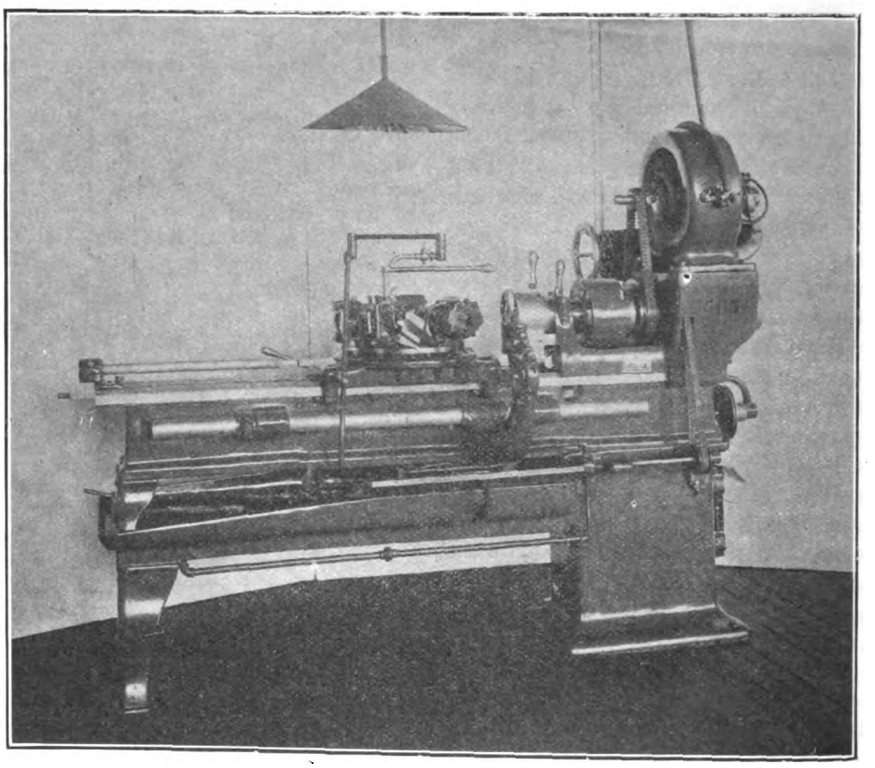
A Turret Lathe, Motor-Driven.

Combine with a machine tool well known for its rapid and accurate work, the use of motor drive with variable speed control, and the result is a close approximation to ideal equipment. Such an outfit is shown in the accompanying illustration, which represents a Hartness flat turret lathe driven by a Crocker-Wheeler form "F" motor. It is a machine for doing general lathe work, in sizes not exceeding two inches in diameter and twenty-four inches in length. Hence it is known as a two by twenty-four lathe, although with special appliances it may be fitted to take bar stock as long as thirty-six inches, or chucked work up to fourteen and even sixteen inches in diameter. Naturally, the maximum economy effected by its use is realized when turning quantities of identical pieces. On such work it is usually allowable to make the limit of variation each way from nominal size 0.0005 to 0.001 of an inch, but at a sacrifice of output it is possible to work as close as 0.00025 of an inch.

Among the distinguishing features of the lathe may be mentioned the peculiar form of the turret, its independent feed stop for each position, the roller feed for advancing the work at the conclusion of each cycle, and the swinging die carrier. The turret is a flat circular plate mounted on a low carriage containing the controlling mechanism. Its power feed is actuated by a worm screw which may be disengaged by an adjustable stop for each individual position. In operation as soon as the turret clears the work on its backward travel it is automatically revolved to the next position, or by an arrangement of trip screws near the centre of the plate it may be caused to turn through three, four or five of its six positions before stopping. The roller feed is mounted on the outside of the headstock and pushes the bar of work through the hollow spindle and chuck until it strikes a stop on the turret carriage. The rolls then slip until the chuck is closed, as they are started and stopped by the same lever that opens and closes the chuck. With the latter is provided a set of interchangeable jaws to take all shapes and sizes of rough stock between two and three-eighths of an inch. The die carrier is mounted on a sliding bar on the back of the frame and arranged to swing into working position. It holds a die of any kind and a pointer for shaping the ends of shafts and bolts, or reducing stock. In this way, two extra operations, or eight in all, are made possible to the one lathe.

A substantial construction is maintained in the headstock to afford strength and the rigidity essential to accurate performance. The motor has a capacity of five horse-power at 1,100 revolutions per minute and 240 volts, and is mounted directly over the spindle which it drives by means of a Renold silent chain. Beneath the spindle is placed the regular back-gear, and when required for large diameter work a triple back-gear is placed below the regular one. The gears are thrown in or out of operation by friction clutches, so that it is not necessary to stop running while making the change. From the motor to the sprocket on the spindle there is a three to one speed reduction, the first back-gear reduces again by a ratio of four to one and the second gives sixteen to one from sprocket to spindle. The motor being supplied with current on the four-wire multiple voltage system of the Crocker-Wheeler Company is capable of six speeds by the separate voltages and six more by the use of one resistance or twelve in all in either direction. Its highest speed is 1,100, which transmitted direct to the spindle turns the latter at about 370 revolutions per minute. The motor's slowest speed, 162, communicated through the triple back-gear makes the slowest speed of the spindle three and one-third revolutions. Between these limits there is a total of thirty-six different speeds in direct or reverse rotation.

The Hartness flat turret lathe is manufactured by the Jones & Lamson Machine Company, of Springfield, Vt.



TURRET LATHE, MOTOR-DRIVEN.

The Vulcan Ammeter.

A new ohmmeter, adapted especially for wiring contractors and others in similar positions, is being made by Geipel & Lange, of London. The meter is an adaptation of the Wheatstone bridge, and operates without plugs. It is contained in a wooden case having a graduated cursor bar and a five-pointed slide switch. The resistance to be tested is connected to two binding-posts at one end of the box, and the two slides are adjusted until the needle of the galvanometer contained in the box does not deflect. The resistance is then read off directly. The range of the instrument is between one ohm and 20,000,000 ohms, making it suitable for a workshop instrument for measuring the resistance of wire or of insulation.

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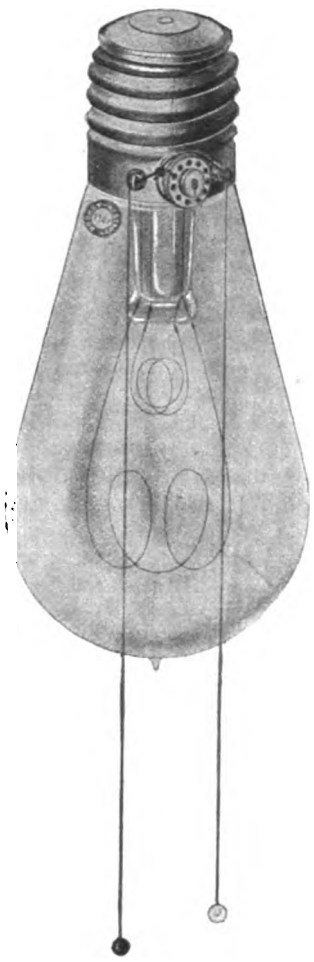
New Types of Incandescent Lamps.

The Rooney-Westbury Electric Lamp Company, New York city, has designed two new types of incandescent lamps which are unique in their construction and merit description.

The "Sun Star" lamp has been designed under the company's two-carbon lamp patent, to meet the requirements of a lamp which will give a sixteen candle-power or a lower candle-power, as desired. The two filaments are in parallel, so that while the large filament takes the usual amount of current, the small filament, which is a regular miniature lamp fila-



TWO-FILAMENT LAMP FOR TURNING DOWN.

ment, only requires one-tenth of an ampere, and if one of the filaments should burn out, the other filament can be used for the extent of its life.

The other lamp is a two-carbon lamp with the two filaments placed in parallel, so that they can be used either singly or together, as may be desired. It is claimed that this lamp will give twice the life of an ordinary single-filament lamp. Where the user desires to save current, he can use the two carbons at once, which will enable him to save current and at the same time obtain the same life as with the ordinary lamp. This type of lamp is manufactured in the following candle-power for each filament: two-candle-power and four-candle-power filaments; two-candle-power and eight-candle-power filaments; two-candle-power and sixteen-candle-power filaments; one four-candle-power and one eight-candle-power filaments; one eight-candle-power and one sixteen-candle-power filaments. Any other combination can be made up specially if desired. It must be understood, however, that where two filaments of different candle-power are placed in the same bulb, they can not be burned together, but only one at a time. Lamps are manufactured in all voltages from 100 to 120.

The operation of changing the filaments is simple, necessitating only the use of a small screw-driver. When one filament burns out a contact screw is loosened for a few turns and the connections to the old filament around this screw is released, and the connection to the other filament brought over and placed in contact. The screw is then again tightened and the lamp replaced in the socket.

Where it is desired to have the two filaments burn together, the first wire is left around the screw and the other wire also brought around the screw, causing both filaments to light up at once.

The lamps are made of the best material, are perfectly exhausted, and carefully tested and photometered, with the design of making lamps of the best quality.

The turn-down lamps are fitted with either a screw arrangement on the base, or, if the lamp is to be used out of reach, it is fitted with a bar arrangement, and two strings, depending therefrom, marked, respectively, "bright" and "dim," are attached.

The Power-House of the Valley Counties Power Company.

At the Nimshew power-house of the Valley Counties Power Company, a subcompany of the California Gas and Electric Corporation, the first two machines have begun operation, feeding into the transmission line of the Bay Counties Power Company.

The power-house is located in the Butte Creek Cañon, twenty-four miles from Chico. The available total head of water is 1,531 feet, taken down in one pipe line 6,200 feet long, and tapering in three sections from thirty to twenty-eight and one-half inches in diameter. Within the power-house the pipe terminates in a Y, each branch of the Y supplying a 3,700-horse-power water-wheel, the largest wheels operated as yet by one single jet of water.

The generators are of the Stanley Electric Company's make, the rotary element mounted on one single shaft with the water-wheel. The entire hydroelectric unit runs in two bearings, the rotary element of the generator between the bearings, and the water-wheel overhung.

The shaft is of nickel steel, hollow forged and oil-tempered, and the disc is a nickel steel forging, both made by the Bethlehem Steel Company. The buckets are steel castings of the patented ellipsoidal type. The total weight of the revolving part of each unit is over forty tons, and the speed is 240 revolutions per minute.

Each water-wheel is provided with a Doble patented needle-regulating deflecting nozzle and hydraulically operated piston gate. A Lombard type D governor with electric speed control takes care of sudden fluctuations of the load by deflecting the nozzle, and the regulating needle is operated by hand and set according to the average load of the respective hours of the day.

The hydraulic machinery, including the shaft, bearings and gates, was designed and built by the Abner Doble Company, of San Francisco, Cal.

Results of the Application of Electrical Traction to the Wannseebahn, Berlin.

The London *Electrician* quotes some interesting remarks made by Herr Bork, before the Verein für Eisenbahnkunde, relative to the application of electric traction to the Wannseebahn, Berlin. The average power consumption per ton-kilometre was found to be twenty-two watt-hours in summer, and 23.3 watt-hours in winter months. The efficiency of the feeder system is said to be 97.7 per cent, and that of the distributing system along the track, 96.4 per cent, that of the batteries being ninety-one per cent. Originally the resistance of one kilometre of line for conducting energy to and from the station was 0.044 ohm, but this has since been reduced to 0.04 ohm. The average insulation per kilometre of track was found to be 500,000 ohms, the lowest measure being 16,000 ohms. With a length of line of twenty-five kilometres and a working pressure of 700 volts, 22.5 watts are thus lost. Working costs per thousand train-kilometres are given in the case of electric traction as 1,065.9 marks, and in the case of steam traction, as 1,065.5 marks.

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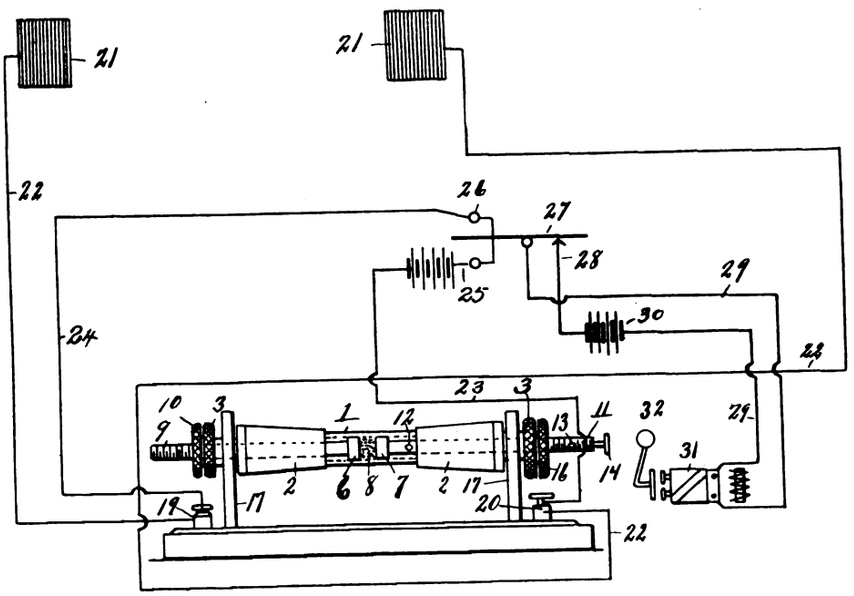
A New Coherer for Wireless Signaling.

The accompanying illustration shows the diagram of the circuit and the application of a new type of coherer for wireless signaling, invented by Mr. Thomas E. Clark, of Detroit, Mich., and for which patent No. 741,767 has been issued. This invention has been assigned to the Thomas E. Clark Wireless Telegraph-Telephone Company, Detroit, Mich.

The objects of the invention are to provide simple and effective means for receiving the impulses or Hertzian waves, capable of such adjustment as to ensure the operation of the receiving apparatus by light or feeble impulses, and enabling the reproduction of these impulses in the signaling apparatus, at the same time providing for decohering the coherer after each impulse is received.



NEW COHERER FOR WIRELESS SIGNALING.

A further object is to provide means whereby the coherer may be readily detached without disconnecting any of the circuit wires, and a second coherer quickly replaced in the receiving apparatus so as to enable an exchange of coherers should one fail to operate, or to enable the introduction into a circuit of a coherer of different adjustment, where the character of the impulse might require such a change.

Referring to the illustration, Fig. 1 is a glass tube provided at its ends with hard rubber or ebony caps 2. These caps are sealed or cemented on the end of the tube. Contact terminals 3 are provided with threaded ends, adapted to screw into the rubber caps. These contact terminals have longitudinal openings extending through them, which receive the stems of the electrodes 6 and 7, respectively, which pass through the contact terminals and enter the glass tube from opposite directions. These electrodes may be formed of any suitable material, but are preferably made of phosphor-bronze, and confine between their adjacent faces within the glass tube the metallic filings 8. The stem of the electrode is threaded so as to enable it to be screwed through the contact terminal, whereby any desired adjustment of the electrode longitudinally within the glass tube may be accomplished. A lock nut 10 screws on to the stem of the electrode for the purpose of locking it after adjustment. The stem of the electrode 7 is provided with a channel running longitudinally through it and opening at its inner end into the interior of the glass tube, the outer opening of the channel allowing the air to be withdrawn from the glass tube so as to obtain nearly a perfect vacuum within the tube. After the air in the tube has been exhausted, a needle-point valve 14 is screwed into the end of the stem of the electrode, closing the channel and maintaining the vacuum. The stem of this electrode is also externally threaded, so that it may be screwed through its contact terminal to effect a perfect adjustment of the electrode, and is secured by the lock nut 16.

The adjustment of the electrodes allows the distance between their adjacent faces to be regulated to increase or decrease the resistance across the filings accompanying the space between them. The contact terminals are provided with flat sides adapted to be received between the opposed contact jaws 17 at each end of the coherer. These contact jaws are mounted upon a hard rubber base. The binding-posts 19 and 20 are connected electrically to the jaws, and the aerials 21 are connected, through their conductors 22, with these binding-posts. Circuit wires 23 and 24 are also connected with these binding-posts, and in this circuit is included a battery 25 and a relay magnet 26. The circuit is normally open at the coherer.

When an electrical impulse is received at the receiving station the wave train is taken up by the aerials and passed along the conductors to the coherer. This operates to cohere the filings in the receiver and close the relay circuit between the electrodes. In this relay circuit may be placed any suitable instrument for recording pulsations. Upon the closing of the relay circuit, the armature 27 is contracted to close at the point 28, the auxiliary circuit 29, including the battery 30, and the electrical tapper 31, the hammer 32 of which is operated to strike the end of the screw in the stem of the electrode and decohere the filings, thereby opening the relay circuit as soon as the impulse is received.

An apparatus of this description enables the tube forming part of the coherer to be readily evacuated, and also makes it possible to change the coherer in the contact jaws if this becomes necessary through failure of this part of the apparatus, or through the necessity of making a different selection in the adjustment of the electrodes in any coherer.

A Small Arc Lamp.

A miniature arc lamp which works with one and one-half to two amperes and burns for about forty hours with one trimming is being put on the market by the Arc Lamps Company, Limited, 62 Old Broad street, E. C., London. The lamp is about sixteen inches long and runs on 100 or 110-volt circuits. It is simple, is said to burn steadily, and gives a soft, clear, white light. The lamp is suitable for interior lighting and also for lighting side streets.

An Electromagnetic Railway Coupling.

An electromagnetic car coupling was described in a recent issue of the *Elektrotechnischer Anzeiger*. This takes the place of the usual coupling or of the two corner bumpers used on European cars. The coupling consists of two parts, having a spherical surface, into one of which is sunk the exciting coil. The couplings are thirty-seven centimetres in diameter, and each gives a pull of 8,400 kilogrammes. The power required is forty watts, which is supplied from a small storage battery.

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A Statement from Mr. Milo G. Kellogg to the Customers of the Kellogg Switchboard and Supply Company.

Mr. Milo G. Kellogg, former president of the Kellogg Switchboard and Supply Company, Chicago, Ill., has issued a statement to the customers of the company, under date of November 2, 1903. This statement sets forth in detail the conditions which led up to the disposition of his share of the stock of the Kellogg company, and his subsequent efforts to recover this.

It appears that in the summer of 1901 Mr. Kellogg became ill, but, under the care of a physician, was able to give some attention to business until about the middle of November, when he was obliged to give up all work and care and leave at once for California, to be gone for an indefinite length of time. During the last half of the year of 1901 the capacity of the Kellogg company for the transaction of business was practically doubled at a large outlay, part of which was met by the sale of the remaining treasury stock of the company, and the remainder, to the extent of $250,000, was to be met by an increase of the capital stock, which was under way when Mr. Kellogg was obliged to leave. During the month of December it became apparent that the Everett-Moore Syndicate would not be able to care for the paper which they had given the Kellogg company to the amount of $222,000, which the company had discounted, and which would mature during the following two months.

At this time it was not expected that Mr. Kellogg would ever recover his health sufficiently to take up active business again. It was therefore thought best by Mr. De Wolf, the vice-president of the company, who had general charge of the business of the company, and to whom, in the absence of Mr. Kellogg, had been given the general power of attorney to transact all business connected with Mr. Kellogg's personal property, to make a sale of the stock, by which the funds needed by the company could be secured, while Mr. Kellogg and his estate would be relieved of the care and responsibility connected with the controlling interest in so large a business. Assisted by Mr. Buckingham, of Chicago, a capitalist and a director of the company, it is stated that Mr. De Wolf disposed of a portion of the stock to Mr. Barton, of the Western Electric Company. Mr. Kellogg states that he was not aware of the transaction until July 4, 1902, six months after it occurred. The stock which Mr. De Wolf disposed of, and the contract of sale including Mr. Kellogg's stock and his own and Mr. Buckingham's, amounted to more than three-quarters of the stock of the company, Mr. Kellogg's holdings amounting to about two-thirds of the company's stock.

As soon as Mr. Kellogg learned of this matter he at once sought the assistance of Judge R. S. Taylor, of Fort Wayne, to attempt to recover without any legal proceedings the stock which he announced had been disposed of without his knowledge and without his consent. The statement includes the correspondence between Mr. Kellogg, Judge Taylor, Mr. Barton and others.

Mr. Kellogg's efforts to repurchase the stock were unsuccessful. A bill in equity, to obtain a decree of court which should declare that the sale of Mr. Kellogg's stock was unlawful, was filed by some of the minority stockholders in June last, to which Mr. Kellogg was made defendant. Mr. Kellogg's counsel, in view of all the circumstances, being of the opinion that the transaction would, upon his application, be held void, and he restored to his former position of ownership, have filed to that end a cross bill to the case in which he has been made a defendant. The case is to be argued on demurrer within a short time.

Trafford City, Pa.

The site of the foundry to be operated by the Westinghouse interests at Trafford City, Pa., which was recently described in these columns, affords opportunity for many unique experiments in economics. One of the most interesting propositions is the large new hotel, Trafford Inn. This building is centrally located at a junction of two of the principal streets, and is designed to fulfil not only the requirements of a first-class hostelry but, recognizing the desire of the members of the community for amusement, to supply also many of the features of a casino. By according these dual functions to one building, it becomes the central feature of the community and, having this idea in mind, it has been very strongly and handsomely constructed of pressed brick with stone trimmings, thus presenting an appearance of substantiality and attractiveness to which all the buildings of the town must conform in order to seem at all in keeping with it. It is of a size sufficient to accommodate seventy-five guests, the general internal arrangement being modeled on the bachelor club plan, the idea being to provide, to the well-paid employés of the foundry who have no families, such comforts and accommodations as will render occupation at the Trafford plant most desirable. This scheme is really an experiment in sociology, the rates charged being such as are not expected to yield any profit. The rooms are arranged singly and in suites with convenient bathroom and toilet conveniences. The interior finish of the rooms is such that they can be made attractive with very little embellishment, and the lighting and heating facilities, furnished from the main power plant of the foundry, aid in making these accommodations comfortable. A large reading room of the first floor adjoins the dining room, and these two rooms by being thrown together can be used for meetings and entertainments. The basement is devoted to a billiard room, bowling alleys, etc. On the same level is a row of eleven brick apartment buildings, two stories high, with a flat on each floor, arranged to accommodate one family.

The city site has been laid out into 2,000 building lots and space has been left for several parks, all of which are thickly wooded. The principal business streets and a portion of the residence streets are paved with brick with curbed flagstone sidewalks. The Philadelphia Company, of Pittsburg, has piped the town with natural gas which is available for illumination and domestic purposes.

A handsome brick passenger station is under construction by the traction companies, with commodious waiting rooms for passengers. Sites for several churches have been purchased, and school buildings have also been projected.

The entire town has been piped for water by the Trafford Water Company, and an abundant supply of excellent filtered water from the Allegheny river is obtained. A complete sewerage system has been installed, which includes separate disposal of storm water and sewage.

James Stewart & Company, of Pittsburg, New York and St. Louis, which have constructed many of the buildings of the various Westinghouse Companies, have been the general contractors.

The projectors of the town site enterprise have placed their interests in the hands of the Real Estate Trust Company, of Pittsburg, and under their supervision restrictions have been placed on the sales of property, so that buyers are required to conform to definite regulations as to character and cost of buildings. No liquor of a spirituous nature can be sold within the city limits.

From the knowledge that the public possesses of the substantial character of all the enterprises controlled by Westinghouse interests, it is predicted that this one, the most complete and far-reaching of all, will be the most enduring and reflect most creditably upon all who have been associated with its inception and operation.

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CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

HIGH-SPEED ELECTRIC ROAD FROM BERLIN TO HAMBURG—Despatches from Berlin state that the Prussian Government is satisfied with the speed tests on the experimental electric railway from Marienfeld to Zossen, and is negotiating with the Siemens & Halske Company, of Berlin, for the construction of a high-speed electric line from Berlin to Hamburg.

ELECTRIC COMBINATION ON THE CONTINENT—A combination of electrical companies, it is announced, has been formed on the Continent, the arrangement including the French Thomson-Houston Company, the Mediterranean Thomson-Houston Company, the General Electric Company, of New York, and several important German companies. In New York it is not believed that this statement has any foundation.

NEW YORK CENTRAL TO BUILD ELECTRIC ROADS—It is announced that the New York Central Railroad Company is planning to establish electric roads as suburban branches in the central and western part of New York state, in order to save local traffic which has been heavily cut into by the independent trolley lines. A section of the Rome, Watertown & Ogdensburg Railroad, which is leased to the New York Central, is to be equipped with electricity, and New York Central trolley cars can be run to and from all points along the southern shore of lake Ontario. This project will possibly also absorb the Rochester & Suburban Electric lines. For some time the New York, New Haven & Hartford management has been acquiring electric lines. This company is now operating about 185 miles of trolley lines located in not less than ten widely separated localities.

LIGHT MERGER APPROVED—The consent of a majority of the shareholders of the Johnstown (Pa.) Light, Heat and Power Company and the Citizens' Light, Heat and Power Company has been secured to the proposition for the amalgamation of the interests represented. The Citizens' company becomes the purchaser of the Johnstown company's stock, and will increase its capital to $1,000,000, the holders of stock in the present companies to receive one and one-third shares for each share now in their names. There has been no opposition expressed by the shareholders of either company to the arrangement concluded by the representatives, and it is expected that unanimous consent will be given to the proposition. It is the intention of the management to equip the plants with the most modern and economical apparatus. The low price at which the city will be furnished with street lights will doubtless result in a large increase in the number furnished, and establish a basis for a large business. By a division of the source of supply a great improvement will be made in the domestic service.

PLANS FOR THE PENNSYLVANIA TUNNEL—It is expected that contracts for the Pennsylvania and Long Island tunnels will be given out in December, when work will immediately commence at several points. Preliminary drawing of the plans and specifications has been fully carried out under the direction of Charles M. Jacobs, Alfred Noble and other consulting engineers. Ten million dollars has been expended in buying several pieces of property in Manhattan and Long Island City, and in New Jersey. It is peculiar that the largest part of this property is in the most expensive residence district in the United States. The tunnels will run from Weehawken, N. J., to Long Island City, L. I. The bottoms of the tunnels are to be trenched for two drains, and on each side there are solid concrete trenches containing the electric conduits. The tops of the trenches form horizontal platforms three feet eight inches wide, which provide emergency walks at about the height of the car windows on both sides of the track. The concrete side walls are carried up four and one-half feet above the galleries, and above that point the roof arch is built with five courses of brick held edgewise and banded together by occasional pairs of brick on end. The concrete lining of the land section is water-proofed with one-half inch Portland cement mortar, and six layers of felt and seven layers of coal tar pitch. There are provided all through the tunnels refuge niches and ladders in the faces of the conduit galleries, drawholes and manholes for the high-tension, low-tension telegraph and telephone conduits, and ladders twenty-five feet apart give access from the emergency platforms to the tracks. The refuge niches are the same distance apart and opposite the ladders. At intervals of 300 feet the two tunnels are connected by transverse tunnels about seven feet high and five feet wide, which have their floors at the level of the emergency platforms and are closed by double-leaved padlocked steel-plate doors. The specifications for the entire work call for 11,840 feet of single-track concrete-lined tunnels; 8,840 feet with two or three tracks; 1,670 feet single-track, concrete lined, built in cut and cover; 3,790 feet four to seven-track tunnels in open cut and cut and cover; 1,700 feet three and four-track tunnels with steel truss beams and concrete lining, and 24,049 feet of cast-steel shell single-track shield-driven tunnel, of which 12,174 feet will have screw piles.

CHICAGO CAR GRANT AWARDED—A tentative ordinance for the Chicago City Railway Company has been announced. This contains an absolute waiver of the ninety-nine-year act, a provision permitting municipal ownership at the end of twenty years, and stipulations for immediate improvements in service. The rate of compensation has not been determined upon, but has been left by the subcommittee for the decision of the transportation committee. This body is expected to take up the consideration of the grant after the directors of the City Railway Company have passed upon it. The ordinance is said to be nothing more than a concrete basis upon which the aldermen can base their final compensation negotiations with the president of the company and the company's attorneys. The ordinance is accompanied by exact tables of specifications showing the field of operations and schedules of receipts and earnings for the last three years. These schedules have not been given out. Electricity is named as the motive power for all the company's lines during the twenty years of the grant. All feeder wires carrying a current of more than 1,000 volts are to be laid underground in conduits. Authority is granted for the construction in streets and alleys of these conduits, which are to be four feet wide and three feet high. The city reserves the right to use the conduits for its own wires, paying in such case half the cost of construction. The company will be entitled to charge for a continuous trip in one general direction within the city limits a fare of five cents for every adult passenger and three cents for every child between the ages of seven and twelve years. Children under seven, when accompanied by a guardian, shall ride free. Each passenger will be entitled to a transfer slip permitting him to continue his journey in the same general direction, but not to reverse it. A transfer upon a transfer may be granted to permit a passenger to reach his destination. The company also bonds itself to make a transfer agreement with the company that may in future receive the franchise for operating the lines on the southwest side, thus permitting the residents in that district to make a continuous trip up and down town for one fare. The city is granted the right to use the trolley poles of the company to carry its signal, telegraph, telephone and electric light wires and lamps. The poles are to be not less than 115 feet apart, constructed of iron or steel, ornamental in design, and kept well painted. All new track hereafter laid in any paved street shall be of the grooved type, known as the Trilby rail, and weighing not less than 100 pounds to the yard. Such rails shall also be laid in renewing worn-out tracks, but it is provided that the company shall not be compelled, on account of the repaving of the street, to remove good, serviceable rails of the old pattern which have not seen ten years' service. In unpaved streets the girder type of rail may be used. The company shall, upon the request of the city council, extend its street car system in any street for which an ordinance may be passed in the future. The company shall not be required, however, to construct more than six miles of track during one fiscal year, and it is also required that at least 150 families reside in each half mile of a new route.

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ELECTRICAL SECURITIES.

The speculative community is still hopeful despite the check of last week to the recent advance in prices. A number of adverse developments and the general outlook, particularly the financial unsettlement at St. Louis, following similar difficulties at Baltimore and Pittsburg, exerted a check on the market, and the probability of further difficulties in other interior points is not impossible. The market, however, remains significant in its resistance to bad conditions of this nature. While prices have not advanced, it is remarkable that they have not furtner declined. It is expected that a firm money market will prevail for some time, but there is no expression that this will bring about any stringency. The banks are in a stronger position than is usual at this period of the year and the prospects of aid from gold imports from abroad are also very good.

ELECTRICAL SECURITIES FOR THE WEEK ENDING OCTOBER 31, 1903.

New York:	*Closing.*
Brooklyn Rapid Transit	35¼
Consolidated Gas	174½
General Electric	148½
Kings County Electric	150
Manhattan Elevated	135¼
Metropolitan Street Railway	109¾
New York & New Jersey Telephone	142
Westinghouse Manufacturing Company	160

The earnings of the Brooklyn Rapid Transit Company for the fiscal year (beginning July 1) to October 19, are $4,594,230, as compared with $4,097,598 for the same period of 1902, an increase of $496,632. From October 1 to October 19 the earnings were $712,552—an average of $37,503 per day, as compared with $656,273 in the same period last year, or an average of $34,541 per day.

The directors of the Consolidated Gas Company have declared the regular quarterly dividend of 2 per cent, payable December 15. Books close November 25 and reopen December 16.

Boston:	*Closing.*
American Telephone and Telegraph	126
Edison Electric Illuminating	235
Massachusetts Electric	77½
New England Telephone	124
Western Telephone and Telegraph preferred	80

Directors of the New England Telephone and Telegraph Company have declared a regular quarterly dividend of 1½ per cent, payable November 14. Transfer books closed November 2 and reopen November 14.

The instrument statement of the American Telephone and Telegraph Company for the month ending September 20 shows gross output of 79,406, and 33,438 returned, leaving a net output of 45,968, as compared with 41,677 in 1902, and 42,096 in 1901. Since December 20, 1902, the gross output has been 812,229, and 358,831 have been returned, leaving a net output of 453,398, as compared with 461,645 in 1902 and 381,882 in 1901. The total outstanding is now 3,603,718, as against a total of 2,987,251 in 1902, and a total of 2,334,698 in the preceding year.

Philadelphia:	*Closing.*
Electric Company of America	7⅜
Electric Storage Battery common	47
Electric Storage Battery preferred	47
Philadelphia Electric	6
Union Traction	43⅞
United Gas Improvement	79½

Chicago:	*Closing.*
Chicago Telephone	117
Chicago Edison Light	140
Metropolitan Elevated preferred	56
National Carbon common	17
National Carbon preferred	88½
Union Traction common	7
Union Traction preferred	32

AUTOMOBILE NOTE.

The annual meeting of the Automobile Club of America will be held at the club house, 753 Fifth avenue, on Monday, November 16, at 4.30 o'clock in the afternoon. The governors, pursuant to the by-laws, have nominated the following ticket to fill the vacancies named: President, Winthrop E. Scarritt; first vice-president, Henry Rogers Winthrop; second vice-president, Harry Payne Whitney; third vice-president, William K. Vanderbilt, Jr.; treasurer, Jefferson Seligman; three governors to serve three years (class of 1906), Dave H. Morris, Sidney Dillon Ripley, Albert R. Shattuck; two governors to serve one year (class of 1904), Harlan W. Whipple, Arthur Iselin.

PERSONAL MENTION.

DR. WILLIAM A. COLLEDGE has been appointed dean of the American School of Correspondence at Armour Institute, Chicago.

MR. HENRY DAVIS, of Tilton, N. H., has been appointed superintendent of the Citizens' telephone system at Tilton and Franklin, N. H.

MR. E. J. KENNEDAY has been appointed principal assistant engineer of the Tennessee Construction Company, with headquarters at Clarkesville, Tenn.

DR. C. K. EDMUNDS, Ph. D. (Johns Hopkins), has been appointed professor of physics and electrical engineering at the Christian College, in Macao, China.

MR. J. M. MARTIN has tendered his resignation as district sales agent at the Philadelphia office of the Nernst Lamp Company. Mr. A. E. Baker has been appointed as his successor.

MR. E. M. WALKER, of Boston, Mass., recently accepted the position of general manager of the Bristol Gas and Electric Company and the Bristol Belt Line Railway Company, Bristol, Tenn.

MR. JAMES P. CLARK has been appointed general manager of the Wabash-Logansport (Ind.) traction lines and the Fort Wayne city lines, with jurisdiction over the Fort Wayne & Southwestern road.

MR. NORMAN G. KENAN has been elected president of the Cincinnati Gas and Electric Company, Cincinnati, Ohio, to succeed General Andrew Hickenlooper, who resigned on account of ill health.

MR. FRANCIS R. WELLER has resigned his position with the engineering department of the District of Columbia and is now associated with Henry A. Pressey, civil and hydraulic engineer, Washington, D. C.

MR. JOHN KISSICK, chief electrician of the Kearsarge, one of the United States battleships, is a native of Paisley, Ontario. He was recently offered a reengagement on the Kearsarge, but thinks of going into electrical engineering.

MR. CHARLES E. FARRINGTON, treasurer of the Massachusetts Chemical Company, Boston, Mass., has just returned from a trip abroad. Mr. Farrington stopped in New York city last week, making his headquarters at the Manhattan Hotel.

MR. FRANK G. BOLLES, formerly manager of the export and foreign department of the Bullock Electric Manufacturing Company, Cincinnati, who has been abroad for some time, recently returned home to Cincinnati, Ohio. Mr. Bolles is no longer connected with the Bullock company.

MR. R. G. SEIGEL has been appointed signal engineer of the elevated lines of the Brooklyn Heights Railroad, Brooklyn, N. Y. Mr. Seigel began his railroad service on the Chicago & Northern Pacific in 1890, and later he went to the Boston elevated, which position he now leaves to go to Brooklyn.

MR. ARTHUR FORTH, who has been manager for the Southern Illinois Telephone Company, Effingham, Ill., has tendered his resignation to accept the position of general superintendent of construction for the Central Union Telephone Company. Mr. T. Turner will succeed Mr. Forth as manager of the Southern Illinois Telephone Company.

MR. C. N. MONEY, of the Union Electric Company, Baltimore, Md., is in New York in the interests of his company. The Union Electric Company is the eastern agent for the Victor Electric Company, of Chicago, Ill., manufacturer of electrical surgical specialties, and Mr. Money reports a very encouraging demand for the latter company's apparatus.

MR. ARTHUR WILLIAMS has consented to remain another year in charge of the department of sign and decorative lighting, and will prepare a new report for presentation at the twenty-seventh convention of the National Electric Light Association, to be held in Boston next May or June. Through the cooperation of the New York Edison Company, the report presented at the Chicago meeting has been printed and distributed without expense to the association.

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ELECTRIC LIGHTING.

MOHAWK, N. Y.—This city has voted $30,000 for the purpose of installing an electric light plant.

ATLANTA, GA.—The city of Douglas has voted to issue $20,000 for waterworks and an electric light plant.

GALVESTON, TEX.—The Houston Light and Power Company is to spend $185,000 on extensions and betterments.

MASON CITY, IOWA—James Rule and others have asked for a franchise for an electric light and heating plant.

TELL CITY, IND.—The council has purchased the electric light plant of the Tell City Electric Light Company, paying $10,700 for it.

KENTLAND, IND.—The power station of the Kentland Electric Light Company has been destroyed by fire, entailing a loss of $7,000.

SANBORN, IOWA—Work has been commenced on the building of the Sanborn electric light plant. It is to have a capacity of 2,500 lights.

NORTH TONAWANDA, N. Y.—Work has been begun on the erection of two new additions to the plant of the Niagara Light, Heat and Power Company.

BRUNSWICK, ME.—The buildings and machinery of the Thomaston Electric Light Company were destroyed by fire recently, entailing a loss of $25,000.

YORK, PA.—The light committee has awarded the contract for street lighting to the Edison Electric Light Company for one year, at eleven cents per light per night.

NEENAH, WIS.—It is said that a special election will be called to determine the wishes of the people in the matter of municipal ownership of an electric plant. A stock company of local capitalists stands ready to put in a $50,000 plant.

KOKOMO, IND.—Ground has been broken for the new power station of the Marion & Western Traction Company. The work on the building will be rapidly pushed, as it is the intention of the promoters to have it completed by February 1.

WALLINGFORD, CT.—The annual report of the board of electrical commissioners shows the receipts of the borough electric plant for the year to have been $19,657.09, and the operating expenses, $14,847.38, leaving a profit for the year of $4,969.25.

TERRE HAUTE, IND.—Plans have been completed for the new power-house of the Terre Haute Electric Company, of Terre Haute, Ind., which will lost $200,000. Work will probably be started in the spring, and it is hoped to have the plant in operation before next winter.

FAYETTEVILLE, N. C.—The Cape Fear Electric Power Company is pushing work on its plant at Buckhorn Falls, on the Cape Fear river, and it is expected that the wires will be running into the city by the end of the winter. The company is said to have secured several large contracts for power.

TRENTON, N. J.—The Washington Electric Light Company's plant, which has been owned and operated for the last three years by a company of Wilkesbarre, Pa., capitalists, has been sold to Harry Reed, of New York city. The price paid is said to have been $25,000. It is stated that Mr. Reed will spend several thousand dollars for improvements.

SHAWNEE, O. T.—The Shawnee Electric Light and Power Company has sold its plant to a number of capitalists who are represented by J. J. Henry, of Denver, Col. The consideration is said to have been $125,000. A large new power-house was recently completed and is now being equipped with new engines. This will be ready for operation in a short time.

WEST PALM BEACH, FLA.—The East Coast Electric Light, Power and Ice Company has been formed to carry on the business of the West Palm Beach Electric Light and Power Company, having purchased the franchise and good will of the latter. The company has also purchased two other plants, one at Fort Pierce, and will make many improvements to its property.

ITHACA, N. Y.—Ground has been broken at Taughannock Falls for the new power station which is to be built by the Trumansburg Electric Lighting Company, and work will be pushed so as to have the plant completed by the first of December. The company has secured water rights along the stream for a distance of three-quarters of a mile, and a dam twenty feet in height will be erected.

COLUMBUS, GA.—At a recent meeting of the trustees of the Catawba Power Company in Rock Hill, S. C., Mr. W. S. Lee, Jr., was elected vice-president and W. H. Martin, Jr., treasurer of the company. The company is developing a large water power on the Catawba river, eight miles from Rock Hill. The plant will not only furnish power to Rock Hill, but also to Charlotte, N. C., twenty miles away.

PITTSBURG, PA.—A new light and power company has been formed at McKeesport with a capitalization of $50,000, which will be known as the East McKeesport Light Company. The company will erect a power plant in East McKeesport in a short time and will operate in that town and in North Versailles township and the Wilmerding Valley. The company has been granted a franchise by the borough council of East McKeesport.

TOLEDO, OHIO—It is stated that Detroit and Wyandotte business men contemplate the formation of a company for the development of the water power of the Huron river. This stream is located midway between Monroe and Detroit. Flat Rock is situated on the river. A company capitalized at $250,000 is talked of. The company expects to furnish electric power to the Detroit, Toledo & Monroe electric car line, north of Monroe.

VANCOUVER, BRITISH COLUMBIA—The Vancouver Electric Light and Power Company has put in another boiler of 100 horsepower, and will furnish power for the contractors who are building the Portland dry dock. The work requires steam hammers and drills and other machines, and the electric light works being adjacent the power can be furnished at small expense. Later on the boiler will be used in the furnishing of additional lights.

BATTLE CREEK, MICH.—The Kalamazoo Valley Electric Company, of Kalamazoo, has filed a trust mortgage with the register of deeds in favor of the American Trust and Savings Bank of Illinois for $100,000. The mortgage is dated October 1, 1903, and is to run for twenty years at six per cent interest. The mortgage is given for the purchasing of the rights of the Jackson & Battle Creek Power Company, Limited, between Battle Creek and Jackson.

WASHINGTON, D. C.—The annual report of Walter C. Allen, electrical engineer for the District of Columbia, shows that 9.4 miles of underground cable, containing 282.85 miles of wire, was laid during the year. The total number of miles of underground cable now laid in the District is 21.58, aggregating 1,046.20 miles of conductor. The work of changing the system of arc lighting from the old-style open-series lamps to those of the enclosed type was completed during the year.

BRISTOL, VA.—The United Gas and Electric Company, of New York, has purchased the property of the Bristol Belt Line Railway Company, as well as that of the Bristol Gas and Electric Company and the Bristol-Goodson Water Company. The new company, which owns similar properties in a number of cities of the United States, announces that it will extend the electric car line and will also provide a new water supply for the city, the cost of which will probably not be less than half a million dollars.

NEW INCORPORATIONS.

SAN SABA, TEX.—San Saba Ice and Electric Light Company. $15,000. Incorporators: T. C. Henry, J. W. Longley, T. A. Murray, John H. Martin, W. S. Sanderson, G. H. Sanderson and U. M. Sanderson.

DES MOINES, IOWA—Iowa City, Kalona & Washington Railway. $50,000. Incorporators: George G. Rodman, W. P. Coast, C. W. Keck, A. N. Alberson, George W. Wagner, U. G. Smith, George S. Carlson, C. S. Welch, S. W. Brookhart.

GUTHRIE, OKLA.—The Lawton, Wichita Mountain & Western Electric Railway Company. $220,000. Incorporators: C. W. Johnson, of Montgomery, Ala.; S. P. Brunbage, of St. Louis; J. R. Brattan, of Carthage, Mo.; Edward F. Mitchell, of El Reno; D. R. Rankin, R. A. Hubard, Charles Mitscherick and J. H. Russell. To build a road running from Lawton to Fort Sill and northwest from Lawton to Lone Wolf, penetrating the entire Wichita mountain system.

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ELECTRIC RAILWAYS.

VINCENNES, IND.—Benjamin G. Hudnut, of Terre Haute, has sold his Vincennes street railway to the E. M. Dean Syndicate, of Grand Rapids, Mich., for $100,000.

CORRY, PA.—A company has been formed to build a trolley line between this city and North East, a distance of thirty-five miles. This line will touch Findlays lake and cut into Chautauqua County, N. Y., and open up a territory which has no railroad facilities.

EUFAULA, ALA.—A franchise has been granted by the city council to the Eufaula Railroad Company, which is composed of J. B. Foy, B. B. McKenzie, R. A. Ballowe, C. A. Martin, H. C. Holleman and A. L. Brassell. An electric railway is to be built in the city and also as far as Abbeville, about twenty-five miles.

AKRON, OHIO—At a meeting of the directors of the Northern Ohio Traction and Light Company it was decided to build an electric line from this city to Massillon over the right of way purchased and partly graded before the failure of the Everett-Moore Syndicate. The directors authorized the officials to proceed with the work as early next spring as practicable, and it is believed that the line will be open and in operation by the middle of next summer.

CAMDEN, N. J.—The Camden & Suburban Railway Company and the officials of the borough of Haddonfield have adjusted their differences, and the double-track trolley line from Haddonfield to Haddon Heights will be commenced at once. When completed one line of cars will run to Haddon Heights, thence to Haddonfield and Camden. The Haddonfield line will be operated to Haddon Heights and thence to Camden, thus forming a complete belt line for the residents of the outlying districts.

CADILLAC, MICH.—The Cadillac Traction Company is the name decided upon for the company which expects to build and equip an electric street railway for the city of Cadillac, and to operate the electric light plant and waterworks in connection therewith. The capital has been placed at $250,000. The company's officers are: President, Willis J. Cornwell; vice-president, John F. Vosburg; secretary, George S. Stanley; treasurer, Francis O. Gaffney; superintendent and general manager, J. H. Orr. The company has filed its articles and will soon begin work on its line.

PITTSBURG, PA.—A charter has been granted to the Pittsburg & Butler Street Railway Company. It is proposed to build an electric line from Pittsburg to Butler by way of the Evergreen road, the old Perrysville pike, the Three Degrees road, and then in a direct line to Butler. The line will pass through Evans City, Brush Creek and Zelienople. At the latter place it will connect with the New Castle system of street railways. Among those interested in the plan are Max Klein, John Sauers, Joseph W. Weinburg, Frederick Gwinner and W. W. Wyant, of Allegheny.

COLUMBUS, OHIO—An electric road, connecting Cincinnati and Toledo, passing through Columbus, is projected by the Toledo, Columbus & Cincinnati Railway Company, which has been incorporated by T. A. Wright, C. H. Haedler, Frances J. Bulask, C. L. Held and H. J. Jarvis. The road is to pass through Hamilton, Clermont, Warren, Clinton, Fayette, Green, Pickaway, Madison, Franklin, Union, Logan, Hardin, Auglaize, Allen, Wood, Putnam, Henry and Lucas counties. The nominal capital of $10,000 is named in the incorporation papers.

SPRINGFIELD, ILL.—Articles of incorporation have been issued for the Illinois Central Electric Railway Company, with its principal office located at Canton. The capital stock is $300,000 and the object is to construct a line from Canton, Fulton County, Ill., to Peoria, Peoria County, Ill.; Galesburg, Knox County, Ill.; Havana, Mason County, Ill.; Fairview, Farmington and Lewiston, in Fulton County, Ill., and Macomb, McDonough County, Ill. The incorporators and first board of directors are Joseph David, Cleveland, Ohio; James A. Lawrence and James S. Hopkins, Chicago; Fred A. Dolph, Aurora, Ill.; David J. Peffers, Jr., Evanston, Ill.

ELYRIA, OHIO—It is understood that the Cleveland & Southwestern Traction Company is planning to extend its system from Grafton in a southerly direction to Ashland. The projected road will run parallel to the Big Four to LaGrange, then taking a direct southerly trend it will pass through Penfield Center, Spencer and Homer to West Salem and thence southwesterly parallel with the Erie Railroad to Ashland, with a probable extension to connect with the Mansfield systems in the course of time. The total extent of the line will be about forty miles. Surveying will be commenced at once, it is said, and it is hoped to begin work on the line early next year. To furnish the necessary extra power needed to operate the proposed system a power-house will probably be located at Ashland.

OBITUARY NOTICES.

MR. JOHN C. DANIELS, who was president of the Garton-Daniels Company, Keokuk, Iowa, died October 25, at his former home at Eau Claire, Wis. Mr. Daniels was formerly the owner of a fleet of raft boats operating on the Mississippi river and in 1892 engaged in the business of the Garton-Daniels Company. Mr. Daniels was born in New York state in 1840. He was a man of sterling character and was well known and held in high esteem throughout the electrical field.

PROFESSOR ROBERT H. THURSTON, director of Sibley College, Cornell University, died at Ithaca, N. Y., on October 25. Professor Thurston was born in Providence, R. I., on October 25, 1839. He took the course of civil engineering in Brown University, graduating in 1859 with the degrees of C. E. and P. B., after which the degrees of A. M. and LL. D. were conferred upon him by Brown, and in 1885 the Stevens Institute of Technology conferred on him the degree of Doctor of Engineering. His father, Robert L. Thurston, of the firm of Thurston & Gardner, was one of the early steam engine builders of the country. Professor Thurston worked in his father's shops until the war broke out in 1861, when he received the appointment of assistant engineer in the navy. He served throughout the war in different vessels along the coast and became engineer of one of the Monitors. From 1865 to 1871 he was instructor in the Naval Academy at Annapolis, and in 1871 was called to the professorship of mechanical engineering in the Stevens Institute of Technology. Professor Thurston remained with the Stevens Institute until 1885, when he was appointed director of the Sibley College of Mechanic Arts at Cornell University. He had a brilliant career as a teacher, author, investigator and organizer. He was United States commissioner to the Vienna Exposition in 1873, and an active member of the United States board appointed to test iron, steel, etc., from 1875 to 1878. In 1880 he was one of the founders of the American Society of Mechanical Engineers and was its first vice-president. He was a member of the American Society of Civil Engineers, a fellow and first vice-president of the American Association for the Advancement of Science, and a member of many foreign societies. While in Europe as a member of the jury of the Paris Exposition of 1889, he made the address in response to the address of welcome in the Hall of the Exposition of Civil Engineers in London. Professor Thurston leaves a wife and three daughters, the eldest of whom is married to Professor Coffin, of the University of Wisconsin.

LEGAL NOTE.

SINGLE-PHASE MOTOR LITIGATION—A decision has been handed down in the United States Circuit Court of Appeals for the Second Circuit, in the suit between the Thomson-Houston Electric Company as complainant-appellant, and the Wagner Electric Manufacturing Company and others, as defendants appellee, in favor of the Wagner Electric Manufacturing Company. The case was heard before Circuit Judges Wallace, Lacombe and Cox, and is an appeal from a decree of the Circuit Court of the Southern District of New York, dismissing the bill on the ground that the defendants' device does not infringe the claims of the patent sued on. The original suit was brought on United States letters-patent No. 430,328, of June 17, 1890, granted to Elihu Thomson on an alternating-current motor. It appears that the issue turns on the contention of the defendants that their motor is not an infringement of the complainant's patent, in that the complainant's patent calls for a starting circuit in its motor different from the circuit necessary after the motor has reached its full speed. In the complainant's patent the motor is started with the circuit through the armature commuted, and when running at full speed the armature circuit is locally closed upon itself. With the defendants' motor the motor is started with the armature circuit locally closed upon itself, and does not make use of two circuits, as called for in the complainant's claims. The defendants have asked for a narrow construction of the claims in the complainant's patent, and the present decision confirms that of Judge Townsend, of the lower court, that a narrow construction is necessary and that the defendants' apparatus does not infringe the patents held by the complainant.

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INDUSTRIAL ITEMS.

THE MANHATTAN ELECTRICAL SUPPLY COMPANY, New York city, will be pleased to send, upon request, its catalogue No. 16. This contains illustrations and descriptions, as well as a price list, of electrical apparatus of every character.

THE ELECTRIC APPLIANCE COMPANY, Chicago, Ill., announces that the "Zenith" lamp, for which it is the selling agent, is meeting with a high-class demand. Booklets illustrating this lamp will be mailed promptly upon request.

THE KELLOGG SWITCHBOARD AND SUPPLY COMPANY, Chicago, Ill., recently received an order from the Cuyahoga Telephone Company, Cleveland, Ohio, for 8,050 telephones, 5,000 wall sets, 2,500 desk sets and 550 pay station sets. The Kellogg company is building for the same telephone company an 18,000-line board.

THE CROWE METAL MANUFACTURING COMPANY, 71-77 West Jackson Boulevard, Chicago, Ill., announces that it has taken over the entire business of the Bogue & Crowe Manufacturing Company, including good will, and is equipped to fill all orders promptly and guarantee satisfaction.

THE BULLOCK ELECTRIC MANUFACTURING COMPANY, Cincinnati, Ohio, is distributing its November calendar card in the series of great men of science and engineering. This contains a portrait and biography of Robert Wilhelm Bunsen. These calendar cards are worthy of preservation.

THE NIAGARA CLIP COMPANY, New York, N. Y., is the New York sales agent for the "Chicago telephone holder." This holder can be placed on any desk and prevents the telephone when being used from disturbing papers lying on the desk. A circular, descriptive of this holder, will be sent on request.

THE PEERLESS ELECTRIC COMPANY, Warren, Ohio, is distributing a unique folder entitled "Long Service." This refers, of course, to the Peerless transformer. The Peerless company is in receipt of numerous letters from light and power companies detailing overload operations of these transformers.

THE WAGNER ELECTRIC MANUFACTURING COMPANY, St. Louis, Mo., will mail on application a pamphlet entitled "A Bit of Industrial War History." This relates the contest of a gas *versus* an electric company in one of the central western states, and shows wherein the man who looks well to his power business will be bound to come out on top.

THE CENTRAL ELECTRIC COMPANY, Chicago, Ill., has just issued its November price list and discount sheet. This is an attractive little book designed to supplement its 1903 general catalogue. It has been revised to date and contains the lowest prices in force, and can not help but be of interest to every one in the electrical field; and every holder of a catalogue who has not received this price list should write for one immediately.

W. F. WARNER, Muncie, Ind., is distributing an attractive circular of the Warner arc lamp. This lamp is for direct-current series circuits. The lamps will operate two in series on a 220-volt direct-current circuit, or five in series on a 500-volt direct-current circuit. The Warner lamp is used for lighting the streets of the city of Muncie, 230 in all being operated with three Western Electric and two "Wood" old-style 9.6-ampere machines.

THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, Chicago, Ill., and Rochester, N. Y., reports that its underground cable department at Rochester is running at its full capacity. A recent shipment of 60,000 feet of underground cable was made to the Keystone Telephone Company, Philadelphia, Pa. It is stated that this cable is a most excellent product. The company has facilities for making cable according to any specification submitted.

THE COOPER HEWITT ELECTRIC COMPANY, 220 West Twenty-ninth street, New York city, is distributing a handsome catalogue descriptive of the Hewitt mercury vapor lamp. Several illustrations are shown, exhibiting the illuminating effect of the Hewitt lamp as an office light, as used in the drafting room, and as used in the machine shop, as well as a number of illustrations of the different types of lamps and apparatus manufactured by this company.

THE HENRY R. WORTHINGTON COMPANY, New York city, is to install at the St. Louis Exposition four twelve-inch, vertical, centrifugal sewerage pumps, each having a capacity of 3,000 gallons per minute and capable of operating against a head of sixty feet. On account of the exposition grounds being partly on a side hill it will be necessary to raise some of the drainage and sewerage by pumping in order to affect its disposal. These pumps will be driven by Westinghouse vertical-shaft induction motors.

THE LUNKENHEIMER COMPANY, Cincinnati, Ohio, manufacturer of brass and iron engineering appliances, is very busy supplying the trade with Lunkenheimer valves. These are made with an iron body, brass mounted in globe, angle, cross, check and swing-check styles, and constructed in screw and flange ends from two inches up. Catalogue will be sent on application. The company has opened a branch office in Paris, France, located at No. 24 Boulevard Voltaire, where it will carry a complete stock of goods.

THE AMERICAN ELECTRIC TELEPHONE COMPANY, Chicago, Ill., announces the following list of exchanges which it has recently equipped with apparatus of the regular express switchboard as well as the Bell express types of central office equipment: Kingman, Ariz., 150-line express; Trenton, Mo., 100-line express; Chillicothe, Tex., 25-line toll board; Lancaster, Mo., 100-line express; West Point, Ky. (U. S. Signal Office), 50-line Bell express; Elmwood, Ill., 320-line Bell express; Mebane, Mo., 8-line toll board; Everest, Kan., 100-line express.

THE AMERICAN BLOWER COMPANY, Detroit, Mich., is distributing some of the handsomest literature which has been produced this year. Bulletin No. 145 describes and illustrates the "ABC" fan system of heating and ventilating, as applied to manufacturing establishments. Bulletin No. 118 describes a system of mechanical draft, forced and induced by blowers and exhaust fans. Bulletin No. 155 describes and illustrates steel plate fans; and two smaller bulletins describe and illustrate, respectively, the moist air dry kiln and other apparatus for heating and ventilating service.

THE PITTSBURGH TRANSFORMER COMPANY, Pittsburgh, Pa., is sending out a leaflet containing a letter from Mr. H. W. Hamblin, general superintendent of the Nassau Light and Power Company, of Roslyn, L. I. This is very commendatory of Pittsburgh transformers. The company has been using Pittsburgh transformers almost exclusively for two years, having a total of about 300 in use ranging in size from one kilowatt to fifty kilowatts. Insulation and core tests after two years continuous service have been particularly satisfactory, and out of the 300 transformers only one was lost by burning out and this was attributed to the fact that it had been operating without oil. In some cases, the company has been compelled to subject these transformers to severe usage, overloading up to sixty per cent in excess of the rated capacity. Some of these, which have been watched very carefully under these circumstances, have been found to operate well within safe temperature limits. The Pittsburgh company is also distributing an attractive calendar for November.

THE CROCKER-WHEELER COMPANY, Ampere, N. J., has within the past few weeks received a number of notable orders. These have been fairly evenly divided among the larger branch offices, an improving condition of business which is not peculiar to any one section. One order from the Lorain Steel Company, Lorain, Ohio, received through the Pittsburg office, called for forty-one motors, ranging in size from two and one-half to 360 horse-power, and representing a total of 1,423 horse-power. Another large order from the New Jersey Zinc Company, of Hazard, Pa., through the New York office, is for one 125 and two 600-kilowatt generators and thirty-seven motors, aggregating 401 horse-power. The Philadelphia office placed an order from the Warren Foundry and Machine Company, Phillipsburg, N. J., for one 200-kilowatt generator, four thirty-five-horse-power and two sixty-horse-power motors; and through the Chicago office, the G. H. Hammond Company ordered for its packing plant at the Union Stock Yards in that city, 150, 125 and 220-horse-power motors and one 800-kilowatt 550-volt engine-type generator.

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CHARLES W. PRICE . . . . . PRESIDENT AND EDITOR
STEPHEN H. GODDARD . . . . . SECRETARY AND MANAGER
WM. HAND BROWNE, JR. . . . . TECHNICAL EDITOR
AINSLIE A. GRAY . . . . . ASSISTANT EDITOR

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TO ADVERTISERS

CHANGES for advertisements should be in this office by *Friday noon* for the following week's issue.

NEW ADVERTISEMENTS should be in the office not later than *Monday noon* to assure publication in that week's issue.

CONTENTS.

EDITORIALS.....
World's Production of Rubber 679
The Expansion of the Telephone 679
Possible Restrictions of Electrical Imports 680
Remodeling Electric Light Plants 680
The Effect of Radium on the Conductivity of Liquids 681
Decorative Lighting 681
Glass Vessels and Quartz Vessels, by Dr. John Trowbridge 682
Report of Rates for Lighting and Power Service 682
Experiments for Improving the Construction of Practical Standards for Electrical Measurements—(Concluded) 683
Colorado Electric Light, Power and Railway Association 686
The Canadian Society of Civil Engineers 687
The Central Station of the Brussels, Belgium, Tramways 688
Shop Testing of Motors and Generators for Commercial Service—VI, by Bertrand B. Abry 691
Rapid-Cutting Steel 693
The International Electrical Congress of September 12 to 17, 1904, at St. Louis 694
Memorial to Dr. Robert H. Thurston 694
Notes on Electrical Engineering 694
Wireless Telegraph Tests 694
The Conditions Governing the Rise of Temperature of Electric Railway Motors in Service—(Concluded). By Cary T. Hutchinson 695
A New Interest in Platinum 698
A New Auto Record 699
A Liquid Rheostat 699
The Advisory Committee on the Building Fund of the American Institute of Electrical Engineers 699
Cable Laying in Manila and a Trip Around the World, by Lewis G. Martin 700
Electrical Mining Notes, by Sidney F. Walker 702
Contact Voltages 703
Electrical Patents 703
Notes from Great Britain, by Our Special Correspondent 706
Electrical Notes from Europe, by Our Special Correspondent 707
Freight Development by Interurban Roads, by E. F. Seixas 709
Notes on X-Light, by William Rollins 711
Reviews of Current Engineering and Scientific Literature 712
A Plea for Better English in Science 713
INDUSTRIAL SECTION:
Motor Starters 714
Electric Automobiles 714
New Type of Conduit Elbow Former 716
A Large-Capacity Electrolytic Generator 716
A Single Phase Motor 717
Book Review 717
American Institute of Electrical Engineers 717
A Gear-Shaper with Motor Drive 718
Insulated Bridle or Distributing Rings 718
A Handy Electric Flashlight 719
Electrical Holiday Decorations 719
CURRENT ELECTRICAL NEWS 720

From statistics published by the Bureau of Commerce and Labor, at Washington, it is seen that the production of rubber for the year 1900 was 57,500 tons, and that, for the year 1902, it was 54,000 tons, a decrease of seven per cent. The principal rubber-producing countries of South America—Brazil, Peru and Bolivia—produce now over half of the rubber output of the world, and the figures for these countries indicate an encouraging increase. The other important rubber-producing country is Africa, where there was a decrease. The present methods of harvesting rubber are exceedingly wasteful, the gatherers thinking nothing of the future, but only of obtaining the largest harvest with the least trouble. With proper methods, the supply should increase, rather than decrease.

THE EXPANSION OF THE TELEPHONE.

Statements are so frequently made nowadays of the wonderful progress of the industrial applications of scientific discoveries, that they attract only a passing comment, while the results of these applications upon our mode of living are almost always overlooked. An exception to this exists in the application of electricity to railway work, one of the most active lines of development, as the changes which the trolley is bringing about have certainly not suffered from a lack of public interest and newspaper notice.

Growing Use of the Telephone.

There is another field of electrical application which is as active as the electric railway, but which attracts little public interest. That is the telephone. Hardly a day passes in which several telephone companies are not incorporated in the smaller cities and towns throughout the country. All the larger cities have large installations, some of them having two. These installations are growing rapidly. Not only is the number of individual stations increasing, but every large business office has a branch exchange, every new apartment house has a telephone in each apartment, and every new hotel a telephone in each room. It would seem from this that the telephone, which long since became indispensable in the transaction of business, is fast becoming a necessity in conducting the affairs of the home.

How the Telephone Helps.

The result of this use of the telephone is to increase opportunities for transacting any affairs whether of a business or social nature, by making it possible for the telephone user to come into direct contact with a far larger number of people than he could reach by personal visits. In this respect the telephone resembles the postal system, but it avoids the delay and uncertainty involved in the use of the mails. It eliminates very largely the need of messengers and middlemen, bringing the individual at once into contact with headquarters. By bringing the producer and purchaser together, business can be transacted quickly and easily with a saving of agents' fees. It is said that, in the West, farmers find the telephone very useful, not only in conducting their household affairs, but in marketing their produce. Where formerly the farmer stored his grain in elevators, waiting for an advantageous time to sell, he now stores it himself, and, by means of market quotations which he receives over the telephone, disposes of his grain whenever, in his judgment, he can do so to the best advantage by means of his telephone; and he does this without loss of time or any exertion other than calling up his dealer. Moreover, he has the satisfaction of closing a bargain at once at the current prices. This is but a single instance, but it shows how the telephone is becoming one of the controlling factors in nearly all lines of business activity.

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POSSIBLE RESTRICTION OF ELECTRICAL IMPORTS.

Russian manufacturers are taking steps to diminish the imports of electrical machinery and to increase the consumption of home products. A petition has been addressed to the Minister of the Interior and to the Minister of Finances, at St. Petersburg, by fourteen of the leading manufacturing establishments of Russia, in which the government is asked to require the municipalities of St. Petersburg and Moscow to order all electrical machinery and apparatus from Russian factories. The manufacturers hope that the result of this petition will be that the municipalities will be obliged to cease importing electrical machinery and other apparatus from foreign houses, and that the government will require all future contracts to be awarded to Russian factories. Such action would, of course, bar American, English and German apparatus from Russian municipal plants, and probably would have some effect on the imports for other purposes. The fate of the petition will be watched with interest in this country, though it will probably affect Germany more seriously should the policy advocated in it be adopted.

REMODELING ELECTRIC LIGHT PLANTS.

It was pointed out some time ago by a prominent electrical contractor, that a generation in electrical machinery is now only three years—that is to say, in three years electrical machines, new to-day, become old and out of date, and if a new installation were to be made, it would differ materially from the three-year-old plant.

Improvements Being Made Constantly.

New machines naturally show improvements and, at times, give evidence of important advances in the art. The efficiency and regulation of generators, and the life and economy of lamps, have increased steadily with improved design and better methods of manufacture, and it is to be hoped that this improvement will continue, although it must, of necessity, be at a diminished rate, unless some radical change is made in our methods of construction.

New Plants Better than the Old.

As a result of this advance, a station built to-day should, and does, if it is well designed, give a higher efficiency and a better service than would have been possible had it been erected and equipped several years ago. Such improvement is simply the healthy growth and development of engineering methods, mechanical and electrical, as it is the constant aim of the manufacturer and operator to improve his apparatus and his methods. We therefore expect not only cheaper machinery, but better machinery, cheaper service and better service.

Desire for the Best Plant.

Such being the case, the manager of an older plant naturally looks with longing upon the showing made by a present-day plant, and he begins to wonder whether he can not make a similar showing. He questions whether it would not be a wise move to scrap the old machinery or sell it for what it will bring, and buy new apparatus. The question may come up simply in the desire to improve the service and to reduce the expenses, or it may come up in connection with necessary enlargements and additions to the existing station. When purchasing new machinery it is, of course, desirable to secure the latest and best designs, and there may be some doubt whether new machines will operate to the best advantage when grouped with the old.

Will It Pay to Scrap the Old Plant?

The question of remodeling or rebuilding a plant requires the most careful consideration. The problem is usually submitted to an engineer, who studies it in all its phases. He must know what the old plant has been doing—which, presumably, is the best that it can do, and what it can be expected to do if retained. He must then figure out the cost of the new equipment. He must know on what terms the money necessary for the change can be secured, and he must make an estimate of what it will cost to operate the new machinery. Having done this, he then seeks answers to the following questions: Will the saving of the new plant over the old allow it to pay interest and depreciation on the outlay, and bring increased returns? Will the improved service so increase the output of the plant—and therefore the income—as to make the change a profitable one? Then other considerations may come up. It may be possible with a newer system to locate the plant at a more favorable position; or the selection of a different system, which will increase the efficiency of distribution, or increase the area in which distribution can be made profitably, may seem desirable. All these questions and many others must be examined, and while the question reduced to its simplest terms is, will the change pay? the answer can only be given after a careful study of all the features of both the old plant and the contemplated installation. The engineer's answer as given in his report is based on the best obtainable information, and it sometimes is in favor of the change, and sometimes against it.

Old Plants Changed to New.

A year or so ago such changes and improvements were not uncommon. In some cases there was, undoubtedly, no alternative—a new plant must be built. In some cases the change was certainly wise; in others it seems to have been thought good policy; and there were, doubtless, times when a change was made perhaps for no other reason than that it seemed to be the proper thing, because others were doing it. Unfortunately, the opinion of an experienced engineer was not always sought, the management taking the responsibility.

Investigating the Results of the Change.

To-day certain of these companies which made a change a year or so ago are investigating carefully the results of the change. They are endeavoring to find out how far the engineer's figures have been verified, and in what respect they differ from what was found to be the actual case. Such investigations are very valuable and helpful, and should be made by all companies which have made a change. There is no doubt that, in many cases—we might say, in most cases—the results will demonstrate the wisdom of the change. On the other hand, there will be found instances where the change has not been profitable. Such cases should be studied with a view of determining in what way the actual outcome differed from that in-

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dicated in the engineer's report. It should be remembered that, in such cases, the engineer must make a prediction. Conditions may change. Difficulties which could not be foreseen may arise, and it may be found that, while the change did not bring the desired results, the results would have been much worse had the old plant been retained. But in any case, whether the change was successful or not, the full lesson should be learned; and it should not be the sole aim of such investigations to show that a good profit has been made, but, as well, how much better the results have been than if the old plant had been retained. And on the other hand, in those plants where the results are not as good as had been expected, every phase of the question should be investigated carefully.

THE EFFECT OF RADIUM ON THE CONDUCTIVITY OF LIQUIDS.

An interesting, and what may prove to be an important scientific announcement, was made recently by Professor Friedrich Kohlrausch, in regard to the action of radium rays in increasing the electrical conductivity of water. Experiments were carried out with rays which were emitted by bromide of radium and barium, and which, after passing through an aluminum screen, were sent through a layer of water. After an exposure of some time, it was observed that the conductivity of the water increased. To account for this two hypotheses are suggested: the effect may be due to the action of the radium rays upon the glass vessel, or there may be a direct formation of ions in the liquid.

Possible Effects of Radium Rays on Glass.

Both of these suggestions seem open to criticism. Glass is a non-conductor, and, unless decomposed, it is difficult to see what effect it can have upon the water itself. Any action of the radium which would affect the glass itself, so as to make it conduct, might cause an apparent increase in the conductivity of water, on account of the conductivity of the glass, while actually the water remained unchanged.

Possible Effects of Radium Rays on Water.

If the effect is due to the action of the rays upon the water, the question arises, in what way is this increased conductivity brought about? Pure water conducts but slightly, its conductivity being attributed by the German theory of solution to the presence of dissociated hydrogen and hydroxyl ions in the water. An increase in conductivity, according to this theory, can only be brought about by increasing the number of ions—that is, by causing dissociation to take place to a greater extent. But this dissociation is limited by the osmotic pressure of the ions in solution, which resists the tendency of molecules of water to dissociate. The effect of radium rays, then, must, according to this theory, either increase the solution pressure—that is, the tendency of the water molecules to dissociate—or decrease the osmotic pressure. But the osmotic pressure depends entirely upon the number of ions in solution, so that a decrease here would indicate a decrease in the number of ions, and, therefore, in the conductivity. On the other hand, according to Nernst, the solution pressure of a substance is a constant for a constant temperature. If the radium rays affect water in this way, will they not also affect other substances in the same way? If so, what effect will this have upon the dissociation theory? Radioactivity has already given chemists a bad turn in regard to the atomic theory, and it is not impossible that it may bring about some modification of electrochemical theories. May there be a true ionization taking place, so that there is an actual convection current due to the presence of charged particles or electrons, just as happens in the case of a gas?

DECORATIVE LIGHTING.

A branch of the art of illumination which has been created by the application of electrical methods is that classed as decorative lighting. This art, although of comparatively recent development, has grown rapidly, and now the question in illumination is no longer simply that of obtaining a requisite amount of light on the floor or table, but this light must be obtained in a pleasing and artistic way. Formerly, when lighting was accomplished by the use of flames, the requirements of the illuminant limited the effects which could be secured. The flame must always be in a vertical position; must be protected from drafts, but have plenty of air, and must be sufficiently far from inflammable material as not to be a source of danger.

Flexibility in the Use of Incandescent Lamps.

With the introduction of the incandescent lamp, these limitations were largely removed, the only one remaining being that of ventilation. Sufficient air must be supplied to the lamps to prevent heating. Since the incandescent lamp, in producing light, wastes a certain amount of energy as heat, this must be given up to surrounding objects, usually the air. When this requirement is met, there is no other precaution necessary, except to see that the work of installation is carried out satisfactorily, and the lamps may be placed wherever most effective or desirable, and the decorative effect may take any form.

Lighting by Concealed Lamps.

The lamps are made in an almost infinite number of types, some of which are, in themselves, highly ornamental. They may be used to good effect as part of the decoration of a room or building, or they may be concealed from view, allowing them to illuminate brilliantly surfaces from which the light is radiated to the points desired. This method of lighting affords opportunity for a great deal of study and the exercise of much skill in order to secure the best effects, and it is being used with excellent results in many instances. A good example of the art of lighting with concealed lamps is given by the new Lyceum Theatre, New York, where every light is hidden from view. To secure the desired amount of illumination in this way may necessitate the use of a large number of lamps, but this is merely the price paid for the end sought. The effects secured are most pleasing and beneficial as the illumination brought about in this way causes less strain on the eyes than that given by a number of brilliantly luminous lamps exposed to view, which can not fail to cause much strain and weariness.

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GLASS VESSELS AND QUARTZ VESSELS.

BY DR. JOHN TROWBRIDGE.

The behavior of the hard Jena glass and of amorphous quartz, at high temperatures, promises to be of practical importance. It is also of scientific interest in spectrum analysis. The only method of submitting gases to very high temperatures consists in enclosing them in glass or quartz vessels and in sending powerful electric discharges through these vessels. In making such suitable vessels I found it desirable to use the oxy-hydrogen blowpipe with the hardest Jena glass; moreover, it was practically impossible to fuse this glass to the ordinary glass used in glass blowing—commonly called German glass. A crack would immediately start at the junction; but platinum would fuse with the hard Jena glass without the need of ordinary sealing in glass.

The oxy-hydrogen blowpipe is essential in working with quartz; and the quartz vessels differ from those made of the hardest Jena glass in two important respects. A powerful electric discharge sent through a capillary of the Jena glass corrodes the inner walls of the glass making these walls appear like ground glass. The same amount of electric energy sent through quartz capillaries leaves the inner walls of the quartz capillary perfectly limpid and apparently untouched by the electric discharge. The second difference consists in the behavior of quartz toward platinum; it is impossible to weld this metal with quartz. In order, therefore, to seal gases in quartz vessels it is necessary to use some form of cement. The accompanying illustration, Fig. 1, shows the behavior of German glass A, lead glass B and quartz C to practically the same temperature. The lead glass is strongly corroded by the electric discharge; the lead blackening the walls and producing an appearance like slag; while the German soft glass is finely roughened like ground glass; and the quartz is unaffected and remains translucent.

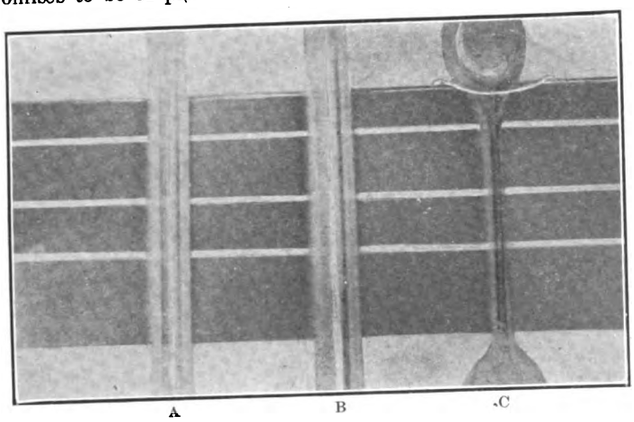

FIG. 1.

At very high temperatures one obtains a continuous spectrum with a very intense light. This continuous spectrum is not due to any luminescence of the glass or quartz. It could arise possibly from a luminescence of the contained gas; but from present indications it seems more likely that it results from the great pressure of the gas due to the explosions. At a point short of the appearance of the continuous spectrum, the hard Jena glass gives the spectrum of boron together with another spectrum partly gaseous and partly due to silicon. The accompanying illustration, Fig. 2, is this spectrum of Jena glass; 1 is the bright line spectrum of boron and atmospheric lines; 2 and 3 the continuous spectrum at a higher temperature; 4 the comparison solar spectrum. The spectrum obtained from German glass not containing lead is similar with the exception of the lines of boron which are absent. Quartz gives a spectrum of oxide of silicon. A continuous spectrum in the case of stars may be due to electric disturbances; and one should not conclude that there are not spectral lines of gases or metals; for they may be completely concealed by the continuous spectrum. There is a strong tendency at present to believe that the light of the heavenly bodies, including that of the sun, is due to electric agency rather than to a high temperature produced by combustion or contraction of gaseous matter.

The powerful discharge from a large condenser charged from a storage battery of from ten to twenty thousand cells through rarefied gases contained in glass or quartz vessels produces a very different spectrum from that arising from condensers charged by a step-up transformer; even when the same voltage is employed. This fact arises probably from the much more sudden fall of potential when the condenser is disconnected from the battery and then discharged. In the case of the transformer the condensers are charged and discharged many times in a second and are only partially charged and partially discharged; remaining always in connection with the spark-gap.

In the use of glass and of quartz I have arrived at a limit of enquiry in regard to the high temperatures of gases; for as is seen from the accompanying illustration, a continuous spectrum sets in with a certain energy of electric discharge which completely obscures any gaseous lines or even metallic lines.

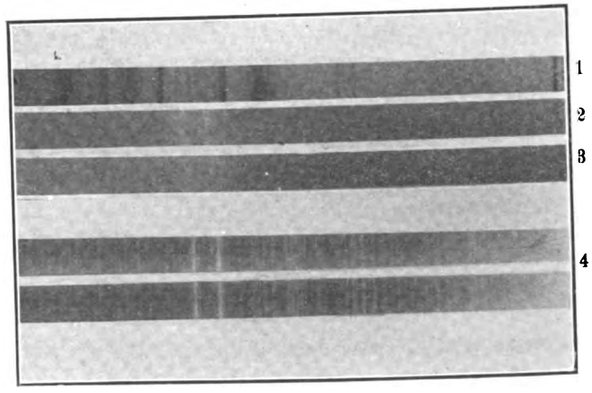

FIG. 2.

Report of Rates for Lighting and Power Service.

The National Electric Light Association has issued to its members a very comprehensive and valuable report on rates for lighting and power service in the United States. The report covers the entire country, and gives the prevailing rates for incandescent and arc lights and for power. It is not limited to data of member companies only, but includes many non-members. As this is the first report of the kind, it is not as complete as the association desires; but it was thought better to publish it while the information was fresh, and to issue later editions from time to time, as it becomes necessary. To this end, the members are invited to cooperate in the publication of the later editions, by sending in suggestions and data pertinent to the subject. The report is issued to members only, and is strictly confidential.

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EXPERIMENTS FOR IMPROVING THE CONSTRUCTION OF PRACTICAL STANDARDS FOR ELECTRICAL MEASUREMENTS—II.

The committee have had under consideration the drawings and specifications for the ampere balance as designed by the late Principal Viriamu Jones and Professor Ayrton. The electrical parts of the instruments need construction under skilled supervision. Tests of various kinds have to be made continually, and the committee have come to the conclusion that this supervision can best be secured by having the instrument constructed in the workshop of the National Physical Laboratory, under the care of Professor Ayrton and the secretary, who, as director, will be able, with the assistance of the staff of the laboratory, to control the work in an efficient manner.

The committee are of opinion that further expenditure will be required in completing the set of platinum thermometers, in particular in providing a satisfactory resistance box and in carrying out the researches on the Clark cell. They consider that it is of great importance that these researches should be brought to a satisfactory conclusion. For these reasons they recommend that they be reappointed, with a grant of £60, that Lord Rayleigh be chairman, and Mr. R. T. Glazebrook, secretary.

APPENDIX I—ON THE VALUES OF THE RESISTANCE OF CERTAIN STANDARD COILS OF THE BRITISH ASSOCIATION.[1]

BY F. E. SMITH.

Changes of very considerable magnitude have taken place since 1892 in the old B. A. standards. The removal of the coils, first to Liverpool, then to Kew, and finally to Teddington, has resulted in the comparisons being incomplete in some years. In consequence, the difficulty of locating differences has correspondingly increased. The observations recorded are in terms of B. A. Flat. Owing to a change in Flat taking place, however, the 1903 comparisons were made chiefly with Nalder 3,715. In table I the approximate difference in B. A. U. between Flat and the B. A. unit coils F, G, H of the association are given. Table II gives the difference in ohms between[1] (1.01358 × Flat) and other platinum-silver coils.

TABLE I.

Year.	Flat.		
	F.	G.	H.
1888	$+47 \times 10^{-5}$	$+91 \times 10^{-5}$	$+77 \times 10^{-5}$
1890	−17	+112	+90
1891	.....	.....	.....
1892	−18	+108	+92
1894	.....	.....	.....
1897	.....	.....	.....
1898	−36	+99	+69
1900	−47	+92	+63
1901	−42	+92	+70
1902	−33	+90	+76
1903	−33	+75	+76

TABLE II.

Year.	(1.01358 × Flat).			
	Nalder 3,715.	Elliott 264.	Elliott 269.	Elliott 270.
1888	.....	.....	.....	.....
1890	.....	.....	.....	.....
1891	.....	$+13 \times 10^{-5}$	.....	.....
1892	.....	.....	.....	.....
1894	-17×10^{-5}	.....	-37×10^{-5}	$+27 \times 10^{-5}$
1897	.....	.....	.....	.....
1898	−17	+9	−46	+27
1900	−17	+23	−49	+27
1901	−17	+23	−54	+27
1902	0	+38	−39	+44
1903	0	.....	−39	+44

TABLE III.

Year.	(1.01358 × Flat).	
	Elliott 288.	Elliott 289.
1897	-27×10^{-5}	$+7 \times 10^{-5}$
1898	−27	+7
1902–3	−10	+24

Table III shows the percentage difference between (1.01358 × Flat) and the unit of two 10-ohm platinum-silver coils of the association at 16 degrees C.

The coils F, G and H are similarly constituted—they are the old B. A. coils made by Matthiessen. No. 3,715 is by Nalder Bros., and the remainder of the coils by Messrs. Elliott Bros. No. 264 is a coil belonging to the Board of Trade, and has been returned to Whitehall; hence there are no observations for 1903.

Tables I, II and III assume Flat to be constant. It will be observed that the differences of Flat and 3,715, 270, 288 and 289 are constant from 1897 to 1901. From 1901 to 1903 a change of about 0.017 per cent is evident between Flat and the coils 3,715, 264, 269, 270, and again between Flat and the units of the coils 288 and 289. This suggests a change in the value of Flat from 1901.

Since 1901 comparisons between Flat and the manganin standards of the association have been made. Table IV gives the observed values in ohms. The values of 1,690, 780, 381 and 147 diminish by 17, 15, 15, and 7 times 10^{-5} ohms respectively in the interval 1901-1902. No. 147 is known to be a variable coil of very low insulation resistance, and may be disregarded for the purpose of estimating the change in Flat.

It is of interest as being a coil brought to Cambridge by Dr. Lindeck in 1892 and left with the secretary. Thus the apparent falls in value of 3,715, 264, 269, 270, 288, 289, 1,690, 780, and 381 are respectively 0.017, 0.015, 0.020, 0.017, 0.017, 0.017, 0.017, 0.015 and 0.015 per cent, giving a mean of 0.017 per cent. This justifies the assumption of a rise in resistance of B. A. Flat of 0.017 per cent in the period 1901-1902.

The following tables V and VI are I and II revised. They take the change in Flat into account by means of corrections applied to the observations of the years 1902 and 1903. The values given are for 16 degrees C.

Tables VII and VIII being III and IV, similarly revised, show no marked

Temperature of observations, 16 degrees C.

[1] From the National Physical Laboratory. The report covers the period 1888-1903 inclusive.

[1] 1 B. O. T. ohm = 1.01358 B. A. U.

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change in any of the coils in those tables excepting 147.

With reference to tables V and VI the data for 1901-1903 show a rise of 0.008 per cent for F, 0.034 per cent for G, and 0.011 per cent for H, indicating that they are certainly changing coils, the resistance for this period increasing with time. From the values recorded, 3,715 and 270, we have evidence that Flat has probably remained constant for the period 1894-1901. Also we infer that 264 is not a coil showing very great changes. Between the years 1892 and 1898 the differences between Flat and the coils F, G and H alter by the amounts 0.018 per cent, 0.009 per cent, and 0.023 per cent respectively. The dissimilarity of these percentage differences is further evidence that the coils have changed among themselves in this period. Comparing the amounts with those of the period 1901-1903, they represent quite normal increments of resistance. The balance of evidence in consequence is in favor of the constancy of Flat over the period 1892-1898, and this constancy has therefore been assumed.

A summarized statement of the platinum-silver coils of the association will be observed in table IX.

It will be observed that a number of the coils are steadily rising in value. The insulation remains good.

TABLE IV—VALUES AT 16 DEGREES CENTIGRADE IN TERMS OF (1.01358 × FLAT), ASSUMING FLAT UNCHANGED.

Year.	Wolff 1,690.	Wolff 780.	Wolff 381.	Wolff 147.
1901	1.00012	1.00002	1.00014	0.99790
1902	0.99995	0.99987	0.99999	0.99783
1903	0.99995	0.99987	0.99999	0.99783

TABLE V (I REVISED)—B. A. U.

Year.	Constant Flat.		
	F.	G.	H.
1888	$+47 \times 10^{-5}$	$+91 \times 10^{-5}$	$+77 \times 10^{-5}$
1890	− 17	+ 112	+ 90
1891	.....	.....	.....
1892	− 18	+ 108	+ 92
1894	.....	.....	.....
1897	.....	.....	.....
1898	− 36	+ 99	+ 69
1900	− 47	+ 92	+ 63
1901	− 42	+ 92	+ 70
1902	− 50	+ 73	+ 59
1903	− 50	+ 58	+ 59

TABLE VI (II REVISED)—OHMS.

Year.	(Constant 1.01358 × Flat).			
	Nalder 3,715	Elliott 264.	Elliott 269.	Elliott 270.
1888	.....	.....	.....	.....
1890	.....	.....	.....	.....
1891	.....	$+13 \times 10^{-5}$	.....	.....
1892	.....	.....	.....	.....
1894	-17×10^{-5}	.....	-37×10^{-5}	$+27 \times 10^{-5}$
1897	.....	.....	.....	.....
1898	− 17	+ 9	− 46	+ 27
1900	− 17	+ 23	− 59	+ 27
1901	− 17	+ 23	− 54	+ 27
1902	− 17	+ 21	− 56	+ 27
1903	− 17	.....	− 56	+ 27

TABLE VII (III REVISED)—VALUES AT 16 DEGREES CENTIGRADE.

Year.	(1.01358 × Flat).	
	Elliott 288.	Elliott 289.
1897	-0.27×10^{-5}	$+7 \times 10^{-5}$
1898	− 0.27	+ 7
1902-3	− 0.27	+ 7

TABLE VIII (IV REVISED).

Year.	Wolff 1,690.	Wolff 780.	Wolff 381.	Wolff 147.
1901	1.00012	1.00002	1.00014	0.99790
1902	1.00012	1.00004	1.00016	0.99800
1903	1.00012	1.00004	1.00016	0.99800

TEMPERATURE COEFFICIENTS OF B. A. COILS.

Some special observations have been made in order to obtain the temperature coefficients of the coils. These were carried out by keeping the standard coil constant and subjecting the tested coil to various temperatures for twelve or more hours so as to ensure no lag. It is interesting to note that the temperature coefficients of some of the coils are appreciably different from the old values of 1892.

COMPARISON OF THE UNIT OF RESISTANCE EMPLOYED AT THE REICHSANSTALT AND THAT OF THE N. P. L.

By the N. P. L. unit is meant the unit of resistance as obtained from the old B. A. coils.[1] Assuming that all the changes have been successfully interpreted, the unit at present employed in the laboratory should be the same as that employed in the Cavendish Laboratory in 1898 and at Edinburgh in 1892. A comparison of the two units was rendered possible in the spring. Two Wolff coils, Nos. 780 and 738, of nominal values 1 ohm and 10 ohms respectively, were despatched to Germany last winter. Their values were determined in Reichsanstalt units (termed international ohms) in March, and the coils immediately returned to the laboratory. Unfortunately, both coils fell in value two or three parts in the hundred-thousandth figure during their journeyings. The values given in the table are those determined on their return. In addition, five new coils were received, varying in value from one-tenth to 10,000 ohms. These enabled a more complete comparison to be made. The laboratory value was deduced by building

[1] 1 N. P. L. unit = 1.01358 B. A. U.

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TABLE IX—SHOWING THE PERCENTAGE INCREASE IN RESISTANCE OF B. A. PLATINUM-SILVER COILS FROM 1888.

Coil.	1888	1890	1891	1892	1894	1897	1898	1900	1901	1902	1903
Flat	..	..	..	..	..	..	..	..	..	.017	.017
F	..	.064	..	.065	..	..	.083	.094	.089	.097	.097
G	..	—.021	..	—.017	..	..	—.008	—.001	—.001	.018	.033
H	..	—.013	..	—.015	..	..	.008	.014	.007	.018	.018
3,715	..	..	..	..	*a*	..	0	0	0	0	0
264	..	..	*a*	..	..	..	.004	—.010	—.010	—.008	..
269	..	..	..	..	*a*	..	.009	.022	.017	.019	.019
270	..	..	..	..	*a*	..	0	0	0	0	0
288	..	..	..	..	..	*a*	0	..	..	..	0
289	..	..	..	..	..	*a*	0	..	..	..	0

a Observation commenced.

TABLE X—SHOWING THE OLD AND NEW VALUES OF THE TEMPERATURE COEFFICIENTS OF VARIOUS COILS.

Coil.	Temperature Coefficient Old Value, per 1 Degree Centigrade.	Temperature Coefficient New Value, per 1 Degree Centigrade.
Flat	0.000277 B. A. U.	0.000271 B. A. U.
F	286 "	268 "
G	274 "	274 "
H	271 "	280 "
3,715	0.000260 ? ohm	0.000307 ohm
264	312 "	283 "
269	.....	285 "
270	.....	315 "

TABLE XI—RESULTS OF MEASUREMENTS OF VARIOUS COILS AT THE REICHSANSTALT AND AT THE LABORATORY, MARCH, 1903.

Coil No.	Laboratory Value at 17 Degrees Centigrade.	Value Deduced from Reichsanstalt Certificate at 17 Degrees Centigrade.	Laboratory Value—Reichsanstalt Value. Percentage Difference.
2,352	0.100007	0.099996	0.011 per cent.
2,351	1.00011	1.00001	0.010 "
780	1.00001	0.99991	0.010 "
738	9.9994_5	9.9985	0.009_5 "
2,450	100.004	99.993	0.011 "
2,449	1,000.06	999.96	0.010 "
2,448	10,000.9	9,999.8	0.011 "

TABLE XII—RESULTS OF MEASUREMENTS OF VARIOUS COILS AT THE BOARD OF TRADE OFFICES AND AT THE LABORATORY, FEBRUARY AND MARCH, 1903.

Coil No.	Temperature.	Laboratory Value.	Deduced B. O. T. Value.	Laboratory Value—B. O. T.
Elliott 270.....	16.0 C.	1.00006	1.00010_5	-0.004_5 per cent.
Elliott 264.....	16.0 C.	1.00008	1.00014_5	-0.006_5 "
Wolff 381.....	16.0 C.	1.00015	1.00021_7	-0.006_7 "
Nalder 6,863.....	15.84 C.	999.13	999.1[3]	.....

TABLE XIII.

Coil.	Temperature.	Resistance.	Temperature Coefficient per 1 Degree Centigrade.
Flat	16.0° C.	1.00050 B. A. U.	0.000271 B. A. U.
F	"	1.00083 "	0.000268 "
G	"	0.99975 "	0.000274 "
H	"	0.99976 "	0.000280 "
3,715	"	1.00050 ohm.	0.000307 ohm.
269	"	1.00089 "	0.000285 "
270	"	1.00006 "	0.000315 "
288	"	10.0060 "	0.0031_0 "
289	"	10.0026 "	0.0026_5 "

TABLE XIV.

Coil.	Temperature.	Resistance.	Temperature Coefficient per 1 Degree Centigrade.
1,690	16°.0 C.	1.00012 ohm.	0.00001 ohm.
780	"	1.00002 "	0.00001 "
381[1]	"	1.00016 "	0.00002 "
147	"	0.99800 "	0.00001_5 "

[1] No. 381 is a manganin coil belonging to the Board of Trade.

up from the unit, and also by direct comparison with coils of similar value.

It is evident from these observations that a difference of 0.010_5 per cent exists, or that

Resistance of Reichsanstalt unit—resistance of laboratory unit = 0.00010_5 ohm. . . . . (A)

COMPARISON OF THE UNIT OF RESISTANCE EMPLOYED AT THE BOARD OF TRADE AND THAT OF THE LABORATORY.

The comparison of these two units is not so complete. Two platinum-silver units and one of manganin have been determined at both laboratories. The measurements taken at Teddington indicate that no change resulted during the journeyings of the coils. In addition one 1,000-ohm coil (Nalder 6,863) has been determined.

The exact relationship between the B. O. T. unit and that of the laboratory is, therefore, still incomplete.

It seems fairly certain, however, that—

Resistance of laboratory unit—resistance of B. O. T. unit = 0.00006 ohm, a difference of 0.006 per cent. . . . (B)

From the two relationships—

Resistance of Reichsanstalt unit—resistance of N. P. L. unit = 0.00010_5 ohm,

Resistance of laboratory unit—resistance of B. O. T. unit = 0.00006 ohm,

we have

Resistance of Reichsanstalt unit—resistance of B. O. T. unit = 0.00016_5 ohm, a difference of 0.016_5 per cent. (C)

The present values of the B. A. coils are as shown in table XIII.

The Wolff manganin coils of the association are also given at 16 degrees C., with a temperature coefficient to be applied for small ranges of temperature only, since it is by no means a linear function.

As has already been explained, the values are given in terms of the laboratory unit which represents 10^9 C. G. S. units of resistance as determined by Lord Rayleigh and Mr. Glazebrook at Cambridge; it has been assumed that the intercomparison of the coils enables that unit to be recovered.

Appendices I and II of the present report afford the means of connecting this unit with those of the Board of Trade, derived from it in 1891, and of the Reichsanstalt, and also with the ohm or international ohm—the resistance, that is, of a certain column of mercury.

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RESISTANCE IN LABORATORY (N. P. L.) UNITS OF MERCURY TUBES.

Tube.	Resistance at 0 Degree Centigrade. Potentiometer.	Resistance at 0 Degree Centigrade. Kelvin Double Bridge.	Tube.	Resistance at 0 Degree Centigrade. Potentiometer.	Resistance at 0 Degree Centigrade. Kelvin Double Bridge.
U	0.99913	0.99913	X	1.00007	1.00007
	0.99912	0.99912		1.00006	1.00006
	0.99914	0.99914		1.00007	1.00006
V	1.00041	1.00041	Y	0.99926	0.99926
	1.00044	1.00044		0.99927	0.99926
	1.00040	1.00039$_5$		0.99925	0.99925
G	1.00034	1.00035	Z	1.00030	1.00030
	1.00036	1.00036		1.00029	1.00029
	1.00035	1.00035		1.00029	1.00029

APPENDIX II—THE RELATION BETWEEN THE INTERNATIONAL OHM (106.300 CM. HG WEIGHING 14.4521 GRAMMES AT 0 DEGREE CENTIGRADE) AND THE UNIT OF RESISTANCE EMPLOYED AT THE N. P. L. PRELIMINARY NOTE.[1]

BY F. E. SMITH.

THE FOLLOWING MEASUREMENTS OF SIX MERCURY TUBES INDICATE THE PROGRESS MADE IN THIS ENQUIRY, AND ALSO THE RELATION OBTAINED.

Tube.	L. Length at 0 Degree Centigrade.	Conical Correction. $\mu \times 10^6$.	Theoretical Length for 1 International Ohm.	a. Calculated Resistance of Tube. International Ohm.	b. Mean Measured Resistance. Laboratory Unit.	b—a.
U	63.0731	5_6	62.1319	0.99905	0.99913	0.00008
V	78.5000	18	73.4759	1.00033	1.00041	0.00008
G	116.507	9	116.478	1.00025	1.00035	0.00010
X	65.6988	2_8	65.7354	0.99997	1.00007	0.00010
Y	62.1867	15	62.2382	0.99917	0.99926	0.00009
Z	68.5199	8	68.5057	1.00021	1.00029	0.00008

APPENDIX III.

B. A.—1.

Date, 1908.	δ	R_1/R_0	Difference of R_1/R_0 from mean.
Feb. 6	1.514	1.38688	—0.00021
" 23	1.505	1.38702	—0.00007
Aug. 7	1.506	1.38708	—0.00001
" 25	1.505	1.38712	+0.00003
" 26	1.514	1.38722	+0.00013
" 31	1.506	1.38722	+0.00013
	Mean 1.5083	1.38709	

Mean value of constants.

R_0	R_1	FI	δ	R_1/R_0
257.905	357.736	99.831	1.5083	1.38709

B. A.—2.

Feb. 12	1.484	1.38867	—6.00014
" 24	1.499	1.38877	—0.00004
" 24	1.495	1.38874	—0.00007
May 19	.....	1.38876	—0.00005
July 30	1.497	1.38880	—0.00001
Aug. 18	1.489	1.38863	—0.00018
" 21	.....	1.38901	+0.00020
" 24	.....	1.38890	+0.00009
" 24	1.493	1.38889	+0.00008
" 26	1.491	1.38892	+0.00011
" 31	1.489	1.38882	+0.00001
	Mean 1.4912	1.38881	

Mean value of constants.

R_0	R_1	FI	δ	R_1/R_0
257.172	357.163	99.991	1.4912	1.38881

[1] From the National Physical Laboratory.

Thus, laboratory unit of resistance = 0.99991 int. ohm.

$$= \frac{106.291}{106.300} \text{ int. ohms.}$$

[The above figures are intended as merely provisional.]

With respect to the measurements of the cross-sections the uniformity of the results shows that an accuracy of 0.001 per cent may be relied upon. Four methods of measuring the resistance will be employed. At present only two of these are completed. The values in each horizontal line refer to different fillings; they are quite concordant, as the values given in the accompanying tables show.

Colorado Electric Light, Power and Railway Association.

The first annual meeting of the Colorado Electric Light, Power and Railway Association was held, October 28 and 29, in the assembly room of the Denver Gas and Electric Company.

The first morning's work began with an executive session, at which the following officers were present: J. F. Vaile, general manager of the Pueblo & Suburban Traction and Light Company, president; William Mayher, president of the Greeley Electric Company, vice-president; George B. Tripp, Colorado Springs Electric Light Company, secretary and treasurer.

Among the state corporations with representatives at the meeting were: Durango Light and Power Company; Larimer Light and Power Company, of Fort Collins; Las Animas Electric Light Company, of Las Animas; Colorado Springs Electric Company; Leadville Gas and Electric Company; Boulder Electric Light and Power Company; Pueblo & Suburban Traction and Light Company; Las Animas Light, Power and Manufacturing Company, of Trinidad; Arkansas Valley Electric Company, of Florence; Gilpin County Light, Heat and Power Company, of Black Hawk; Denver Gas and Electric Company; Denver City Tramway Company; La Junta Electric Company; Greeley Electric Light Company; Crested Butte Water and Power Company; Roaring Fork Electric Light and Power Company, of Aspen; Loveland Light, Heat and Power Company; Lamar Electric Company; La Bella Mill, Water and Power Company, of Goldfield; Colorado Electric Power Company, of Canon City; Colorado Springs & Interurban Railway Company, and Pagosa Springs Electric Light and Power Company.

Among the associate members represented were these: Albert Sechrist Company, Denver; E. C. Means, agent Adams-

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B. A.—3.

Feb. 9	1.511	1.38740	+0.00010
" 26	1.511	1.38730	0.00000
Aug. 10	1.509	1.38714	—0.00016
" 18	1.522	1.38732	+0.00002
" 24	1.511	1.38724	—0.00008
" 25	1.515	1.38736	+0.00006
" 26	1.510	1.38731	+0.00001
" 31	1.510	1.38738	+0.00008
	Mean 1.5124	1.38730	

Mean value of constants.

R_0	R_1	Fl	δ	R_1/R_0
258.367	358.434	100.069	1.5124	1.38730

B. A.—4.

Feb. 11	1.485	1.38816	—0.00009
" 23	1.499	1.38833	+0.00008
" 26	1.500	1.38826	+0.00001
Aug. 10	1.497	1.38835	+0.00010
" 18	1.473	.....	.....
" 24	1.497	1.38825	+0.00000
" 26	1.494	1.38812	+0.00013
" 31	1.503	1.38826	+0.00001
	Mean 1.4935	1.38825	

Mean value of constants.

R_0	R_1	Fl	δ	R_1/R_0
257.627	357.616	99.989	1.4935	1.38825

B. A.—7.

257.749	357.771	100.022	1.506	1.38806
Thermometer electrically heated to 1,400 degrees for two hours :				
270.036	375.213	105.177	1.506	1.38949

APPENDIX IV.

The following table gives the resistance at a temperature of 60° F. (15.55 C.) of a wire of pure annealed copper 1 metre in length, having a mass of 1 gramme, as deduced from the most recent determinations.

In making the reductions, the values for the temperature coefficient and for the density given by the author have been used.

TABLE GIVING RESISTANCE AT 60° F. OF A WIRE OF PURE ANNEALED COPPER, SUCH THAT 1 METRE WEIGHS 1 GRAMME.

Authority.	Source of Copper.	Reference.	Value in Ohm.
Fitzpatrick	Electrolytic	B. A. Report, 1890	0.1475
Swan and Rhodin	Swan's Copper	Proc. R. S., 1894	0.1493
" (second sample)	" "	Proc. R. S., 1894	0.1486
Fleming*	" "	Phil. Mag., 1893	0.1487
Lagarde	Grammont Electrolytic	Hospitalier, 1894	0.1488
		Mean value	0.1486

* In reducing Prof. Fleming's result, the density has been taken as 8.91 grammes per cubic centimetre.

Bagnall Company, Denver; Phelps Company, Detroit; Western Electric Supply Company, of St. Louis; National Carbon Company, Cleveland; Mutual Oil Tank Line, Omaha; W. A. Layman, of the Wagner Electric Company, St. Louis; Westinghouse Electric Manufacturing Company, of Pittsburg; and these of Denver: Gilbert W. Kes & Company; R. J. Cory, of the Allis-Chalmers Company; Thomas H. Smith, American Steel Wire Company, and B. K. Sweeney, B. F. Vreeland, W. I. Otis and George A Wooley.

There were discussions on the subjects of the best methods for lighting cities, for rapid transit, for placing wires underground and for an economic fuel supply, while the following papers were read:

"Hints on Advertising," the Denver Gas and Electric Company; "Fuel Economies," E. E. Summers, of the Denver Gas and Electric Company; "Meters," C. W. Humphrey, of the Denver Gas and Electric Company; and "Single-Phase Motors," by W. A. Layman, of the Wagner Electric Manufacturing Company, St. Louis.

A "question box" provided subjects for impromptu discussion on various topics.

The Canadian Society of Civil Engineers.

The electrical section of the Canadian Society of Civil Engineers held its first meeting on October 15, 1903. The subject for the evening was the electrical equipment of some Canadian hydroelectric power stations. Dr. R. B. Owens, of McGill University, Montreal, president of the electrical section, introduced the subject. In calling this meeting to order, Professor Owens acknowledged the honor which he felt attached to the presidential office, and outlined briefly the efforts to be made to have the meetings for the coming season successful—successful in the sense that some increase of knowledge relating to the profession of the members may come to each one. The membership, he said, was composed of men who had attacked the problem of efficiently utilizing the waste energy of certain Canadian waterfalls, and who had sometimes been compelled to retreat, but who, in every case, had finally led capital to positions of vantage from which have resulted profits and dividends.

At the second meeting it is intended to discuss, as fully as present knowledge permits, the characteristics and consequent spheres of usefulness of alternating-current traction motors. It was needless, Professor Owens said, to emphasize to a Canadian audience the value of devices likely to cheapen the long-distance haulage of material of every kind. No great time is likely to elapse before the necessity of reducing motive power expenditure, and the desire for increased earnings, will require on the part of transportation management a careful consideration of heavy traction electrical methods and when such a time arrives, it becomes members, as electrical engineers, to be ready, both with methods and means. Alternating-current motors promise, better than motors of other types, to meet the demands of steam railway traffic conditions. Hence their consideration is opportune at the present time. Papers on the subject have already been promised from several sources.

The subject for the third meeting, the relative cost of producing power by steam and by water under different conditions, will have a peculiar local interest.

The fourth meeting will be devoted to a consideration of some of the more recent developments in the art of electric illumination; and at the fifth meeting, a return will be made to the consideration of the use of electricity on canals.

At the last meeting of the season, the matter of station design and operation, as affected by the steam turbine, will be discussed.

Mr. R. A. Ross is vice-president of the electrical section, and Mr. W. A. Duff is secretary.

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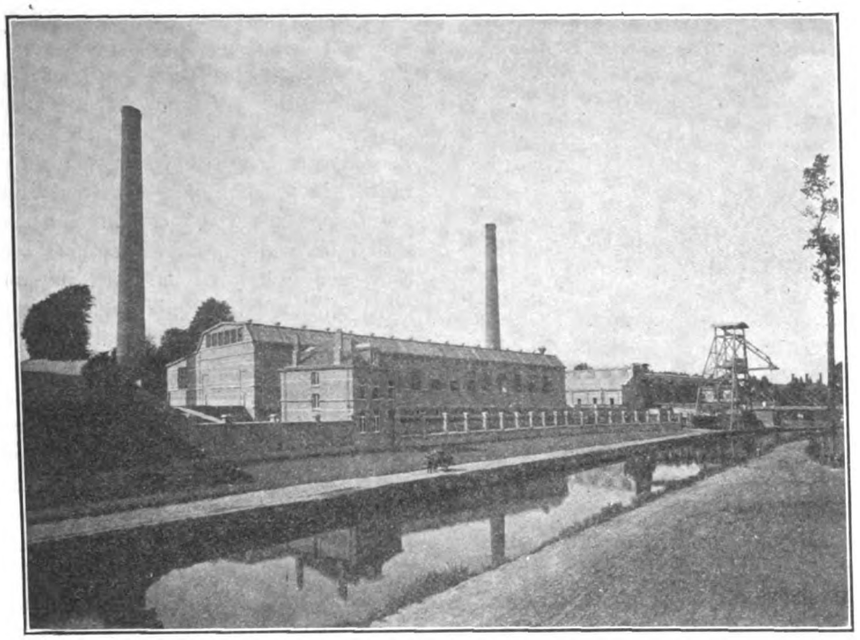
The Central Station of the Brussels, Belgium, Tramways.

By Emile Guarini

THE large central station which the Brussels (Belgium) Tramways recently inaugurated, and of which some photographs are here given, taken immediately after the inauguration, presents certain analogies to the central station of the Paris Metropolitan Railway.

The station is situated at Anderlecht, a suburb of Brussels, and replaces the former central stations distributed



THE CENTRAL STATION OF THE BRUSSELS TRAMWAYS.

throughout the city. The latter operate now as substations. All of the electrical apparatus has been furnished and installed by the Union Elektricitäts Gesellschaft, of Berlin. The steam engines were supplied from the shops of Van der Kerkoven, of Ghent. The current produced at the central station is three-phase at 6,600 volts. It is transmitted to three substations which feed, each separately, a particular district. The system is partly trolley and partly conduit, and comprises about eighty kilometres of double-track. The car service is rendered at present by 190 trains, each weighing fifteen tons. At times of heavy traffic there are 295 trains of the same weight.

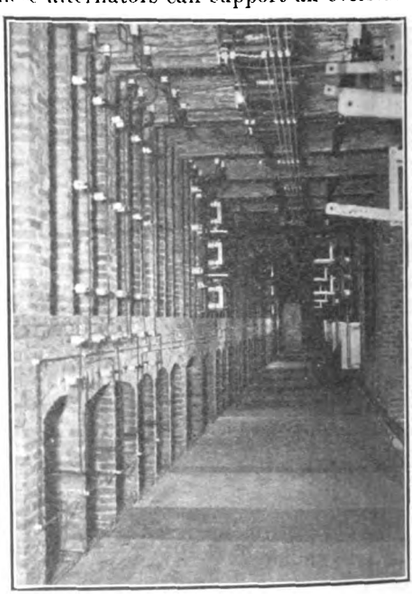
Two of the substations are former central stations. The original distributing cables have also been utilized without change. At each of the three substations the three-phase current is first transformed to the low tension of 410 volts by stationary transformers; then it is converted to continuous current at 550 volts —the tension of the system. Each substation is provided with a battery having an output of sixty ampere-hours at 500 volts, connected in parallel with a starting group. This battery forms a reserve and supplies the lights in the substation.

The engine room contains at present four generating groups of 1,500 kilovolt-amperes. Each group is composed of two engines of the tandem-compound type, with piston valve, rated at 900 to 1,400 effective horse-power, coupled to the same shaft which supports the rotating part of the three-phase alternator. The speed of the engine is ninety-four revolutions per minute. The temperature of the steam at admission is 275 to 300 degrees centigrade. The variations in speed do not exceed one-half per cent for constant load; two per cent for a quick change of load of twenty-five per cent, and six per cent variation for a quick change from no load to full load, or the reverse. The rotor of the dynamo, of which the moment of gyration is 700,000 kilogramme-metres, assures by its mass cyclic regularity of the dynamo, a special flywheel being unnecessary. The steam is expanded from fifteen to six and one-half times its volume at admission. Each group of engines is served by two surface condensers formed of bundles of brass tubes, around the exterior of which passes the condensing water, and through which circulates the steam. The circulating pumps and the air pumps are coupled directly to the crank pin of the engine by means of a connecting rod. This drives also the feed pumps which return the condensed water to the boilers.

The hand wheel of the admission valve, all the valves for the drips, the pressure indicators and speed indicators, etc., are grouped in the rear of the engine. From this point the engineer has complete control of the engines, having at the same time under his eyes all the distributing apparatus, the governor, etc. The governor—there being one for the group of two engines—controls the steam admission of the four cylinders and shuts it off if the load accidentally surpasses a fixed limit.

A small motor controlled from the distributing switchboard allows the counterweight on the engine governor to be displaced easily, so as to vary the speed of rotation and to facilitate in this way synchronizing alternators, which are to be put in parallel.

The four alternators have a normal output of 1,500 kilovolt-amperes at 6,600 volts. At the normal speed, the periodicity is twenty-five cycles per second. These alternators can support an overload



GALLERY WHERE HIGH-TENSION SWITCHES ARE LOCATED.

of fifty per cent for half an hour. The efficiency of the dynamos is ninety-six per cent for a power-factor of unity and at a load of 1,250 kilowatts, including excitation. The exciting groups are three in number, of which two are driven by induction motors supplied at 6,600 volts. The third is driven by a steam engine.

A battery of accumulators serves as a reserve for the exciters, in case of the

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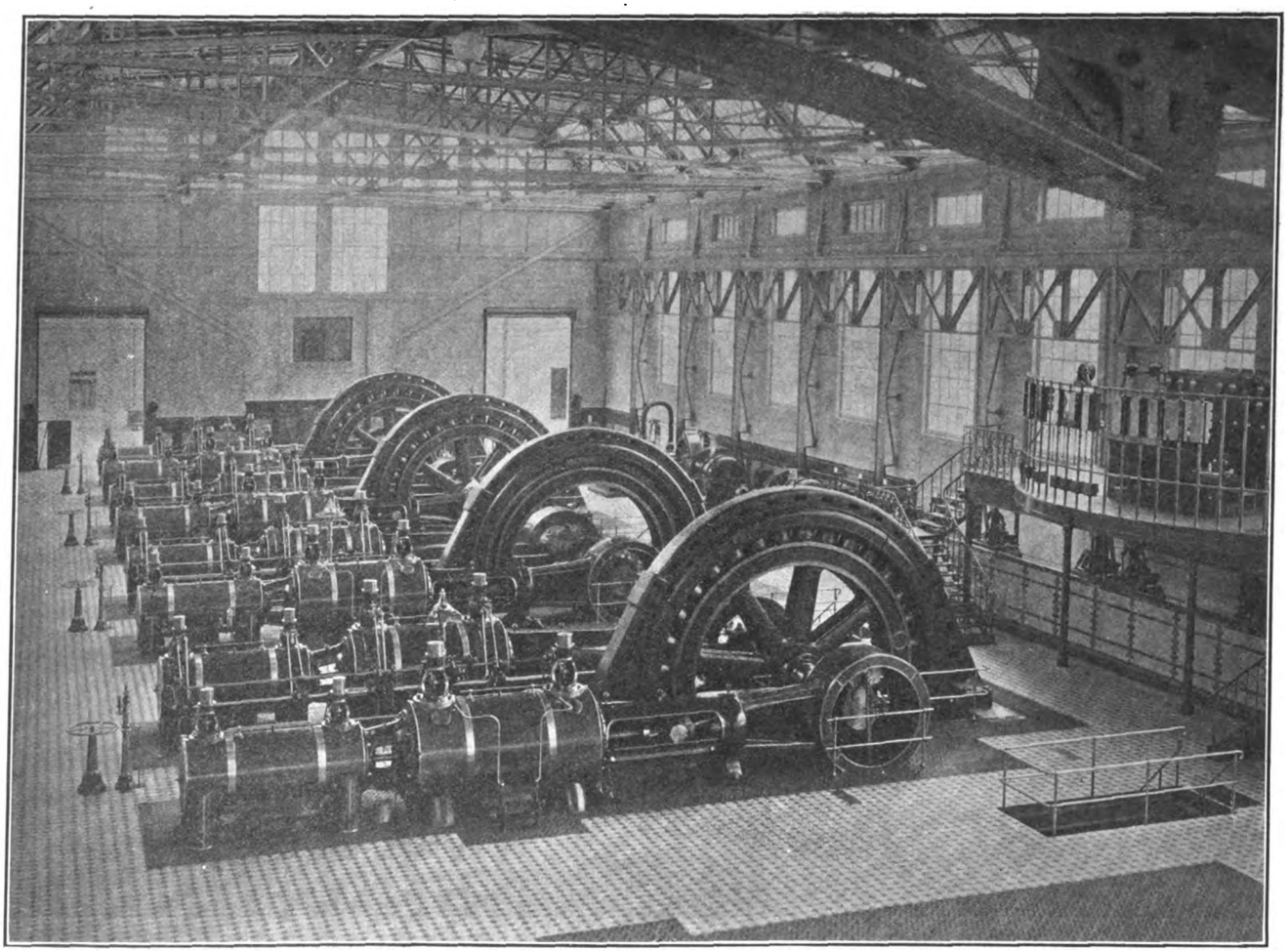
stoppage of any of them. The exciting dynamos have eight poles and an output of 100 kilowatts at 110 volts. They run at 230 revolutions per minute. The battery, as well as one of the exciting groups, supplies power for lighting and for auxiliary motors. In order that the exciting circuits may be unaffected by exterior causes, it is kept independent of the motor and lighting circuits, having no common point with them except the negative pole of the dynamo.

The switchboard and apparatus depending on it have been studied with a view of rendering operation as simple and easy as possible. In order to protect absolutely the employés against the dangers of high-tension apparatus, all of it is separated by masonry partitions. All high-tension interrupters are oil break switches controlled from a distance by small low-voltage continuous-current motors.

The switchboard proper of the station is placed on a platform, and is divided into three distinct parts. The first contains the low-tension and continuous-current apparatus for excitation, for the batteries, for the station lighting, and for the station motors. The second part of the switchboard includes principally the controlling apparatus for the high-tension interrupters. These are controlled from a distance, the apparatus appearing on the switchboard being only the motor switches for operating the oil break switches, for the three-phase generators, for the feeders going to the substations, for the induction motors driving the exciters, and for the switches which divide the principal bus-bars into sections. An arrangement of indicating lamps shows at all times whether the switches are open or closed. All of this apparatus is arranged on an operating-table placed in the centre of the platform. The third section of the switchboard includes the measuring apparatus for the three-phase generators, for the feeders, and for the motors, and the overload relays for automatically disengaging the oil break switches.

Each feeder, each generating dynamo and each induction motor has its panel where its instruments are assembled. All of these are low-tension instruments. The feeder panels include an ammeter for each phase. The generator panels are supplied with a phase meter, an ammeter, a voltmeter and a wattmeter. The induction motor panels are supplied with an ammeter and a voltmeter. In the middle of the table are placed a Lincoln synchronoscope and synchronizing lamps. In addition there is, corresponding to each induction motor, an automatic overload relay controlling an oil break switch. These relays are separated from the secondary circuit by small current transformers, and are fixed to the lower part of the switch columns.

All the high-tension apparatus is placed in the basement. A 550-ampere-hour accumulator is also in the basement of the coal house. This battery serves for lighting at night and as a reserve for the exciters.



INTERIOR OF CENTRAL STATION, SHOWING ENGINES AND GENERATORS AND SWITCHBOARD.

The oil break switches are of recent pattern, and were designed by the General Electric Company, of Schenectady, N. Y.

The boiler room contains ten Babcock & Wilcox boilers with 350 square metres of heating surface and six and one-half of grate surface. These are arranged in five groups of two each. One of the groups is equipped with Babcock & Wil-

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cox revolving grate stokers. Each of the five groups is furnished with a reheater and a Green fuel economizer. The latter consists of iron pipes placed in the smoke flues, and the feed water circulating through the pipes. The cleaning scrapers surrounding the tubes are raised and lowered by a small electric motor.

The boilers are fed normally by means of pumps connected directly to the cranks of the engines. As a reserve to these pumps, two steam pumps and one electric pump have been provided, the latter serving also to supply the water necessary for cleaning the tubes by means of a revolving scraper.

Each of the boilers is furnished with a superheater of about eighty square metres heating surface. This is composed of four transverse boxes, two above and two below, and connected by 144 steel tubes with an exterior diameter of thirty-eight millimetres.

The principal piping for the superheated steam is of weldless steel. A group of valves allows any section of pipe or any engine or boiler to be cut out without interfering with the other. The expansion of this pipe is taken up by two packed sleeves.

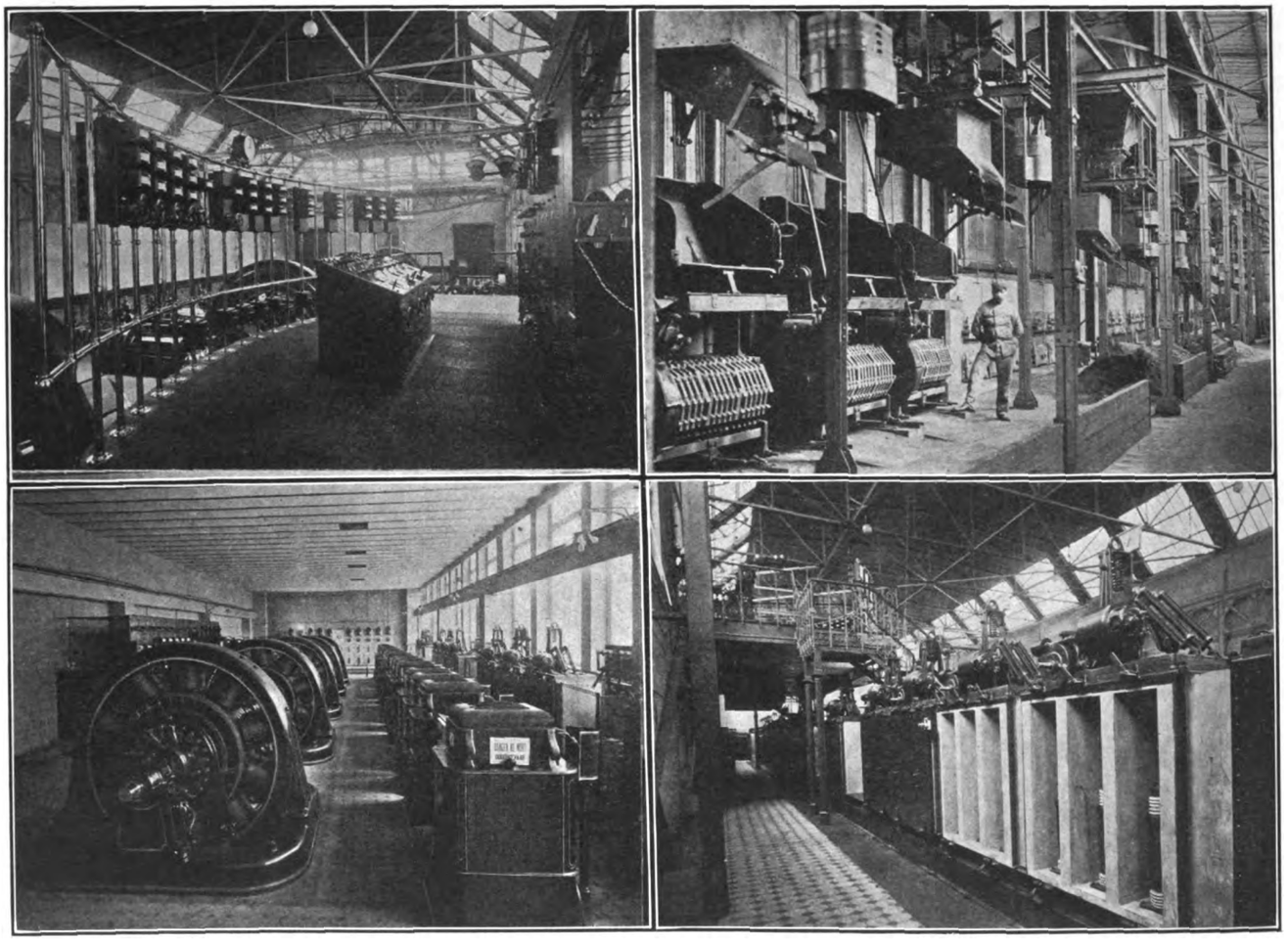
The coal-handling apparatus takes the coal directly from the boats or wagons and delivers it to the coal storage, delivers it before each boiler, and removes the ashes from the furnaces. It is driven by a continuous-current electric motor.

The Brussels Tramways, as has been said before, possess at the present time three substations placed in convenient localities for the city and the suburb. These three substations contain synchronous converters each, and do not differ materially from one another. The converters are six-pole machines, 410 volts on the alternating side and 550 volts on the continuous-current side. The output of these units is 550 kilowatts. Each converter has its three stationary transformers of 200 kilowatts each, which reduce the primary voltage from 6,600 volts to 410 volts. The end of each secondary is connected at two points of the armature diagrammatically opposite. The efficiency of the converters has been found to be about ninety-four per cent, at a power-factor of unity. They can support an overload of fifty per cent for a half hour, and are compound-wound.

The stationary transformers are air-cooled. Their efficiency is ninety-eight per cent, with a power-factor of unity, and they can stand the same overload as the converters.

The converters are normally started from the continuous-current side, and there is at each substation a starting group composed of an induction motor for 6,600 volts, driving a continuous-current dynamo of seventy-five kilowatts, 550 volts.

The design of the station was made toward the beginning of 1901. Work was started in September of the same year. The installation was completed in June, 1903. In its equipment the latest advances in electrotechnics have been followed.



MEASURING INSTRUMENTS AND SWITCHBOARD GALLERY. BOILER ROOM, BRUSSELS CENTRAL STATION.
INTERIOR OF ONE OF THE SUBSTATIONS, SHOWING CONVERTERS AND STATIC TRANSFORMERS. HIGH-TENSION CIRCUIT-BREAKERS.

The following are a few details in regard to the Brussels Tramways: The personnel has been increased at the present time to 2,000 men. The number of cars is 500. Electric traction enjoys such favor with the Brussels public that the road has carried during the year 1903 70,000,000 passengers, an enormous figure for a city as small as Brussels, which, without suburbs, does not possess more than 150,000 inhabitants. This is the more remarkable since the number of 70,000,000 does not include the numerous passengers who patronized the steam tramways, the suburban lines and the omnibuses.

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SHOP TESTING OF MOTORS AND GENERATORS FOR COMMERCIAL SERVICE—VI.

BY BERTRAND B. ABRY.

5—THE ALTERNATING-CURRENT GENERATOR.

We wish to consider here the usual factory tests made on an alternating-current generator. They are as follows:

1. Determination of polarity.
2. Measurement of resistance.
3. Iron loss and saturation test.
4. Short-circuit test.
5. Electromotive-force regulation test.
6. Temperature test.
7. Insulation test.

1. Determination of Polarity—In prefacing these articles on shop testing attention was called to the tests in general on electrical machinery. It was pointed out that the tests determine, first, the electrical performance of the machine, and second, the mechanical construction and

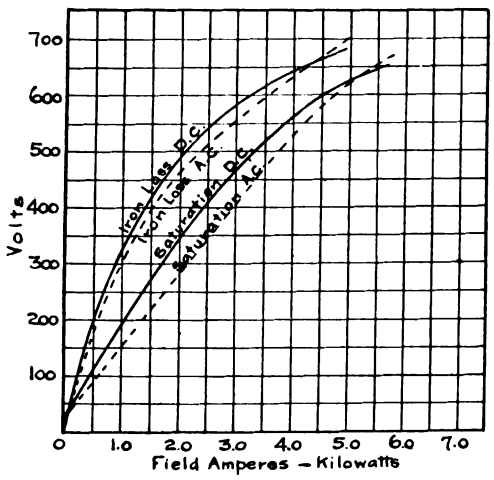

FIG. 15.—IRON LOSS AND SATURATION CURVES OF D. C. AND A. C. GENERATORS.

workmanship. It is for the purpose of detecting faults in the workmanship and in the assembly of the machine, and particularly in the field connections, that the test for the determination of polarity is made. More especially in the case of generators having a great number of poles are mistakes likely to occur in properly placing and connecting the field coils. The quickest method of detecting whether alternate poles are north and south is by the use of a compass or a simple steel needle suspended from its centre point by means of a thread. Such an instrument can very readily be made from a short piece of steel wire, and gives possibly better and more positive results than the small magnetic compass, the polarity of each pole being quickly determined by passing the needle before it.

2. Measurement of Resistance—As in the case of direct-current machines, the resistance of the field and armature of an alternating-current generator is measured by the fall of potential method, employing direct current. If, for example, the machine is a revolving field three-phase generator, we may first measure the cold resistance of the field, being careful in all cases not to use so great a current as will unduly heat the windings and increase the resistance during the observations, which may be recorded as follows, noting also the air temperature:

FIELD RESISTANCE AT TWENTY-SIX DEGREES CENTIGRADE.

Volts.	Amperes.
63.5	73.6
59.0	68.0
49.0	56.4

Usually if the drop and current are measured accurately it is not necessary to take more than three or four sets of readings from which to obtain the average resistance, but in order to eliminate as far as possible any error which may occur in reading the instruments, it is advisable to take at least three sets of observations. The number of the instrument and the scale used, whether high or low, should be noted in all cases, so that proper corrections can be made for the calibration, as explained earlier. In the case of the armature, the resistance of each phase is determined as follows:

ARMATURE RESISTANCE AT TWENTY-SIX DEGREES CENTIGRADE.

1-2.		1-3.		2-3.	
Volts.	Amperes.	Volts.	Amperes.	Volts.	Amperes.
111.0	34.4	103.0	32.3	102.6	32.1
86.0	26.6	96.8	30.3	97.0	30.4
80.8	24.6	92.2	28.8	92.0	28.8

Knowing the current and drop in each case, the resistance may be calculated for any number of observations and the average resistance obtained therefrom. Finally these resistances may be reduced to twenty-five degrees centigrade as explained heretofore.

3. Iron Loss and Saturation Test—The method of making an iron loss and saturation test on an alternating-current generator is very similar to the test on a direct-current machine. The generator is belt-connected to a shunt motor arranged to drive it at a constant speed. The following observations are made during the test:

Motor.			Generator.			
Volts.	Amperes.	Field Amperes.	Speed.	A. C. Volts.		Field Amperes.
				1-2.	1-3. 2-3.	

In the case of a three-phase machine the voltage across each phase is measured and recorded. These voltages should be exactly the same. The iron loss in watts is calculated from this data obtained during the test in the same manner as with a similar test on direct-current machines.

In Fig. 15 typical iron loss and saturation curves of corresponding direct and

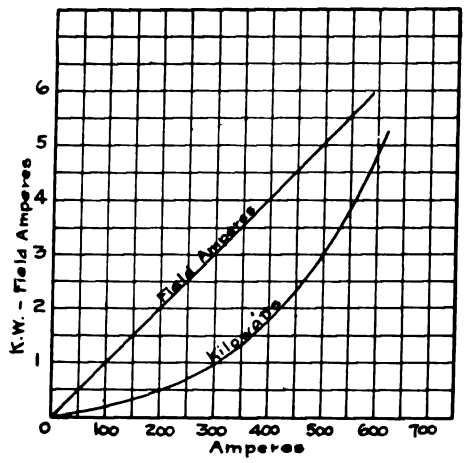

FIG. 16.—CURVES PLOTTED FROM SHORT-CIRCUIT TEST.

alternating-current generators are shown. It will be seen that the iron loss curves in both cases are somewhat similar, but we wish to call attention especially to the difference in the saturation curves of the two machines. As compared with the saturation curve of the direct-current generator, the saturation of the alternating-current machine is practically a straight line. That is, the iron is purposely worked at a lower induction in the case of the alternator. With direct-current machines proper regulation is secured on heavy loads by the automatic strengthening of the field. Alternating-current machines are, as usually designed, provided with a large number of poles. The proximity of the poles to each other gives rise to a greater magnetic leakage than in the case of direct-current machines. Excessive magnetic leakage would mean poor regulation on inductive loads.

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The alternator is usually designed then to run at a lower saturation under normal conditions so that this leakage will not defeat the effort to maintain normal voltage on such inductive loads. Hence the results of such a test when plotted should give very nearly a straight line saturation curve.

4. Short-Circuit Test—This test is usually made just after the iron loss and saturation have been determined. The same wiring and connections used in the iron loss test are employed, and the generator, with armature short-circuited, is driven at a constant speed by the shunt motor. After properly adjusting the motor field to give the correct generator speed, the first observations are made with zero generator field charge.

After the first set of readings is taken, a second set of observations is made with a generator field charge sufficient to give a dead short-circuit current through the armature equal to one-half the normal current output of the machine. Generally three sets of observations are all that is necessary to give the results desired. A final reading is taken with a field charge sufficient to give full load short-circuit current. The figures in the table above are only approximate and given merely for the purpose of showing the convenient method of recording observations.

Motor.			Generator.				
Volts.	Amperes.	Field Amperes.	Speed.	Amperes. Phases A	B	C	Field Amperes.
110	60	5.2	510	0	0	0	0
110	125	5.15	511	185	183	183	3.8
110	162	5.11	510	375	374	373	8.1

Having obtained these results we may plot a curve which will give at once the copper loss in the machine for any current output. The copper loss for two points on this curve is equivalent to the difference between the product of the motor volts and amperes with zero generator field current, and product of the motor volts and amperes for the two conditions as noted. This difference is plotted in watts or kilowatts. Fig. 16 shows this curve and the field ampere curve plotted with short-circuit amperes as a base and watts and field amperes as ordinates.

It will be seen from the curve that the copper loss increases very gradually at first, but on heavy loads the rate of increase is very rapid. This rapid increase in the copper loss accounts to considerable extent for the decreasing efficiency at these loads.

5. Electromotive-Force Regulation Test—By electromotive-force regulation of an alternating-current generator is meant the increase in per cent of the terminal voltage which results when the load is thrown off, the speed and field current remaining the same.

Alternating-current regulation tests on composite machines are usually made to determine what is known as (1) constant potential regulation, and (2) commercial regulation with maximum compounding.

In making such tests the generator is belt-connected to a motor arranged to drive it at constant speed. The wiring and connections for the motor are similar to those which were shown in Fig. 4 in the article on direct-current generator tests.

In making a constant potential regulation test the separate field is excited to give normal voltage on no load and this field current kept constant. The following observations are noted:

The test is begun at zero load and increased gradually up to about twenty-five per cent overload. If the machine is a three-phase generator, for example, the current in each phase is recorded as well as the electromotive force across each phase. With generators of this kind it is necessary to adjust the compensator by hand in order to secure constant potential regulation. Therefore during this test note also the different compensator amperes and volts to give constant potential with each change in load. The regulation curve is plotted as shown in Fig. 17 together with the separate field amperes, and the compensator amperes and voltage curves.

Generator.					
Speed.	Amperes.	Volts.	Field Amperes.	Compensator. Volts.	Amperes.

A commercial regulation test on an alternating-current compound-wound generator is usually a three-point regulation—zero, one-half and full load—with the compensator so adjusted as to give maximum compounding. The test is carried out in this way: with the generator running under the same conditions of speed and excitation as above noted, but with normal load, the compensator brushes are shifted until the maximum generator voltage is secured. When this point has been determined the brushes are left in that position throughout the test. After adjusting the compensator the generator load is reduced to zero and the first set of readings taken. Then increase the load to one-half full load, and finally full load, making a second and third set of observations respectively. Fig. 18 shows the curves plotted for the commercial regulation test. Constant potential regulation tests are made with a non-inductive load. A commercial regulation test with maximum compounding is usually made with a non-inductive load also, but very often it is desired that such a test be made with an inductive load of a certain per cent power-factor. If such be the case, the compensator is first adjusted to give maximum compounding. Such a load is obtained by the use of a rack and choke coils in parallel. If, for instance, it is desired to make a regulation test with an eighty-five per cent power-factor, the non-inductive and inductive loads are adjusted to give approximately this percentage. A wattmeter reading is then taken of the true kilowatt output, and the current and voltage measured to give the apparent kilowatts with the machine running at normal load. The ratio of the true kilowatts to the apparent kilowatts gives of course the power-factor. If we find in this way that the power-factor is too high, then the rack load should be decreased and more choke coils added until the desired ratio is obtained, and *vice versa* if the power-factor is too low. Fig. 19 shows the curves plotted from a test with inductive load.

In the case of those generators built with a separate field winding only, it is necessary to vary the field current by means of a rheostat in order to secure the desired regulation. However, we have not considered such a generator in particular, because almost all standard machines are built with compensator windings.

6. Temperature Tests—As in the case of direct-current machines, temperature

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tests on alternators are made to determine the temperature rise above the surrounding air after running at some specified load for a given time. This temperature rise bears a close relation to the rating

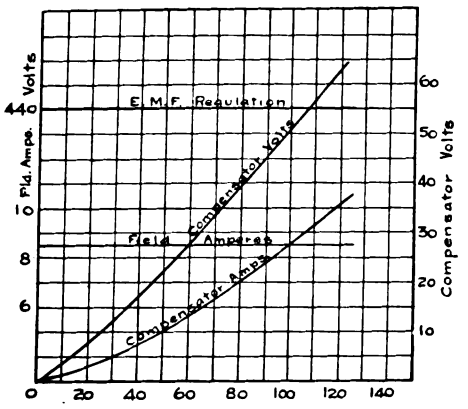

FIG. 17.—CONSTANT POTENTIAL REGULATION—RACK LOAD.

of the machine. On the smaller size alternators it is perfectly feasible to make a temperature test at normal load or some specified overload under usual operating conditions, in much the same manner as with the direct-current generator. But with the larger size generators running up to several hundred kilowatts capacity, facilities are not always at hand for taking care of such a load. If such a generator be a separately excited machine, the usual temperature test made is with a slightly higher field current than normal, with the armature open-circuited, and is in reality a field temperature test. During such a run, the speed, field current and field drop are observed every hour, and at the conclusion of the run thermometer readings are taken also. The test is continued under the above conditions until the field drop is practically

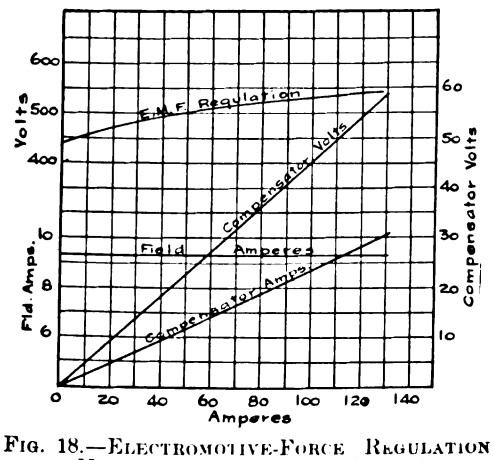

FIG. 18.—ELECTROMOTIVE-FORCE REGULATION WITH MAXIMUM COMPOUNDING—RACK LOAD.

constant, and may vary in length from eight to ten or twelve hours. The field is excited with a field current a little greater than normal in order to provide approximately the same conditions during the temperature run as would obtain under full load operating conditions with armature reaction present.

If the generator be a composite machine, such a temperature test is made with normal field excitation and the compensator open-circuited, it being assumed that the compensator current will offset the armature reaction when operating under normal conditions.

7. Insulation Test—Standard insulation tests on alternating-current generators are usually made between windings and ground at an alternating potential of approximately twice the rated voltage of the machine for those generators designed to run at 2,200 volts or over. For lower voltages than this, the insulation test may be at a potential as high as four times the rated voltage of the generator. There is a general tendency among manufacturers and engineers to adopt the American Institute standard in-

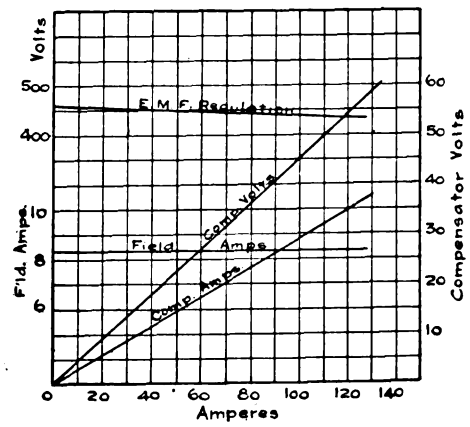

FIG. 19.—ELECTROMOTIVE-FORCE REGULATION WITH MAXIMUM COMPOUNDING—POWER-FACTOR LOAD.

sulation test of twice the rated voltage for one minute.

Wireless Telegraphy in China.

It is reported that the Italian legation at Pekin has installed a wireless telegraph station which will enable it to maintain communication with the Italian ships stationed at Taku, Tien-Tsin and on the coast. The first messages to be sent from the station were to the admiral's vessel, Vettor Pisani, in the Gulf of Pechili, 130 miles distant.

Rapid-Cutting Steel.

A joint committee, consisting of members of the council of the Manchester Association of Engineers, of Manchester, England, and of members of the Manchester School of Technology subcommittee, together with Dr. J. T. Nicolson, professor of mechanical engineering at the school, have just completed a long series of experiments, the purpose of which was to test the capabilities of some of the high-speed tool steels that have recently been introduced. The report of the committee embodying the results of the tests was presented at the meeting of the Manchester Association on October 24. The following abstract is from the *Electrical Engineer,* of London. In carrying out the experiments, a large lathe capable of carrying a steel forging of three tons weight was driven through countershafts by a 100-horse-power electric motor. The power was measured by the use of carefully calibrated volt and amperemeters, and the net horse-power used in cutting was ascertained by the aid of a powerful transmission dynamometer and a large Prony brake. In addition, the actual force exerted upon the tool when cutting was measured by a lathe tool dynamometer having a capacity up to fifteen tons fitted to the lathe. Cuts up to three-eighths inch by three-eighths inch were taken with the tool fixed in this dynamometer, the load being read off in the simplest way by means of a standard pressure gauge. It appeared from the trials that speeds of from 110 to 150 feet per minute were possible for soft steel, 80 to 110 feet for steel of medium hardness, and forty to fifty feet for hard steel. In the case of cast iron, speeds of 100 to 110 feet for soft, fifty to sixty feet for medium, and thirty to forty feet for hard were obtained. It was also found that forty-five square feet may be machined over in an hour by these rapid-cutting steels when operating upon soft steel with a cut three-sixteenths inch deep, the figures for medium and hard steel being thirty and eighteen respectively. With cast iron a surface of forty-two, eighteen and fifteen square feet may be turned off at the same cut in the case of the soft, medium and hard varieties respectively. But few specially heavy cuts were attempted, but it was found possible (when taking a cut three-eighths inch deep by one-eighth inch traverse) to remove 440, 330 and 180 pounds of cuttings per hour from the soft, medium and hard steel forgings respectively, and 450, 200 and 190 pounds from the soft, medium and hard cast-iron specimens. In one instance, with a three-eighths inch by three-eighths inch cut, cuttings were removed at the rate of 510 pounds per hour from soft-steel bar. The tests further showed that the forces acting upon the tool point when cutting were over 100 tons per square inch of area of section of cut in steel, and from fifty to eighty tons per square inch for cast iron. One of the most noteworthy facts discovered is that the cutting force does not increase, but appears rather to diminish, with increasing speeds. This is

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contrary to the opinion generally held by turners and machine tool experts, as instanced by the objections raised by workmen to an increase of the cutting speed on account of the anticipated springing of the work. This objection can no longer be sustained, for although higher speeds of taking a given cut will, of course, require a greater driving power almost in direct proportion to the increased speed, no greater but rather a smaller force will be brought upon the tool, and the load acting on belts and gearing, and the tendency of the lathe and work to spring, will be rather diminished than otherwise. On the other hand, it has been conclusively shown by these trials that heavy cuts at moderately high speeds are much more economical in power than light cuts at the highest possible speeds the tool can stand. For the cutting speed does not increase as fast as the area of the cut diminishes, so that more material can be machined off in a given time with a heavy cut than with a light cut at its corresponding faster speed. Further, the total or gross horse-power required for cutting consists of the sum of that lost by friction of the intermediate gearing and of the lathe, as well as the effective work spent upon cutting. Now, the frictional power does not vary much, whether there is a heavy or a light cut on the machine; it therefore forms a much larger percentage of the whole at light cuts than at heavy cuts. The value of the report is enhanced by the exhaustive tests of the physical and mechanical properties and the chemical constituents of the six different materials operated upon—namely, forged steel and cast iron, each of three grades of hardness.

The International Electrical Congress of September 12 to 17, 1904, at St. Louis.

We are informed that the following appointments have been made by Professor Elihu Thomson, president of the Committee of Organization of the St. Louis International Electrical Congress, for the officers of the various sections:

GENERAL THEORY.

Section A—Mathematical, experimental. Professor E. L. Nichols, chairman, Cornell University; Professor H. T. Barnes, secretary, McGill University.

APPLICATIONS.

Section B—General Applications. Dr. C. P. Steinmetz, chairman, Schenectady, N. Y.; Professor Samuel Sheldon, secretary, Polytechnic Institute, Brooklyn.

Section C—Electrochemistry. Professor H. S. Carhart, chairman, University of Michigan; Mr. Carl Hering, secretary, Philadelphia.

Section D—Electric power transmission. Mr. Charles F. Scott, chairman, Pittsburg; Dr. Louis Bell, secretary, Boston.

Section E—Electric light and distribution. Mr. J. W. Lieb, Jr., chairman, New York; Mr. Gano S. Dunn, secretary, Ampere, N. J.

Section F—Electric transportation. Dr. Louis Duncan, chairman, Massachusetts Institute of Technology; Mr. A. H. Armstrong, secretary, Schenectady.

Section G—Electric communication. Mr. F. W. Jones, chairman, New York; Mr. A. B. Gherardi, Jr., secretary, New York.

Section H—Electrotherapeutics. Dr. W. J. Morton, chairman, New York; Mr. W. J. Jenks, secretary, New York.

It is understood that all of these gentlemen, who are well-known specialists in the departments they represent, have already accepted these appointments, with the exception of one who has been yet unable to do so, owing to absence in Europe, but who is now returning.

The section officers will have charge of the proceedings of the congress at St. Louis in their respective sections.

The papers that are to be read at the congress will be communicated by invitation from well-known authors in this country and abroad. They are to be read and discussed at St. Louis during the congress week, September 12 to 17, 1904. They are then to be printed and published in book form.

Invitations to join the congress are steadily being issued to persons and parties interested in electricity. Over 6,000 such circular letters of invitation will be sent out in the United States, and a similar number to foreign countries. Most of the circulars are being directed to members of electrical industries, societies and scientific institutions. Joining the congress will entitle the members to attend the various functions at St. Louis and also to receive a copy of the subsequent transactions. It is expected that many will join the congress who can not expect to attend the sessions in St. Louis, merely to receive the subsequently printed transactions. The transactions are expected to form a very valuable addition to electrical literature, both theoretical and practical. Already about 350 Americans have joined the congress in response to circulars, and only part of the circular catalogue has been covered. There is, consequently, every reason to expect a large and representative membership in the congress, both from this country and abroad.

Communications concerning the congress should be addressed to the general secretary, Dr. A. E. Kennelly, Cambridge, Mass.

Memorial to Dr. Robert H. Thurston.

It has been proposed by President Schurman, of Cornell University, that the old students, alumni and friends of Sibley College and of the University undertake the erection of a new laboratory for Sibley College, as a memorial to the late Dr. Robert H. Thurston, and that the building be called Thurston Hall.

Notes on Electrical Engineering.

In connection with the instruction of non-electrical engineers in fundamental features of electrical applications and engineering at Sibley College, Cornell University, it has been found desirable to prepare an outline of a course of sixty lectures. The more elementary parts of this have been necessarily amplified into almost text-book form. These notes have been printed, in order to issue them to the large classes requiring them, to which they are supplied at cost price. It has occurred to the authors, Professors Harris J. Ryan and Henry H. Norris, that other institutions might find these notes useful, and they will be glad to furnish them to such as desire them, practically at cost. Those interested should address Professor Henry H. Norris, Sibley College, Cornell University, Ithaca, N. Y.

Wireless Telegraph Tests.

On October 24 Mr. William Marconi sailed from Portsmouth, England, on the battleship Duncan, for the Mediterranean, where he intends to carry out further experiments on wireless telegraphy. During the voyage he will attempt to establish communication with Gibraltar before he loses communication with the British ship, Hector, which will remain stationed off Portsmouth. It is said that the apparatus installed on the Duncan differs in some essentials from the standard instruments with which most of the men-of-war are equipped. Captain Jackson, who commands the Duncan, is an authority on wireless telegraphy, having recently served a commission in the Vulcan on the Mediterranean station, a vessel to which he was appointed to enable him to pursue his experiments. The Duncan took out a large quantity of wireless telegraph apparatus for distribution among the British Mediterranean fleet.

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THE CONDITIONS GOVERNING THE RISE OF TEMPERATURE OF ELECTRIC RAILWAY MOTORS IN SERVICE.

(Concluded.)

BY CARY T. HUTCHINSON.

The ratio of average to maximum core loss depends on the variation of core loss with speed and current; to fix this variation, the individual core loss curves of a number of motors were plotted, and a curve determined showing the average variation of the core loss. Curve-sheet 9 shows the curve of the average variation of core loss used in this investigation; the values from this curve were plotted on the various velocity time-sheets and integrated; this gives the core loss during acceleration on the motor curve. In addition to this, core loss curves of several motors, differing widely, were selected, and the ratios of average to maximum for different operating conditions were determined. These ratios were found to differ comparatively little for the different curves—much less than the actual values of the core losses differ. The average core loss during the period of acceleration on resistance was taken at forty-two per cent of the maximum core loss. This value was obtained from a number of separate core loss curves.

The average percentage heat loss during acceleration to the same maximum velocity for any motor is practically independent of the initial acceleration; the ratio of average to maximum copper loss increases with the acceleration, while the ratio for the core loss decreases.

The variation of the loss with initial acceleration in two typical cases is given in the tables following:

TABLE I.

Average heat loss, for velocity of 150.
Copper loss at rated load = 3 per cent
Core " " " " = 3 "

Initial Acceleration.	Average Loss.
1 mph/sec.	3.88 per cent
1.5 "	3.91 "
2 "	3.91 "
2.5 "	3.91 "

TABLE II.

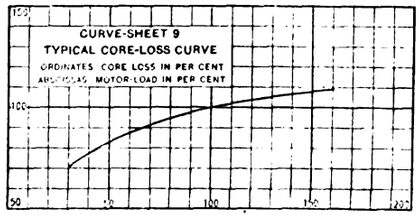
Average heat loss, for velocity of 150.
Copper loss at rated load = 7 per cent
Core " " " " = 1 "

Initial Acceleration.	Average Loss.
1 mph/sec.	4.77 per cent
1.5 "	4.92 "
2 "	5 "
2.5 "	5.03 "

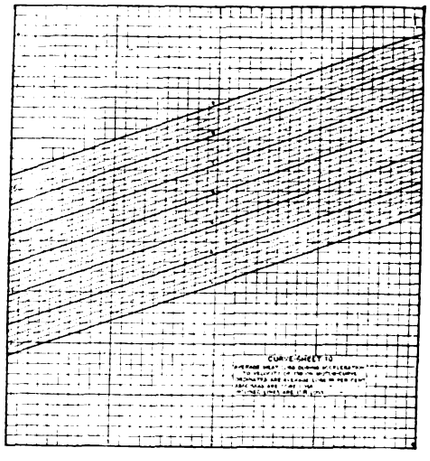
For velocities greater than 150, the variation is greater; for lower velocities, it is less. The values for $(a) = 1.5$ are used.

Although this approximation is satisfactory for the purpose, yet if greater accuracy is desired, it is possible to plot the average loss for the various initial accelerations separately; but the complication is very much increased.

Curve-sheet 10 gives the average percentage heat loss during acceleration for any combination of copper and core losses within the range covered, for a velocity of 150 on the motor curve. The ordinates are average loss, the abscissæ core loss, and the inclined lines copper loss; for instance, for a four per cent copper loss and 2.5 per cent core loss, the intersection of the vertical at 2.5 with the inclined line marked four, gives the average loss of 4.12 per cent, and this this will be the average loss occurring in a motor accelerating by series parallel, and then on the motor curve to a velocity fifty per cent greater than the velocity when resistance is cut out, the motor having a four per cent copper and 2.5 per cent core loss; the capacity being determined by the product of the torque during initial acceleration and the velocity with resistance out, that is the maximum power input.



CURVE-SHEET 9.

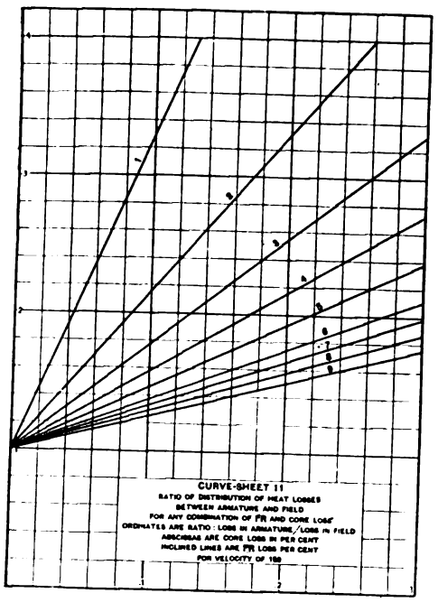


CURVE-SHEET 10.

The ratio of distribution is practically independent of the initial acceleration for a given maximum velocity, and for the range of initial acceleration used, *i. e.*, from $(a) = 1$ to $(a) = 3$. While this is not strictly correct, yet the difference between the values calculated accurately and the values found by assuming an average ratio of mean to maximum copper and mean to maximum core loss, does not exceed five per cent for the range covered; since this ratio is used only to fix the appropriate value of the radiation constant (of which the determination is in itself necessarily rough) the degree of accuracy is sufficient.

Curve-sheet 11 gives, for a velocity of 150, the ratio of distribution as ordinates, with core loss as abscissæ, and with inclined lines for the various copper losses; for instance, with copper loss of four per cent and core loss of 2.5 per cent, the ratio of distribution is 2.44. It is assumed that the copper loss is half in armature and half in field.

These curves then determine the average loss during acceleration and its distribution; to get the average loss during the run the ratio of time of acceleration to time of run must be known.


CURVE-SHEET 11
RATIO OF DISTRIBUTION OF HEAT LOSSES
BETWEEN ARMATURE AND FIELD
FOR ANY COMBINATION OF FR AND CORE LOSS
ORDINATES ARE RATIO: LOSS IN ARMATURE/LOSS IN FIELD
ABSCISSAS ARE CORE LOSS IN PER CENT
INCLINED LINES ARE FR LOSS PER CENT
FOR VELOCITY OF 150

CURVE-SHEET 11.

Referring to Fig. 3,

$$RH/OR = AD/OD$$

i. e.,

$$(100 + a\,t_2)/Y_t = (t_1 + t_2)/x$$

and

$(100 + a\,t_2)/Y_t \times x/T = (t_1 + t_2)/T =$ time of acceleration divided by total time.

x/T is taken from curve-sheet 1 for the various values of A and (a), thus the ratio of the times is determined for all conditions the corrections to the type curve must be allowed for.

Curve-sheet 12 has been prepared in this way—it gives the average percentage loss during the run, for various initial and through accelerations, for a motor having a copper loss of four per cent, a core loss of 2.5 per cent, and consequently an average loss during acceleration to a velocity of 150, of 4.12 per cent. The ordinates are average losses in percentage

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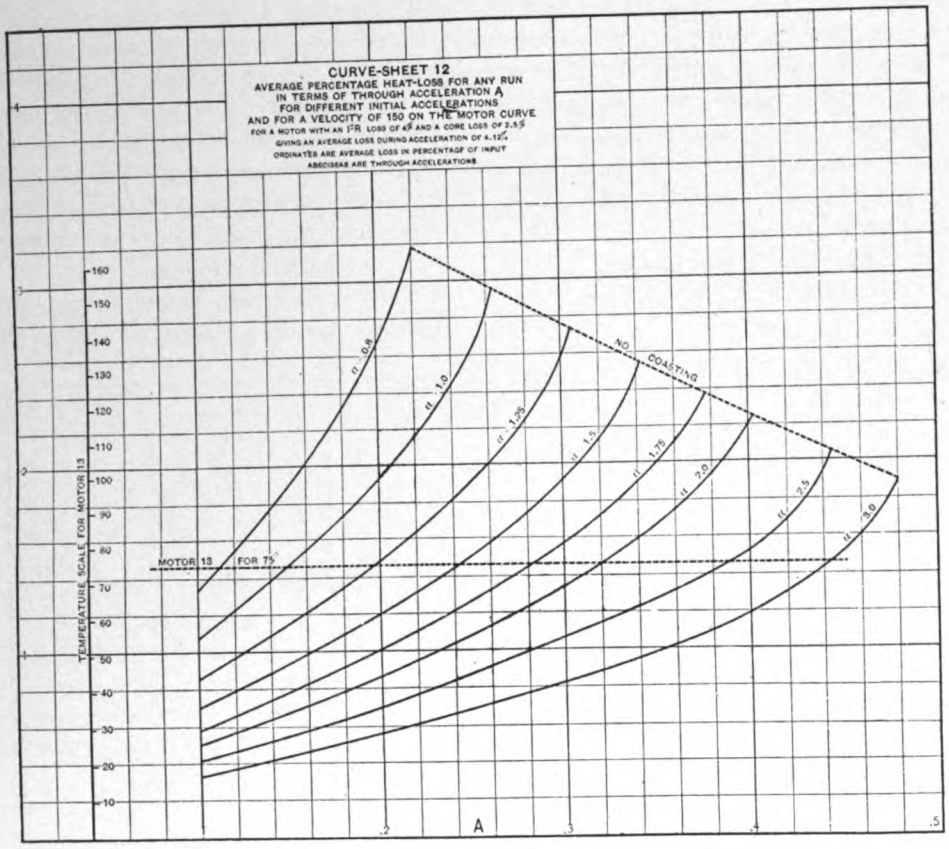
of maximum input; the abscissæ are through accelerations and the separate curves are for the different initial accelerations.

The average loss during any particular run is equal to the average loss during acceleration multiplied by the ratio of the


CURVE-SHEET 12
AVERAGE PERCENTAGE HEAT-LOSS FOR ANY RUN IN TERMS OF THROUGH ACCELERATION A FOR DIFFERENT INITIAL ACCELERATIONS AND FOR A VELOCITY OF 150 ON THE MOTOR CURVE
FOR A MOTOR WITH AN I²R LOSS OF 4% AND A CORE LOSS OF 2.1%
GIVING AN AVERAGE LOSS DURING ACCELERATION OF 4.12%
ORDINATES ARE AVERAGE LOSS IN PERCENTAGE OF INPUT
ABSCISSAS ARE THROUGH ACCELERATIONS
TEMPERATURE SCALE FOR MOTOR 13
MOTOR 13 FOR 75°
a = 0.8
a = 1.0
a = 1.25
a = 1.5
a = 1.75
a = 2.0
a = 2.5
a = 3.0
NO COASTING
A

Curve-Sheet 12.

times, and since this ratio is independent of the losses in the motor, it is obvious that curve-sheet 12 will represent the average loss during that run for any motor, if the ordinates are varied in proportion to the average losses during acceleration. Curve-sheet 10 gives the average losses during acceleration; hence these two sheets will determine the average losses for any motor for any run, accelerating to a velocity of 150 on the motor curve. For example, a motor with a nine per cent copper and two per cent core loss has an average loss during acceleration of 6.7 per cent; curve-sheet 12 is plotted for an average loss of 4.12 per cent, hence if its ordinates be multiplied by $6.7/4.12 = 1.63$ it will give average loss for the second motor.

For example,

For (a) = 1.25 mph/sec.
and A = 0.2 "
Average loss = 1.48 per cent (curve-sheet 12)

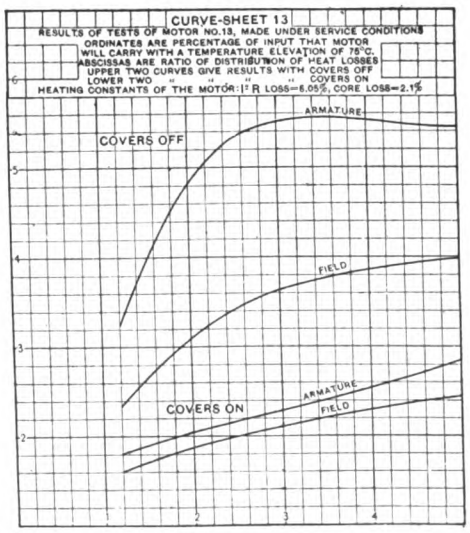
and therefore

1.63×1.48 per cent = 2.41 per cent.

is the average loss of the second motor for the same run. Similarly for other combinations of copper and core loss.

These curve-sheets determine the average heat loss of any motor for any run, and its ratio of distribution; it remains then to connect these calculated values with results of test made under comparable conditions of service, giving the temperature rise for various losses, *i. e.*, with the radiation coefficient of the motor under consideration.

Many tests of this nature have been made by the General Electric Company on its experimental track at Schenectady,


CURVE-SHEET 13
RESULTS OF TESTS OF MOTOR NO.13, MADE UNDER SERVICE CONDITIONS
ORDINATES ARE PERCENTAGE OF INPUT THAT MOTOR WILL CARRY WITH A TEMPERATURE ELEVATION OF 75°C.
ABSCISSAS ARE RATIO OF DISTRIBUTION OF HEAT LOSSES
UPPER TWO CURVES GIVE RESULTS WITH COVERS OFF
LOWER TWO " " " " COVERS ON
HEATING CONSTANTS OF THE MOTOR: I²R LOSS=6.05%, CORE LOSS=2.1%
COVERS OFF
ARMATURE
FIELD
COVERS ON
ARMATURE
FIELD

Curve-Sheet 13.

by running trains back and forth over the track until permanent conditions of temperature have been attained, and at the same time, measuring the losses in the motors.

Curve-sheet 13 gives such test results for a motor in general use; the ordinates give the average loss in percentage of input that the motor will carry with a rise of temperature of seventy-five degrees centigrade under the conditions of service determined by the ratios of distribution denoted by the abscissæ; these curves are calculated from test results which give the rise of temperature per watt lost for field and armature separately; the curves are given for tests made with covers on the motors and covers removed. Thus curve-sheet 13 shows that for a ratio of distribution of two, the armature of motor No. 13 will carry, with covers off, a load giving a loss of 4.82 per cent, whereas the fields will stand only 3.1 per cent; but if this motor be used with covers on, then at the same ratio the armature will stand a load giving a 2.05 per cent, and the fields a 1.88 per cent loss—very nearly the same, as should be.

These test results are used as follows:

Motor No. 13 has

Copper loss = 6.05 per cent
Core " = 2.10 "

Then

Average loss during acceleration to velocity 150 = 5.06 per cent (curve-sheet 10)

Ratio of distribution of losses = 1.77 per cent (curve-sheet 11)

At this ratio of distribution, the permissible loss, with covers on, is

Armature, 1.98 per cent (curve-sheet 13)
Field, 1.80 " (curve-sheet 13)

Hence the field controls, and the motor can carry only a load giving a loss of 1.8 per cent; the armature will then run much cooler than seventy-five degrees; in fact, at $1.8/1.98 \times 75° = 68°$ centigrade.

Curve-sheet 12 is plotted for an average loss of 4.12 per cent, hence to apply it to motor No. 13, the ordinates should be increased in the ratio of $5.06/4.12 = 1.23$: if this were done and a horizontal section of curve-sheet 12 were taken with the 1.8 per cent line for ordinate, the initial accelerations would be determined, for each through acceleration, that would result in a loss of just 1.8 per cent and consequently in the exact temperature rise permitted; but the same numerical results will be obtained by taking a cross-section of curve-sheet 9 at the ordinate 1.8 per cent $/1.23 = 1.46$ per cent.

The dotted line marked "motor No. 13" shows this cross-section.

The values of (a), the initial acceleration, as determined by this cross-section, are plotted on curve-sheet 14 in terms of A as abscissa; the corresponding values of energy per ton-mile and of horse-power

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per ton for velocity of 150 are taken from curve-sheet 3 and 4. Thus, curve-sheet 14 gives the data for this motor under any conditions of service, for a maximum velocity of 150. The comparison has been made on the tacit assumption that the test results of curve-sheet 13 represent average losses during running time; if, as is usual, the test values represent average losses during total elapsed time, they must be increased in the ratio of total elapsed time to running time and this increased value used for the cross-section of curve-sheet 12.

This is all for a rise of temperature of seventy-five degrees centigrade; if the permissible rise be sixty degrees, then the permissible loss will be only

$60/75 \times 1.8$ per cent $= 1.44$ per cent

and 12 must be cross-sectioned at

$1.44/1.23 = 1.17$ per cent

to determine the proper accelerations for the various through accelerations.

Curve-sheet 12 then gives the rise of temperature of any motor for any through acceleration, with any initial acceleration, after its cross-section line has once been fixed; for example—for this motor the seventy-five degrees rise is given by the accelerations having for ordinates 1.46 per cent; suppose that for the through acceleration A = 0.2, an initial acceleration of 1 be used; then the average loss will be 1.93 per cent, and since temperatures are proportional to losses, the temperature of the hottest part will be $1.93/1.46 \times 75° = 99°$ centigrade. If an initial acceleration of 1.75 per cent be used, the rise of temperature will be $1.00/1.46 \times 75° = 51°$ centigrade.

That is, for any motor and any value of A, the ordinates of curve-sheet 12 will give the rise of temperature for any initial acceleration; each initial acceleration corresponds to a definite rise of temperature for each through acceleration; a vertical cross-section of curve-sheet 12 at any value of A shows the relation of rise of temparture and initial acceleration for that through acceleration. The dotted vertical line on curve-sheet 12 gives the temperature scale for motor No. 13, for A = 0.25 and $(a) = 1$, the rise will be 134°; for A = 0.15 and $(a) = 2$, the rise will be 40.5 degrees. The temperature scale can thus be drawn in sheet-curve 12 for any motor, knowing its heating constants.

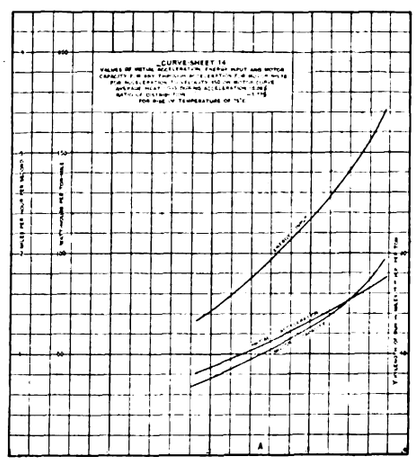
In order to avoid confusion, it is essential to recall that each change of initial acceleration means a proportional change in motor capacity, the motor capacity being directly proportional to the product of initial acceleration and the maximum velocity. It is thus tacitly assumed that the engineer has a complete range of motors of all capacities, all with the same heating constants; but the results are given in horse-power per ton and hence they give merely a determination of the load that any given motor will carry, under the various conditions.

Returning to the example given on page 6, where the initial acceleration was assumed to be 1.25 mph/sec.; if the heating constants of the motor to be used are known, the initial acceleration will be fixed; assume the motor for this run to have these constants:

I^2R loss = 3.6 per cent
Core loss = 2.75 per cent

Then

Ratio of distribution = 2.8 (curve-sheet 11)
Average loss during acceleration = 4.06 per cent (curve-sheet 10)



CURVE-SHEET 14.

Assume,

Radiation at ratio of 2.8 = 1.6 per cent.
Then a horizontal section of curve-sheet 12 having as ordinate $4.12/4.06 \times 1.6$ per cent = 1.62 per cent gives, for A = 0.266 — the through acceleration under consideration, —
Initial acceleration = 1.5 mph/sec.

and

Energy = 83 wh (curve-sheet 3)

$$\text{Capacity} = 11.6 \left(\frac{7{,}000}{5{,}280}\right)^{\frac{1}{2}} = 13.3 \text{ hp/ton (curve-sheet 4)}$$

This example corresponds to an actual case; the engineers of the project have decided to use an initial acceleration of 1.5 mph/sec., and expect to obtain an energy consumption of eighty-seven wh per ton-mile; these figures agree closely with those above.

Curve-sheet 14 gives what may be called the "characteristic performance" of motor No. 13, used for any schedule. It is obvious that curve-sheets similar to this can readily be plotted for maximum velocities of 125 and 175. A comparison of such curve-sheets for the different maximum velocities will, in general, show slight variations in motor capacity for different initial accelerations for a given schedule. In some cases the minimum motor capacity is attained with an average maximum velocity, say, from 140 to 150; in other cases the motor capacity diminishes as the maximum velocity is increased, up to the limit used in this investigation. No general conclusions can be drawn for the particular relative maximum velocity to be used; this depends principally upon the heating constants of the motor, including the radiation. It is clear, however, that by aid of curves such as curve-sheet 12 for the various maximum velocities, the minimum motor capacity can be found for any particular motor; all that is necessary is to draw the cross-section lines at the proper points, thus fixing the value of the initial acceleration, and then to select the values of energy and horse-power from the different curve-sheets. In the case of motor No. 13, curve-sheet 14 for velocity of 150 gives practically the minimum motor capacity; there is a diminution for greater maximum velocities, but it is comparatively unimportant.

In all cases, the particular initial acceleration leading to the minimum motor capacity should be adopted, even though this initial acceleration does not give minimum energy. The curves give the energy required per ton of total weight; hence the energy required per car is proportional to these figures multiplied by the relative weight of the car. The difference in the energy per ton for any schedule is comparatively slight for the different maximum velocities, and in all cases the energy required per car is a minimum for the minimum motor capacity with which the schedule can be made; the increase in the weight of equipment much more than balancing the diminished energy per ton obtained by using higher initial acceleration and higher motor capacity. Curve-sheet 15 gives the ratio of weight of equipment of different capacities; it is substantially the same as curve-sheet 15 of the former paper. The energy per ton multiplied by the ordinates of this curve-sheet gives relative figures showing the energy per car.

By this method, the two quantities that have, up to this point, been matters of arbitrary choice, are determined, *i. e.*, the initial acceleration and the relative maximum velocity on the motor curve. Having then a motor with known heat-

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ing constants, all the conditions which should govern its use for any particular schedule are fixed, and consequently the difference in the results attained by the use of motors with different heating constants is also determined.

I have illustrated the application of this method in comparing the availability of motors with different heating constants for a particular service. It is clear that it can also be used to obtain the data for different schedules. As an example of this use, suppose the data for various schedule speeds for a run of 7,000 feet, with twenty-five second stops, are to be determined. Assume the motor represented by curve-sheet 12, a maximum velocity of 150, and that the motor has a radiation coefficient of 1.6 per cent, for a rise of temperature of seventy-five degrees, at the ratio of distribution 2.44, determined by curve-sheet 11. From these data the following table is deduced, showing the performance of this motor for the different schedule speeds.

Column 1 of table III gives the assumed schedule speed; column 2, the calculated average speed; column 3, the calculated through acceleration; column 4, the initial acceleration from curve-sheet 12, the values being the intersection of the horizontal line having an ordinate of 1.6 per cent, with the several values of the through acceleration; column 5 is taken from curve-sheet 3; column 6 is taken from curve-sheet 4; column 7 is the ratio of the numbers of column 6, and gives merely the relative capacity of motor equipments required; column 8 gives the relative weights of motor equipments, from curve-sheet 15; column 9 gives the relative total energy; it is obtained by dividing the product of the figures of columns 5 and 8 for any schedule speed, by the corresponding product for a schedule speed of twenty-five mph. Since the weights are all given for a motor car of a definite seating capacity, these figures give the relative energy requirement per car seat, or per passenger, for the various schedule speeds.

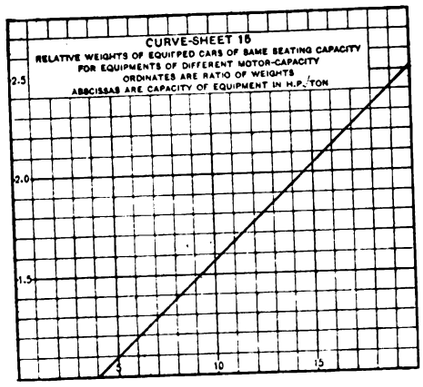
The curve-sheets show initial accelerations as high as three mph/sec., and through accelerations up to A = 0.4; these values are beyond the range of practice, both on account of the excessive motor capacity demanded and the close approach to the slipping point of the wheels, with the usual percentage of total weight on drivers. The boundary lines of the curve-sheets can fairly be taken as

$$A = 0.1 \text{ to } A = 0.3$$

and

$$(a) = 0.8 \text{ to } (a) = 2$$

This indicates the comparatively narrow limits within which all schedules are brought by the use of the quantity A.



CURVE-SHEET 15.

It is obvious that the methods outlined here can be applied to alternating current motors by the use of appropriate speed-torque curves in place of those of curve-sheet 2.

The method which has been developed takes account of all the factors governing the rise of temperature of motors under conditions of service. While certain assumptions have of necessity been made—as, for instance, a constant value for train friction—it is perfectly feasible to recalculate the curve-sheets with other values of train friction; a set of curve-sheets similar to curve-sheet 12, including as many maximum velocities as may seem desirable, can be prepared and used as standard curves from which the rise of temperature of any motor can be determined very simply, for any conditions of service.

While the results obtained by this method are of necessity an approximation because of the number of assumptions that it is necessary to make in developing the method, yet numerous applications of the curve-sheets to practical examples have shown that the approximation is close, and that the curves furnish a useful means for determining the performance of any motor in service.

TABLE III.

Schedule Speed.	Average Speed.	Through Acceler-ation.	Initial Acceler-ation.	Wh/Ton.	Hp/Ton.	Relative Motor Capacity.	Relative Weights of Equipment.	Relative Total Energy.
1	2	3	4	5	6	7	8	9
25	28.8	.174	1.04	58	9.2	100	1.49	100
27.5	32.1	.216	1.25	69	10.9	119	1.65	132
30	35.6	.266	1.52	83	13.4	146	1.89	181
32.5	39.1	.320	1.87	102	18.5	201	2.37	280
35	42.9	.386	2.34	134	26.5	288	—	—

A New Interest in Platinum.

Ever since the discovery, in December, 1901, of the platinum group of metals in the copper ores of the Rambler mine, Wyoming, interest in that scarce and valuable metal seems to have been greatly stimulated. One indication of it has been the increased demand for bulletin No. 193 of the United States Geological Survey, which is a report by Professor James A. Kemp on the "Geological Relations and Distribution of Platinum and Associated Metals." The original issue having been exhausted, the Survey has ordered a reprint of the bulletin.

It is unfortunate that the world's known supply of platinum is so limited. The uses of the metal would be greatly increased if it could be obtained in sufficiently large quantities to lower the price. There is, unhappily, for many purposes, no metal to take its place, and the limited supply maintains its price almost equal to that of gold. The demand for it has been somewhat increased in the last few years by the discovery of a use for osmium, which occurs to a considerable extent in American platinum as the mineral osmiridium. Its presence formerly interfered very seriously with the sale of the crude platinum product, as it is a heavy, hard, refractory mineral that made the treatment of the platinum very difficult. Osmium is now required for the manufacture of the filaments of the new Auer incandescent electric lights, so that platinum, both on its own account and on that of its heretofore despised attendant, osmiridium, has become wholly desirable.

According to Professor Kemp platinum deposits occur in three forms or ways: (1) In placers, as exemplified by those in the Urals, Colombia, Brazil and British Columbia. (2) In veins, as at Tilkerode in the Hartz; Minas Geraes, Brazil; Santa Rosa, California; Beresovsk, Russia; Gualdalcanal, Spain; and the Rambler mine, Wyoming. (3) Disseminated in eruptive rocks, in two ways; (*a*) in sperrylite, with the copper-nickel ores in uralitized norite, Sudbury, Canada, and (*b*) as a native metal in basic eruptive rocks, especially peridotites, frequently intimately associated with chromite.

The conclusions of practical value arrived at by Professor Kemp are: 1. That platinum is very sparsely distributed in the mother rock, so that the chances of finding it in quantity sufficient to mine are small; also, if found, the problem of recovering the platinum other than by stamping and washing is yet to be solved; furthermore, the metal may be in a very finely disseminated state, and its extrac-

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tion will necessarily be difficult. 2. Large and permanent placers should be sought only on very old land areas, which have been subjected to protracted degradation and concentration. 3. In the assay of antimonial, arsenical, and other copper ores (especially tetrahedrite) it is advisable to search for small percentages of platinum. 4. Deposits of chromite should be tested for the presence of the metal.

A New Auto Record.

Charles L. Edgar's electric automobile, equipped with the new Edison storage battery, which made the run described in the ELECTRICAL REVIEW for October 31, from Boston to New York in remarkably good time, made the return trip from New York in the time of forty-eight hours and thirty minutes. The carriage has double-motor equipment, sixty-eight cells of Edison battery and solid tires. The total weight of the carriage, without driver, is 3,150 pounds.

H. M. Wilson, who ran the carriage through to New York on the previous trip, started on the return trip to Boston on Friday evening, October 30, at 5.35 o'clock, the start being made from 1684 Broadway, the central auto station. Stamford was reached at 9.10 A. M., stopping fifteen minutes on the way. The battery was put on charge at Stamford at 9.16 A. M., at a high rate, for three hours. Leaving Stamford at 12.36 P. M., the railroad bridge at Bridgeport was passed at 2.30 P. M., and New Haven was reached at 4.18 P. M. The cyclometer reading was seventy-nine miles from New York. The battery was then given a little less than three hours charge and the auto left New Haven at 7.30 P. M. being driven by F. H. Sadler, of the Edison Storage Battery Company.

As Mr. Sadler had never been over the road, and as the run was to be made at night, a man was hired to accompany him to Springfield. A quick run was made to Hartford, arriving there at 11.05 P. M. The battery was put on charge at 11.10 P. M., for two hours and fifty minutes, at 100 amperes; after the first half hour, however, owing to the wiring of the carriage getting hot, this rate was reduced. Mr. Sadler then headed for Springfield at 3 A. M., Saturday.

At 4.30 A. M., in pitch darkness, the headlight revealed a sharp turn in the road. The auto was going at full speed, and before Mr. Sadler could change his course he found himself plowing through red mud and broken sods. In a few seconds the rear wheels settled down to their hubs in it and the motors were quite out of sight. After vain attempts to get it back into the road, a native near by was persuaded to leave his warm bed and hitch up his team of horses. With their assistance the auto was soon on the beaten road again and none the worse, except for the extra load of real estate which it brought with it into Springfield. Springfield, owing to this delay of one hour and forty-five minutes, was not reached until 7.21 A. M. The battery was then put on charge for four hours and twenty-five minutes at as high a rate as possible.

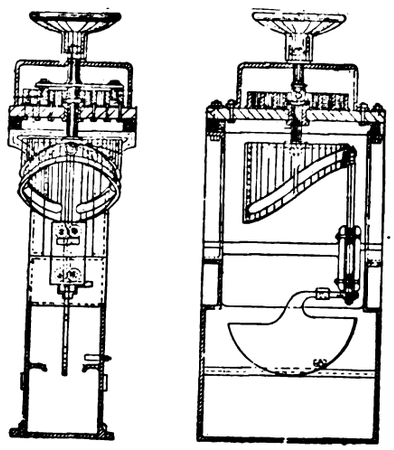
The start was made from Springfield at 1.07 P. M., Mr. Wilson being accompanied by W. G. Bee, of the Edison Storage Battery Company. Between Springfield and Worcester some very bad stretches of sandy road were encountered, and for much of the way the motors required double the normal amount of current, even on level portions of the road. After climbing the long steep grade at Spencer, the speed had greatly diminished; and it was deemed expedient to stop at the electric light station and obtain a short charge if possible. Upon arriving there, there was a delay of one hour waiting for the engineer to come, and when he finally did arrive it was found that there were no facilities for charging.

The only thing to do was to keep on and be as economical of current as possible, and in a few minutes the long down grade into Worcester carried them well into the city. After two miles or more at a snail's pace, the charging station was reached, and none too soon, the battery being so low that it was necessary to push it up the incline to the garage. The charge of three hours and forty-five minutes at a high rate was then given the battery, and Messrs. Bee, Sadler and Wilson started off at 1.50 A. M. Sunday for Boston, passing through Marlboro, Framingham Centre, and following the line of the Boston & Worcester cars to Wellesley Hills, and then through the Newtons and into Boston, arriving at the Electric Vehicle Company's station on Stanhope street, at exactly 6.05 A. M.

The total elapsed time from New York to Boston was forty-eight hours and thirty minutes, and the actual running time was twenty-two hours and fifty-two minutes, the average speed being 10.8 miles per hour. Had the motors been geared for a higher rate of speed the actual running time could have been materially decreased, the battery being capable of a much higher rate of discharge. The total cyclometer readings going to New York and returning were remarkably close. From Boston to New York the cyclometer read 249⅛. On the return trip, although some changes were made in the route, the cyclometer read 249½.

A Liquid Rheostat.

A convenient form of liquid rheostat has been developed by Messrs. Steel, Peach & Tozer, of Sheffield, England. The liquid is contained in a rectangular box of iron, which forms one electrode. Into this a semi-circular plate of iron dips, the motion being imparted to it by means of a roller connected to a stem extending from the plate, and a cam which is turned by means of a hand wheel placed on the top of the rheostat. Connection is made with the plate through brass rings and sliding blocks. The rheostat is connected in such a manner that turning the hand wheel to the right starts the motor in one direction, and turning it to the left starts it in the other. When the dipping plate has reached the limit of its motion, a contact block short-circuits the rheostat. This type of starting box is now being used by



NEW TYPE OF LIQUID RHEOSTAT.

the makers for controlling the motors used in their mills. It is said to be suitable for voltages up to 900, and for motors of any horse-power.

The Advisory Committee on the Building Fund of the American Institute of Electrical Engineers.

The following gentlemen have been appointed by President Arnold as members of the advisory committee on the building fund of the American Institute of Electrical Engineers, for the year ending September 25, 1904: Mr. Union N. Bethell, 15 Dey street, New York city; Mr. N. F. Brady, 57 Duane street, New York city; General Eugene Griffin, 44 Broad street, New York city; Mr. Charles W. Price, 13 Park Row, New York city; Major Samuel Reber, army headquarters, Washington, D. C.; Mr. J. H. McGraw, 114 Liberty street, New York city; Mr. F. J. Sprague, 20 Broad street, New York city; Professor Elihu Thomson, General Electric Company, Lynn, Mass., and Mr. Samuel Insull, 139 Adams street, Chicago, Ill.

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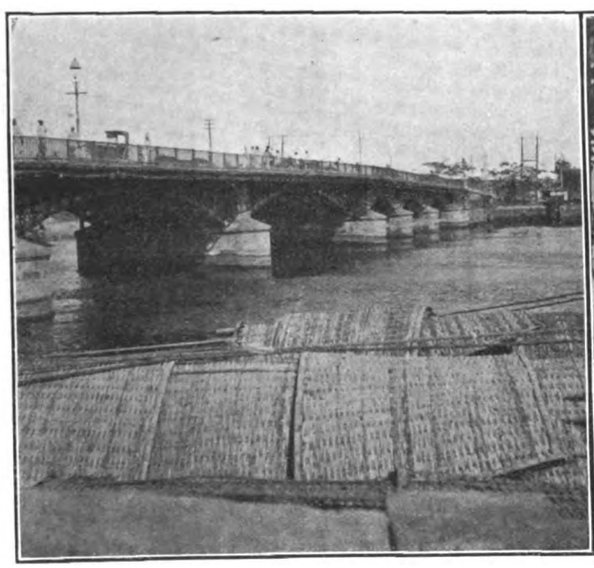
CABLE LAYING IN MANILA AND A TRIP AROUND THE WORLD.

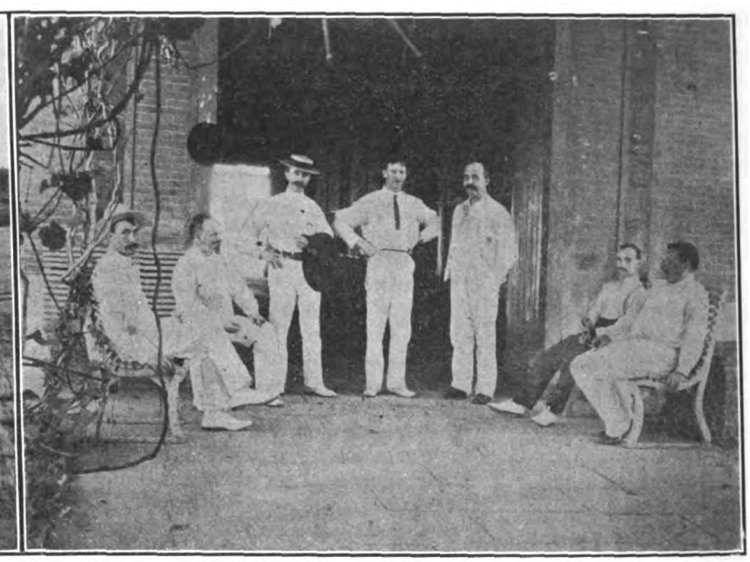
BY LEWIS G. MARTIN.

Around the world in 137 days is not an extraordinary performance, but allowing for a stop-over of three days in San Francisco, sixty-six days in Manila, four days in Hong Kong and twelve days in London, which leaves seventy-two days of actual travel, makes it appear more like a hustle.

In the ELECTRICAL REVIEW of February 14 I gave an account of experiences on my expedition to San Francisco and Honolulu, to lay land cables for the Commercial Pacific Cable Company. My commission this time was to proceed to Manila to do similar work for the same company.



BRIDGE OF SPAIN, PASIG RIVER (MANILA).



OFFICERS OF CABLE COMPANY, MANILA.

Reading from Right--Messrs. Jones, Martin, Grey, Pattison, Grant, Cuttriss and Cameron.

Leaving New York on April 29, I arrived at San Francisco, *via* New Orleans, on May 5, left there on May 8 in the S. S. Doric, and arrived at Manila on June 3. The voyage was a pleasant one, and the following places were called at en route: Honolulu, Yokohama, Kobe and Nagasaki. At Yokohama I made one of the party of five that left the ship and traveled over land to Kobe. This was a very interesting trip from every point of view. After spending a few hours in Yokohama, which is a prosperous and well-kept city of 190,000 inhabitants, we took train for Tokio, the capital of Japan. There we visited the principal temples and tombs of the great Shoguns, and graves of the forty-seven Ronins, famous in Japanese history as powerful and aggressive rulers, drove through the grounds of the Imperial palace and did the city generally. The palace and grounds are protected by a wall and moat and are very well kept up. Tokio has a population of 1,500,000 and is rapidly becoming modernized. An electric traction line is now in course of construction which is to connect up all the principal points of the city.

From Tokio we took train for Kioto, a city of 350,000 inhabitants, famous for its temples. En route we had several views of the celebrated volcano, Fuziyama, from base to summit, a magnificent sight, rising as it does several hundred feet above the surrounding mountain peaks. Kioto, the old seat of government, is a large manufacturing centre noted principally for its silks and embroideries, porcelain, bronzes and metal work of every description.

Our next stopping place was Osaka, where an international exposition was being held. This we visited, and were surprised to find how well every country —particularly the United States of America—was represented. The electrical exhibits, though not very large, were well selected. Other distinguished visitors at the exposition the day we were there were the Crown Prince and Princess of Japan and suite, and we paid double entrance fee for the privilege of being in their company. Osaka is the second largest city in Japan, having a population of 800,000. From this city we proceeded to Kobe, and there rejoined our ship.

Our next port of call was Nagasaki, and after a short stay there the S. S. Doric headed for Manila.

Very interesting from an engineering point of view was the evidence of thoroughness in everything undertaken in Japan. The railroads are well built throughout and well maintained, and, taken as a whole, the telegraph and telephone and electric light lines—all overhead—are models of construction. Hotel accommodation at all the places visited was excellent in every respect, the meals being served in European style, everything well cooked and the variety up to the standard of the average first-class hotel. All the hotel clerks speak English fluently.

The work to be done at Manila was to lay underground in three-inch galvanized iron pipes three four-conductor cables, from the cable houses at Malate to the offices in the town, a distance of, roughly, two and three-quarter miles, two in one pipe and one in another, the single cable being for the Eastern Extension Australasia & China Telegraph Company, Limited, and to be used in connection with its Hong Kong and Ilo Ilo circuits. The cables were similar to those laid in San Francisco and Honolulu, namely, conductor, 170 pounds copper to the mile, insulated with "Okonite," to a diameter of 0.295 inch, each core taped and leaded, the four cores then laid up around a jute centre and covered with lead three-thirty-seconds of an inch thick, each core plainly marked for distinguishing purposes and subjected to breakdown and other tests before being cabled.

After some delay, caused by the late

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arrival of the cable and material, work was finally commenced on July 13, and proceeded at the rate of three quarter of a mile lengths per day; and on August 5, the cables being completed, they were handed over to the cable companies. Final tests corrected to seventy-five degrees Fahrenheit gave D.R. 5,063 megohms per mile, and C.R. five ohms per mile for all cores. These are the only properly constructed underground cables in Manila, or, in fact, in the Philippines.

The laying of the cables took twelve days, and the splicing fourteen days, the rest of the time being lost in waiting for pipe and on account of bad weather. For four days the wind, accompanied by terrific rain squalls, blew with hurricane force, which completely flooded our trench and incidentally thoroughly demoralized all telephone and electric light service. The government telegraphs—a pattern of good construction—weathered the storm well.

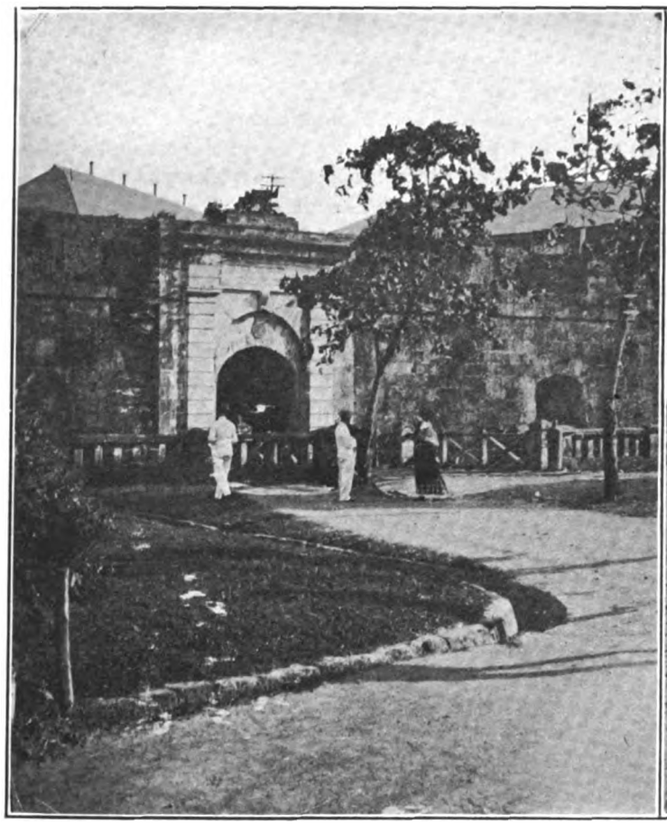
From what had been said of Filipino labor it looked as if there would be much difficulty in securing suitable men for a cable gang, but, thanks to Mr. Moffett, city electrician of Manila, I was able to secure a very good gang of natives and an intelligent native foreman. These men had been trained by Mr. Moffett and had been culled from scores of probationers. Filipino labor is, without doubt, poor, due, of course, to past treatment and neglect, but with intelligent handling and proper instuction can be, as has been proved by Mr. Moffett and others, converted into a useful asset.

Mention was made above of the government telegraphs. These, under the able and efficient management of Major Glassford, of the Signal Corps, are to-day in a high state of efficiency. The telephone and electric light services, however, both run by private corporations, leave much to be desired. All the construction is overhead, and very antiquated at that. The street cars are hauled by native ponies—toy animals out of all proportion to the size of the cars, and when making good time, probably cover nearly three miles an hour. An electric traction company, however, had just completed its preliminary survey when I left Manila, and no doubt has already commenced the construction of lines which are to replace the present ones.

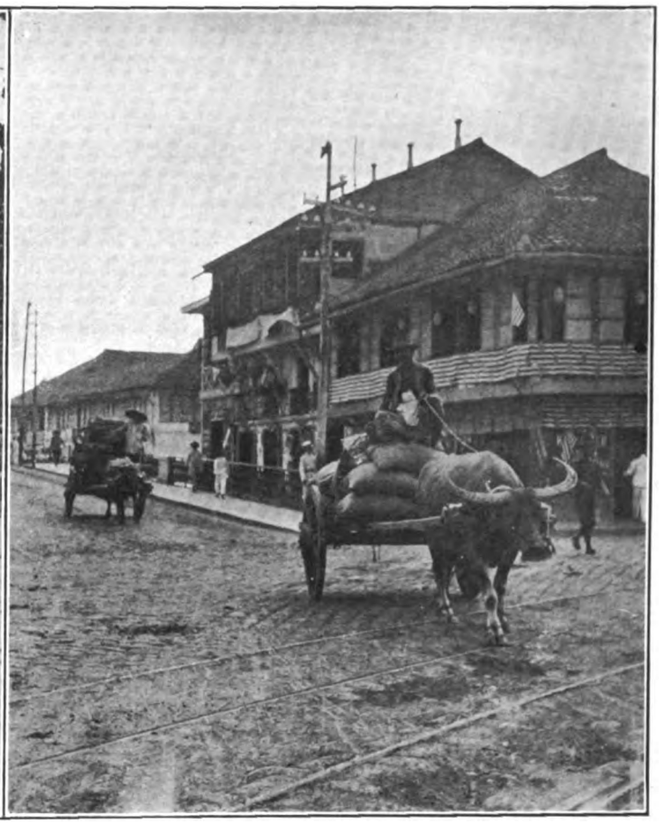
In the Philippines, on account of exceedingly uncertain mail communication, one feels very much out of the world. During my sixty-six days' stay there only three mails came in from the United States, and this, it was said, was about up to the average. One gratifying feature was that each mail brought copies of the ELECTRICAL REVIEW, which is well known and widely read by the electrical and military men in the islands.

My work being completed, I left Manila for Hong Kong on August 8, and after a four days' stay there sailed for London by way of Singapore, Penang, Colombo, Aden, Suez, Port Said, Marseilles, Calais and Dover.

Hong Kong is picturesque and interesting and, of course, very Chinese. Most of the Europeans live on the slopes of the hills, and a prettier sight from the water, when entering the port at night-time, with all the residences lighted up, can not be imagined. An electric car system is in course of construction, which is ultimately to encircle the whole island. At present the only car service on the island is a cable system running from the town to the Peak, which rises very suddenly to a height of 2,000 feet.



ENTRANCE TO OLD CITY (MANILA).



STREET SCENE (MANILA).

Singapore, our first port of call, is a thriving city. The first electric line is now being built, and is to connect up the suburbs and outlying towns. Electric lighting is in a backward state and is almost exclusively furnished by isolated plants. The telephone service here, as in almost all of the eastern cities visited, is of the most primitive character and, according to general opinion, not at all satisfactory. Penang was seen in a hurry on account of our short stay there, and the only things of interest seen were a funeral and a wedding procession, and I had to be told which was which, because

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the former looked like a funeral and the latter like a jollification.

Colombo, of tea, spices and jewel fame, our next port of call, was also seen in a short space of time, but there was time enough to note the good condition of the roads, magnificent tropical scenery and an artificial harbor formed by a breakwater which probably is the finest in the world. The officers of the ship said that the breakwater, formed of huge blocks of a special form of concrete, is actually improving with age.

At Aden, Suez and Port Said there was scarcely time to go ashore, so that these must be passed over as simply interesting places as they appeared from the ship.

The trip through the Suez canal, a distance of eighty-seven miles, which took sixteen hours, kept every one on the qui vive. Now passing a ship tied to the banks to let ours pass; then one of the canal company's stations and everybody anxious to know what the signals meant; once being tied up ourselves to let H. M. S. Vindictive, convoying the Terra Nova, sent out by the British Government for the relief of the Discovery, lost in the Antartic, to pass; these and ever-changing scenes on the banks made this part of the voyage as fascinating as it was interesting.

In the Mediterranean, passing through the Straits of Messina, with Italy on the one side and Sicily on the other; and through the Straits of Bonifacio, with Corsica on the one side and Sardinia on the other, was a very pleasant relief from the monotony of a long voyage, and the sight of Stromboli in eruption made everybody feel that they were amply repaid for all the discomforts which must necessarily accompany being cooped up in a ship for five or six weeks.

Marseilles, Calais, Dover and London are too near home to make more than a passing reference to. All are forging ahead electrically. Marseilles has a well-managed electric car service with plenty of cars and good accommodations. There are some well-equipped trolley lines in and about London. At Ilford there are in service double-deck cars with the upper as well as the lower part enclosed—odd looking affairs, but much more sensible than the prevailing all-the-year-round open-top cars.

On September 26 I left London for New York by way of Southampton and Cherbourg, joining the S. S. New York at Southampton. The New York, like most Atlantic liners, is equipped with wireless telegraph, which, from all accounts, though working well is not very extensively patronized by the traveling public.

Since my arrival home on October 3 I have been asked by many which part of the trip was the most interesting to me, and I feel that I can not do better than close this narrative with my reply—"coming up the bay into New York."

ELECTRICAL MINING NOTES.

BY SYDNEY F. WALKER.

At the autumn meeting of the institution of Mining Engineers, which was recently held at Nottingham, electricity was almost as much in evidence as at the meeting in London. The autumn meeting has only one day for the reading and discussion of papers, the two following days being devoted to excursions to colleries, and places of interest in the neighborhood. Of ten papers down for reading, three were on purely electrical subjects, and three others contained descriptions of electrical plant or apparatus. There were two descriptions of collieries in the neighborhood, Sherwood colliery and Glapwell colliery, which were visited on the excursion days. Both collieries, which are more or less in the stage which is known as opening out, have three-phase electrical power plant, and both well supplied by the Westinghouse Company. Two fifty-kilowatt machines, with their exciters, are installed at Sherwood colliery, though the pit has only just been sunk, and coal is not even being found yet, the current being used for driving the fitting-shop tools, mortar mills, a stone breaker, and the fan that was used during the sinking operations, by means of induction motors.

The whole of the shot firing required during the sinking operations at this colliery was done by electricity. A shaft-sinking frame was employed, suspended from the surface, on which the men worked, and on which the compressed air rock drills that were employed were carried. Twenty-two holes were drilled at the same time in the bottom of the shaft, vertically downward, six in a circle of four feet radius, and sixteen outside of these, in a circle of nine feet radius, all the holes being six feet deep and two inches in diameter. All the twenty-two shots were fired together, and twenty-four horizontal holes in the side of the shaft were then drilled, in a circle of eleven feet radius. These were all fired together, and it is stated that the blasting left the shaft quite clean, no dressing having to be done afterwards by the pick. The total sinking to 1,400 yards only occupied fifty-four weeks, a very creditable performance indeed, and a great advance upon the previous records due evidently to the intelligent use of the electric shot firing. The shaft bottom was lighted, during the sinking, by six incandescent lamps of thirty-two candle-power each, held in a special fitting, and suspended in the shaft by an armored cable.

At Glapwell colliery there is a 225-kilowatt Westinghouse, three-phase generator, supplying power for three motors of fifty horse-power, one of thirty horse-power, and five of seven and one-half horse-power, at various parts of the colliery. Fifty horse-power motors drive endless rope haulage—secondary haulage, as it is called—drawing the coal trams from distant parts of the colliery to points where it can be attached to the main haulage system, consisting of endless ropes, driven by engines on the surface, the ropes going down the shaft to the main roads, and coming up again, the rate of travel being from one and one-half to three miles an hour. This is one of the favorite methods of working the main haulage systems in Yorkshire and north Derbyshire. Another favorite method in other districts is to have a band rope, virtually a driving rope, running from the engine on the surface to a set of wheels under ground, from which the ropes for the different roads are driven. In some parts of the country, notably at one large colliery in Scotland, the band driving rope is giving place to an electric motor fixed near the pit bottom, fed from a supply service on the bank in the usual way. The other motors at Glapwell are used for driving pumps principally, or for small pieces of secondary haulage. The method of fixing the cables at Glapwell is worth noticing, as part of it is novel. The cables are the usual triple cables employed with three-phase currents each cable consisting of thirty-seven No. 11 copper wires, fully insulated with paper, lead, jute outside, the three cables laid up spirally together in one, and armored outside of all. The cables in the shaft are enclosed in pitch-pine casing, supported to steel channel buntons placed at intervals in the shaft for the purpose. It is stated that the joints in the casing are made so that it is impossible for water to get in. On the roads underground, the cables are laid in puddled clay trenches, slightly wedged shaped in section, and fixed between the two haulage roads.

One of the points to be noticed at Sherwood and at Glapwell, which marks very distinctly the great advance which electricity is making in collieries in this country, is the elaborate nature of the switchboards provided. At both the collieries named, the switchboards have marble panels, with the usual quota of switches and measuring instruments, and the whole arrangement would discredit many of the smaller electricity supply stations of our towns. The switchboards are protected by a handsome wooden rail

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in front, and the bulk of the working parts are behind, and can only be got at by going into a small room behind the board, the kev of which is kept by the responsible electrician at the colliery. Substantial india-rubber mats are also provided all around the generators, and in front and behind the switchboard.

Glapwell colliery has also been the seat of an unfortunate but interesting accident in connection with the three-phase installation. In the neighborhood of one of the haulage motors there are two switches of the triple form used with three-phase working, and of the type used by the Westinghouse Company, for starting its induction motors. The switch is off when the handle is vertical, throwing it to one side, and then throwing it over to the opposite side is necessary for starting. Fuses connected these two switches, and the fuses were naked copper, and came through a hole in a board from one switch to another. At a certain time, when both switches were in the "off" position—this is quite certain—a man who was at work in the neighborhood of the switches accidentally touched one of the fuses and was killed. His Majesty's inspector of mines, who described the case to the present writer had the matter tested. He had an iron stake driven into the ground at the point where the man stood, and had the pressure taken between the fuse and the iron stake. It was found to be 150 volts. The lights at Glapwell and Sherwood collieries are taken from the three-phase service, at 100 volts by means of transformers. While on the subject of electrical plant collieries, it will perhaps be as well to mention a colliery to which members of the British Association were invited during the recent meeting at Southport.

Hulton colliery is situated near Bolton le Moors, one of the large manufacturing towns in Lancashire, and the seat of the works of the Lancashire & Yorkshire Railway. At Hulton they have adopted Parsons three-phase turbo-generators. Two of 300 kilowatts are already fixed, and two more are to be provided. The turbines are supplied with steam at 150 pounds pressure, and exhaust into a condenser, the steam consumption being twenty-two pounds per kilowatt-hour, with 26.7 inches of vacuum. These figures are given by the colliery as the result of a test made by their own officials last May. The generator is bipolar, the armature rotating at 3,000 revolutions per minute. The current is to be employed for lighting, for haulage, pumping, and for driving forced draft fans, workshops, and in fact everything about the colliery except the winding engines. The feature that is worth noticing, as at Sherwood and Glapwell, is the switchboard. It has seventeen panels, two for the generators, two for the exciters, one for the voltmeter, one for the wattmeter, and eleven for distribution. The two alternators are to be run in parallel, voltmeters and lamps being provided to enable this arrangement to be carried out. The usual arrangement of triple switches for the generators and for the distributing panels is provided, and there are two recording wattmeters. The elaboration of the whole shows more than anything else the enormous strides that electricity is making in connection with mining in this country. In the early pioneer days, and for long after, almost up to recently, it was very difficult indeed to persuade colliery managers to go to the expense of any measuring instruments. If you included them in your tender for a contract, you usually lost the contract, and if you tried to get them in afterwards, you were looked at with considerable suspicion. Coal-cutting by electricity is to be done at Hulton as well as other things.

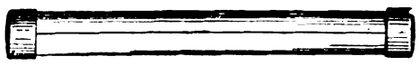
(To be continued.)

Contact Voltages.

A recent issue of *L'Eclairage Electrique* contains an article giving the results of an investigation upon the influence which the degrees of polish and the superficial densities of bodies have on the difference of electrical potential produced by their contact. The following conclusions are given: Of two surfaces of a particular metal, that which is most polished always becomes positive. When two different dielectrics are brought into contact, the hardest one ordinarily becomes positive. The contrary takes place with metals. When a hard material presents, on account of its structure, few points where contact is possible, it behaves like a soft substance. Glass wool becomes negative in contact with cloth, porcelain and glass. Hygroscopic surfaces, when poorly dried, behave like water. A body which easily crumbles into dust, or a glue-like body which leaves traces on the surface with which it is in contact, becomes negative. Thus, ebonite becomes negative when in contact with emery paper, but it is positive when it is rubbed with a paper in order to polish it. Two pieces of quartz, sugar or pyrite, which give a phosphorescent light when knocked together, are both positively electrified. The particles produced by knocking are, on the contrary, negatively charged.

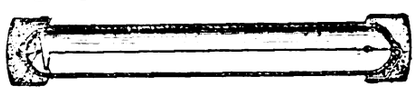
Electrical Patents.

In the increasing use of electricity for the purposes of advertising, ornamentation, illumination, etc., the compactness, simplicity and effectiveness of the apparatus employed and its constitutive elements are becoming more and more important. Where the current leaves or passes out of the element or member at the same end at which it enters, as in the ordinary incandescent bulb, it is difficult to vary the form so as to give the best results or produce the most



PLAIN VIEW OF ELEMENTS.

pleasing effect, and in a group of bulbs the several elements have no distinguishing trait or consequential individuality other than what is imparted to the mass. When other forms made on the same principle are resorted to, the cost of construction and application and the inherent defects of the separate members detract from their utility. Mr. Dennis J. O'Brien, of San Francisco, Cal., has assigned to the O'Brien Electric Light Letter Company, of the same place, a patent on a system of electrical characters and means for forming them. The invention is designed to provide a system of this character, embodying a principle which will combine the greatest strength and simplicity of construction with the most effective results, whether the elements are used singly or in groups and also irrespective of their



SECTIONAL VIEW OF ELEMENTS.

size, shape or proportions. Where the invention is to be utilized for advertising purposes, which is the primary object, its elements are made into such shape that the very least possible number of them may be arranged or grouped together to form the different letters of the alphabet. These elements are so constructed that they may also be arranged as symbols, designs, etc., or simply disposed in plain lines for ornamentation or even illumination. The elements may be of any suitable size or dimensions in length or cross-section and are made tubular, with all or a portion of the length of each provided with a transparent light passage or adapted for the passage or emission of light rays from the interior. Each of them is formed from an exhausted glass tube of substan-

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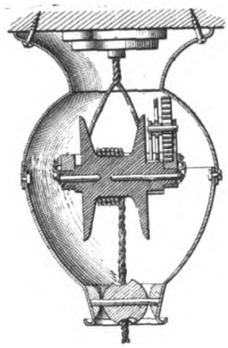
tially the same area in cross-section throughout its length. In this manner the different tubes or receptacles with their accompanying parts can be quickly and cheaply formed and arranged into the desired characters with a uniform and well defined outline. Mounted within each tube or receptacle aforesaid is an illuminator, as an incandescent filament, which extends from one end thereof to the other and is placed at each end in electrical connection with an electrical contact, such as a metallic cap or band, which preferably encircles the tube and is secured thereon by means of cement or plaster. As the filament expands and contracts from the effects of the electrical current, it is necessary to provide a means for counteracting such expansion and contraction, which can be done very effectively by an automatic take-up or elastic device for instance, a spring formed or interposed in the length of the filament or its support. In forming the elements as above described, the glass tube is cut off to the desired length and the filament with the platinum strips secured thereon is inserted. One of the strips, preferably the one having the spring, is then sealed in the end of the tube. This will cause the other strip to extend to the other end of the tube, where it is also sealed in after placing the filament under sufficient tension to stretch the spring to such an extent that the expansion of the filament from the action of the current will all be taken up by the retraction of the spring. By sealing in the platinum, having the spring before sealing in the other end, the proper tension can be given to the spring, as the other piece of platinum being straight or plain can be drawn out and fastened at any point, whereas if it were fastened first the spring might extend out too far, and thereby prevent its being sealed in properly to give the requisite tension to the filament. It will be seen that as applied the filament and the platinum pieces form a direct path for the current through the tube from one end to the other, and all danger of damage from the action of the current is avoided.

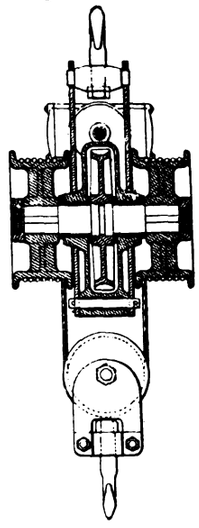
A novel hanger for electrical lamps and the like has been patented by Mr. Michael C. Donahue, of Colorado Springs, Colo., who has assigned a three-fourths interest to John Skinner, F. G. Armbruster, and F. A. Neff, of the same place. The aim of the inventor is to provide a comparatively inexpensive structure, which will support a lamp at any height desired and which will permit the raising and lowering of such lamp without sparking. An open-ended tubular casing is employed, comprising detachably associated sections. The upper section is adapted to be secured to a ceiling and enclose the usual rosette, from which the lead wires extend. This upper section carries at its lower end a horizontally disposed frame, in which is journaled a drum. Spring mechanism geared to the drum serves to rotate the same in one direction. The journals of the frame project through the drum and contain suitable conducting rods, the outer ends of which contact with springs secured to the frame. The leads are connected to the spring by means of fuses. Wound upon the drum and electrically connected to the conducting rods is the lamp wire that extends downwardly through the lower section of the casing and from its lower end. This wire or cord supports the lamp. The lower end of the casing is provided with a horizontally disposed ring, within which is journaled a clutch ball, the cord passing between the ball and the ring. An annular groove is formed in the ball and is provided with



A New Hanger for Electric Lamps and the Like.

oppositely extending lateral grooves that terminate on opposite sides of the annular groove. As long as the cord is in the annular groove it may be drawn downwardly or passed upwardly through the casing, the spring drum taking up the slack and also permitting the cord to unwind. When the desired adjustment has been obtained, it is only necessary to swing the lamp slightly to one side, so that the cord will travel into one of the lateral grooves, and thereupon will be pinched between the ball and ring, consequently securing the lamp at any desired height.

Mr. Frederick A. Waldron, of Stamford, Ct., has devised a new electrically driven suspension hoist and has assigned the patent obtained thereon to the Yale and Towne Manufacturing Company, of the same place. The invention consists in a hoist with a single point of suspension and comprising a motor, a worm-wheel, a drum, a worm-shaft, the worm-shaft being located at an angle to the armature-shaft on the motor and on the side of the suspension point opposite the motor. Suitable suspensible plates are mounted at their ends on the crosshead to a crosshead which covers the suspension hook. This hook is swiveled in the crosshead so as to permit the hoisting mechanism suspended therefrom to turn freely thereon, and is located in line with the lower hook, which receives the load, which line is of necessity the centre line of the tackle as a whole. The side plates are curved laterally at their upper ends, the crosshead carrying the suspension plates being mounted in these curved ends near the free ends of the latter, and they are secured together in parallel relation by a crosshead by spacing bolts and by the casing. This casing is made in two sections bolted together and is of general cylindrical shape to comfortably cover



New Design of Electrically Driven Hoist.

and enclose the worm-wheel. This casing is provided near its centre with enlarged hubs, which latter are mounted in openings formed in the suspension plates. The lower end of the casing is enlarged to span the space between the two plates and is locked to the latter by a bolt or pin. Mounted in the hub of the casing is the shaft, and secured to the shaft within the sectional casing is the worm-wheel, and to the ends of the shaft outside the plates are the winding-drums. The hoist cable or chain is secured at its ends to the drums. Hence when the latter are rotated by the rotation of the worm-wheel, the cable or chain will be wound upon or unwound from the drums, as the case may be. This cable or chain carries the hoist-pulley. Secured to the casing is the electric motor. The motor is located at one side of the suspension point and receives its current through wires in the well-known manner and is provided with the

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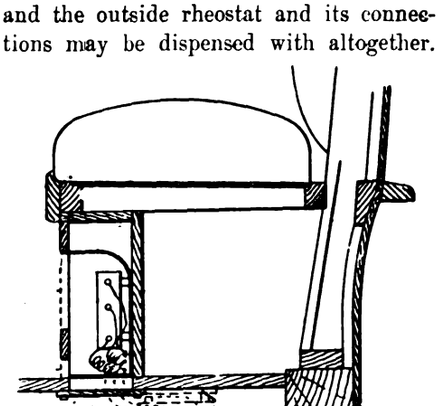
ordinary switch and rheostat by which the movement of the motor is controlled and, if desired, may be provided with a brake for holding the load suspended and for regulating the descent of the load. With a screw in which the pitch or angle of the threads renders it self-holding a brake would not be necessary, but with a screw that is not self-holding a brake would be desirable. The armature shaft of the motor passes between the suspension plates and a point beyond the centre line of the tackle and is mounted near its free end in a bearing, secured to or integral with the casing. Secured to the free end of this shaft is the bevel-pinion which meshes with another bevel-pinion secured to the worm-shaft. The rim of this piston rests below and inclines downwardly from an armature shaft at an angle of the latter and the body or spokes of the pinion project downwardly in the form of a cone, so as to bring the hub of the pinion close up to the side of the casing on the side or edge farthest removed from the motor. The pinion and its hub are enclosed by the conical casing secured to the other casing. The casing is provided on its side or edge opposite the motor with a housing in which the worm-shaft is mounted. This shaft normally rests in an inclined position wholly to one side of the centre line of tackle and at an angle to armature-shaft, and rests at its lower end in the step held in place by a lower removable cap. The interior of this housing is somewhat greater in area than the diameter of the worm-shaft, thus forming an oil-chamber in which the thrust-bearing may be submerged.

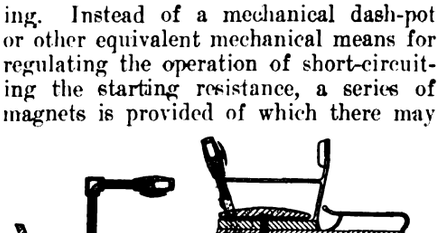
The Westinghouse Air Brake Company, of Pittsburg, Pa., has purchased a patent from Mr. Edwin M. Herr, the entire interest in a patent granted to him on an electric heater for cars. The invention relates especially to that class of heaters which also serves as resistance devices or rheostats for the controller of electric cars to regulate the current supplied to the motors or to regulate the current generated in a local brake circuit; and it has for its object to provide means whereby the heater may be located in a position to warm the interior of the car during cold weather, as in winter, and may be moved to another position where its heat does not affect the interior of the car during warm weather, as in summer. Heretofore two resistance devices have been employed for this purpose—a rheostat located outside of the car and an electric heater located within the car—with a switch for connecting either the outside rheostat or the inside heater into the circuit for controlling the starting and stopping of the car. This necessitates a double equipment and connections, which is very expensive, while by the use of the present invention the electric heater may be used as the controller resistance device at all times and the outside rheostat and its connections may be dispensed with altogether.



SHOWING ARRANGEMENT OF ELECTRIC CAR HEATER.

This invention therefore consists in a movable electric heater which may constitute the resistance device or rheostat for the controller of an electric car and is adapted to be moved from one position, where its heating effect is utilized to warm the interior of the car, to another position, where its heat does not affect the temperature of the interior of the car. The electric heaters are normally supported beneath the seats of the car and may be secured by means of screws or in any suitable manner to the usual upright pieces. An air-casing having top and bottom front openings and a deflector for the circulation of air over the heater may be employed, if desired. As the heater also constitutes the resistance device or rheostat for the controller to regulate the current in starting and stopping the car and is subject to the heating effects at all times when the car is operated, means must be provided whereby the heating effects will not render the interior of the car uncomfortable during warm weather. For this purpose there is an opening normally closed by a cover in the floor of the car beneath the heaters, and the heaters are provided with flexible electrical connections, whereby they may be lowered through the openings in the floor and secured outside of the car, where their heat will have no effect upon the temperature of the interior of the car.

Mr. John D. Ihlder, of Yonkers, N. Y., has assigned to the Otis Elevator Company, of East Orange, N. J., a patent obtained by him on a novel motor control. The object of the invention covered by this patent is to enable a motor to start with any load and practically unlimited current, without the aid of a mechanical dash-pot controlling the starting resistance. In place of this usual dash-pot, the inventor provides an electrical equivalent of the same so arranged that the starting resistance is not short-circuited too rapidly. The motor may be of any suitable type, but preferably shunt-wound adapted to be connected in circuit with the supply mains and provided with a series field winding and a shunt field, the shunt field being also connected to the mains. A suitable switch is arranged to control the admission of current to the motor armature, and the throwing of the switch lever into engagement with the contacts will first complete the circuit of an electromagnet, connected across the mains and controlling contacts in the main armature circuit. The energizing of this magnet closes these contacts and completes the circuit to the motor through the resistance and the series field winding. Instead of a mechanical dash-pot or other equivalent mechanical means for regulating the operation of short-circuiting the starting resistance, a series of magnets is provided of which there may



SHOWING ARRANGEMENT OF CONTROLLING DEVICE FOR MOTOR VEHICLES.

be any desired number, connected across the line and receiving the line potential. These magnets are arranged for a high time constant, taking three or four seconds, for instance, to come to a full magnetization. Large magnets are therefore required or additional means are needed for accomplishing this end, as for instance, an additional coil having a high time constant connected in series with the magnets, which may be termed the "accelerating magnets." The magnets are wound to different strengths, so that the first operates to attract its armature with less current strength than the second, and the second has a like relation to the third. The inventor states that any other equivalent construction and arrangement of magnets may be provided so that the resistance and series field will be gradually short-circuited as the motor starts. The time constant of the accelerating magnets may be made adjustable by providing an adjustable winding as a shunt in a magnet, or by varying the position of the iron core in the coil thereof.

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Notes from Great Britain.

By Our Special Correspondent.

THE Board of Trade recently issued a return of the capital, traffic, receipts and working expenses of the railway companies of the United Kingdom for the year ended December 31, 1902. Naturally this has largely to do with steam railways, but the figures relating to the few electric lines of this character which we have are not without interest. The report mentions nineteen authorized electric railway companies, the total authorized share and stock capital of which was some $120,000,000, the loan and debenture stock amounting to $41,250,000. Of these companies, however, six had raised no capital whatever on December 31, 1902, and, leaving these concerns out, the total capital paid up on the date in question, including loans and debenture stock, was $57,000,000. There are actually eight undertakings under the heading of railways (as distinct from tramways) in operation, having a total length of track (equivalent of single) of eighty-eight miles. The total gross receipts on all these, from every source, amounted to $3,750,000. On six of the lines in operation the percentage of expenditure to receipts is as follows—72, 56, 52, 44, 80 and 47. By the date of the next report the Mersey Railway will be included, when an interesting comparison can be made as to the difference between steam and electric traction. The lines dealt with in the report above referred to include three tube railways, one overhead railway, three that are a combination of tramway and railway, as they run on both public and private roads, and one exceptional line which runs on the seashore with a gauge of eighteen feet. But the figures of the latter are not very large, being included in the report for the sake of completeness. There does not at present seem any prospect of further electric railways being opened this year, although the Metropolitan and Metropolitan District conversion is well on the way, as well as several of the Yerkes tubes. The Lancashire & Yorkshire Railway is also in process of reconstruction for electric traction, while preliminary trials have been made with cars on the North Eastern Railway, which scheme has often been mentioned in these notes.

Two instances of municipal trading, which have been spoken of previously but which seem always to provide something new to report, have done much to reduce the dignity of town councils, albeit there are not many of this description about. First, with regard to the purchase by the Marylebone Borough Council of that portion of the Metropolitan Electric Supply Company's business which lies within its area. I have before recounted the circumstances of this, how the council had to buy at a high figure under special circumstances, and that as soon as the purchase price was made known a large section of the ratepayers were immediately up in arms against it. But the council was obliged to see the thing through, and ever since 1901 has been beset with difficulties at every turn. The council had contemplated securing the company's business on advantageous terms to itself. Since the award, however, great difficulty has been experienced in procuring a loan to complete the purchase, neither the London County Council nor the Local Government Board feeling itself legally able to grant a loan until the transfer has taken place, and evidently the company will not sanction the transfer until the money is forthcoming. That is the present position. But the council will no doubt promote a bill in Parliament next year.

The municipal telephone exchange, which has just been erected by the Brighton corporation under a license from the Postmaster-General, has just been opened for public service. The system adopted is the automatic ring-through system, the subscriber only having to lift the receiver from the hook to call the exchange and to replace it in order to ring off. A special feature is that in the event of a called subscriber not responding at once, the caller may himself ring without affecting the exchange. The switchboard is at present fitted for 1,000 subscribers, but will ultimately have a capacity of 5,000. Twenty-five miles of conduit have been laid, this portion of the work only having been commenced in March of this year. The cable, which has been drawn into the ducts, commences at the exchange with 626 wires and extends to the borough boundary on all sides, gradually diminishing, as connections are made to subscribers' premises, to twelve wires at the extremities. The number of wires at the exchange end is at present 3,000. The number of applications for connection now greatly exceeds 1,000, and extensions are to be immediately put in hand. The annual subscription is $27 for unlimited service.

A small electric lighting and tramways system has just been opened at Bexley, in Kent, in which both single-phase and continuous current supply is given. Generation takes place at 2,100 volts, which is then transmitted to substations situate in kiosks in the streets, which also serve as arc lamp posts. As a matter of fact, a 150-kilowatt single-phase alternator, working at 2,100 volts and fifty periods per second, and a 150-kilowatt shunt-wound continuous-current generator are directly coupled to two engines, the idea being to keep the steam engine load-factor high. Westinghouse transformers reduce the current to 400 volts. Messrs. J. G. White & Company had the contract for the permanent way of the tramways, which is not a very extensive system at present.

Good progress is being made with two power companies which have been authorized but a short time. One, the Yorkshire company, has accepted tenders for 6,000 horse-power of plant together with the necessary equipment for transmission and distribution. The first power station will be built at Thornhill, and the contractors are already in possession of the land. The latest type of Curtis steam turbine, which will be manufactured by the British Thomson-Houston Company, is to be used. It is expected that power will be available in about ten months. The Lancashire Power Company has entered into a contract with a construction company for the erection of works, and the work is being proceeded with.

Some interesting figures are given relative to the all-British Pacific Cable in a newly published return. This shows the sums issued from the consolidated fund authorized by the Pacific Cable Act of 1901. By this act $10,000,000 is authorized. Up to the end of March, 1903, over $9,000,000 had been expended. The full $10,000,000 authorized has been borrowed and the first payment of the annuity which has been created as security is due in December, 1903, the last being payable in December, 1952. The actual traffic receipts during the year were slightly under $10,000. There is a grant in aid in addition and the balance on hand at present is nearly $150,000.

A. W.

London, October 31.

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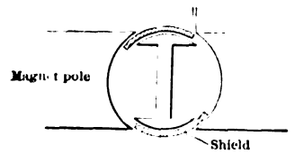
Electrical Notes from Europe.

By Our Special Correspondent.

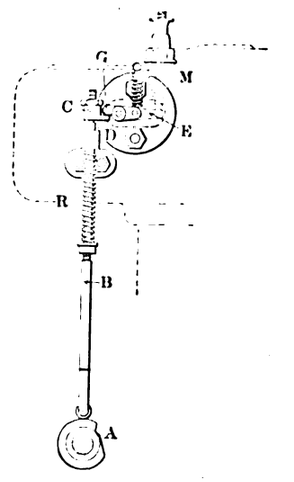
ONE of the latest improvements in the way of sparking devices for petrol motors is that which is used on the Pengeot automobile, one of the leading Paris makers. The magneto which produces the current for the spark is disposed as shown in the diagram. Between the poles of a permanent magnet is placed a shuttle-wound armature. The latter is also fixed, and the variation of flux is obtained by a revolving shield of soft iron which moves between the field and armature and thus generates a current in the latter. To produce the spark for igniting the explosive mixture of the motor, the following device is adopted. A cam A (see diagram), operated by the motor, works a rod B which can move up and down. The rod is held against the cam by a spring R. It carries at the top of the trip piece C which engages with the lever arm on the right. This lever is mounted on a movable shaft D which passes into the cylinder through a tight joint. The lever carries an arm E on the end inside the cylinder (shown in dotted lines), which serves to make or break contact with an insulated metal piece M which is inserted in the cylinder. A spring on the outside keeps the arm E in contact with M. When the rod B is pushed up by the cam, the trip C pushes up the end of the lever G and causes a break between E and M. The spark passes between these two points and ignites the gas. As the cam continues to revolve the rod falls into a depression in the cam and the spring establishes the contact between E and M. The circuit from the magneto has one wire connected with the insulated piece M and the other with the mass of the motor.



MAGNETO FOR PENGEOT AUTOMOBILE IGNITER.

An exposition of considerable interest is to be held at Milan in 1905, in which the mechanical and electrical sections will occupy an important place. The exhibits of the electrical section will include apparatus relating to electric traction, dynamos, motors, etc. A special section will be devoted to telegraphy and telephony. Wireless telegraphy is to be well represented, and especially the latest forms of portable stations for field work.

An electrically operated pumping plant has been recently installed in Greece in connection with the draining of lake Copais, which has been an important enterprise. The streams which fed the lake have been turned out of their course, and the ground forming the bed of the lake is now utilized for agricultural purposes. The lake formerly received a number of streams coming from the slopes of Mt. Parnassus and Mt. Helicon. The Melos and Kephisos rivers are the largest of these streams, to which were added a number of mountain torrents whose volume was greatly increased in the winter. To draw off the water of all these streams and divert it into the basin of the neighboring lake Likeri has been an important piece of engineering work. The water comes through an underground tunnel and empties into the lake, and between the tunnel and the surface of the lake there is a difference of level of twenty-five or thirty feet. It was decided to utilize this fall by constructing a hydraulic plant which would generate sufficient current for operating the drainage



PENGEOT AUTOMOBILE METHOD OF IGNITION.

pumps which are needed in the basin of the old lake. It is found necessary to drain out the water which collects at points which are below the level of the drainage canals, especially during the winter season. Steam pumps have been used for this purpose up to the present, but fuel is very expensive in this region and needs to be brought in from long distances. The use of electric motors for driving the pumps will thus give a great economy. The remainder of the current furnished by the plant will be utilized for the local lighting and also for operating electric motors in the neighborhood for agricultural work. The new plant uses two turbines of the Francis type, coupled to three-phase alternators of 150 kilowatts each. These machines work at 280 revolutions per minute and deliver 500 volts. The current is sent direct from the machines to the pumping plant without using transformers. From the switchboard a three-wire line, mounted on wood poles, leads for eight miles to the pumps. The poles also carry a telephone line. The drainage pumps lift the water thirteen feet high at the rate of 250 gallons per second. The electrical outfit for the pumps, as well as the station plant, has been furnished by Ganz & Company, of Budapest. At present two pumps have been installed on the above system. Each is driven direct by a three-phase motor of eighty horse-power, working at 490 revolutions per minute.

The researches of Professor Kohlrausch seem to prove that radium rays have a certain effect in increasing the electrical conductivity of water. The experiments were carried out with rays which were emitted by a bromide of radium and barium which after passing through an aluminum screen of 0.17 millimetre were sent through a layer of water eighteen millimetres thick. The water must be kept under action of the rays for some time in order to observe an appreciable effect, but after a certain time it is found that the electrical conductivity of the water is increased. To account for this phenomenon two different hypotheses have been advanced; first, that of a direct formation of ions in the liquid, and second, the action of the rays upon the glass of the containing-vessel.

The new physical testing laboratory which has been lately fitted up at the Conservatoire des Arts et Metiers at Paris contains some of the most recent improvements in the way of electrical testing apparatus, among which may be mentioned several new forms of electric furnace for laboratory work. They have been installed for making different tests upon metals at high temperatures. Two of them are of the incandescent type, while a third uses the arc for heating. The Heraeus electric furnace uses a porcelain tube which is wound with a thin

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platinum strip forming the incandescent conductor. This type of furnace can be constructed more cheaply than one which uses platinum wire for the winding, as the strip winding uses a less quantity of platinum. In the Heraeus furnace the strips are cut out of thin sheet metal which is only 0.007 millimetre gauge. The strip adheres closely to the surface of the porcelain tube and gives a good contact, while at the same time it affords a large heating surface. One of the furnaces which has been installed at the laboratory is of the vertical type, while the second has the tube placed horizontally. In the vertical form the tube is six inches high and the quantity of platinum which is needed for the heating coil is relatively small, being only five grammes in all. A temperature of about 1,400 degrees centigrade can be obtained by the incandescent spiral, using a current of 110 volts and fifty amperes; or 5.5 kilowatts. To regulate the temperature the furnace is provided with a small switchboard which contains a rheostat for changing the voltage at the terminals of the spiral. In this way the temperature of the furnace can be kept within the limits of 1,200 or 1,400 degrees centigrade. The vertical form of furnace is designed to receive a small crucible in the interior and is used mainly in determining the fusing points of metals or alloys. The horizontal furnace is formed of a percelain tube twenty-four inches long and two and one-half inches inside diameter. It uses a somewhat higher weight of platinum than the former, or twenty grammes. It is used for making temperature tests on different metals as well as traction tests upon metals in the form of wire or rods at high temperatures. This furnace is also provided with a rheostat for changing the temperature or keeping it at a constant point. The third electric furnace uses the heat of the arc for melting small quantities of metal in a crucible or for heating small pieces. The crucible is placed between two arcs which are formed on either side of it between pairs of carbons. The arcs are connected in series on 110 volts, with a rheostat in the circuit. The crucible rests upon a base of refractory material which passes through the bottom of the furnace. An ingenious device has been adopted in order to give a movement to the crucible so that the arcs will not always strike it in the same place and so deteriorate or melt it at these points. This device rotates the crucible and at the same time moves it up and down. The refractory base which supports the crucible is fixed on the end of a vertical shaft. A large pulley on the shaft is connected by a belt to a small pulley on the shaft of an electric motor, and the crucible is thus rotated at slow speed. To give the up-and-down movement, the shaft carries a soft iron armature at the lower end which can be attracted down by an electromagnet placed beneath it. On the shaft is a commutator which makes or breaks the current in the electromagnet as the shaft revolves, and causes the electromagnet to draw down the shaft at regular intervals against the action of a spring. This type of furnace has proved very successful and different metals, such as iron or nickel, can be melted in a few minutes. The heaviest current used is about seventy-five amperes, which with 100 volts makes a consumption of 7.5 kilowatts. Starting from a cold furnace it takes only fifteen minutes to melt fifteen grammes of nickel.

According to the annual report of the Electric Lighting Company, of St. Petersburg, for the year 1902, the total length of the cables operated by the company is 326,483 metres for public and private lighting. The total number of transformers is 8,937, and meters 5,191. The public lighting is the equivalent of 6,450 lamps of ten-candle-power. The company has 6,208 subscribers for light and power. Among these the winter palace of the Czar uses the largest number of lamps. The total for public and private lighting is the equivalent of 240,044 ten-candle-power lamps. Incandescent lamps figure in the total consumption of current for 88.8 per cent; arc lamps, for 4.4 per cent; motors, 6.1, and electric fans, etc., 0.7.

A project for a large hydraulic station, which is to be used mainly for traction purposes, has been lately submitted to the Italian government by the North Milan Railway Company. This company controls the greater part of the lines which are now in operation between Milan and the Italian lake region, besides several lines of tramway in the city of Milan. According to the present project the hydraulic power is to be obtained from the river Liro. The company has applied for a concession for an 850-foot fall which is expected to give 5,600 horse-power. Most of the current will be utilized for operating the railroad or tramway lines, and the rest for electric motors in various factories in the region. According to the present project the hydraulic plant will be located on the left bank of the Liro, near Chiavenna. The station will contain five turbines of the horizontal type, each having a capacity of 1,000 horse-power. The alternators, which will be direct-coupled to the turbines, are of the three-phase type and give 750 kilowatts each. These machines work at 2,000 volts, which will be raised to 30,000 volts for the line by step-up transformers. If the present project is carried out the plant will rank among the largest in Italy.

Messrs. Commelin and Viau have obtained a patent in France for a constant high-voltage battery which works on closed circuit and can be easily renewed. The elements of the battery are peroxide of lead for one pole and metallic cadmium for the other, in an electrolyte of dilute sulphuric acid. The peroxide of lead is used in the form of plates, while the cadmium, which is contained in a perforated lead basket, is placed in the cell when it is needed for use. The cell is hermetically closed and contains a ten per cent solution of sulphuric acid. To renew the battery, the cadmium sulphide is emptied and the battery washed out with water. The cell is then refilled with the sulphuric acid solution and the lead basket filled up with a fresh supply of cadmium, in the form of small pieces. This form of cell is said to work very successfully.

Preparations are being made for an international traction congress which will be held at Vienna in 1904. The congress relates especially to the subject of traction upon short lines of railroad, and electric traction will naturally occupy a prominent place. The first congress of the kind was held at Paris in 1900, and a second in London in 1902. The principal subjects for discussion at the present meeting have already been decided upon. Among the leading questions are the advantages and disadvantages of electric traction upon short railroad lines, also the kind of current and the voltage to be used. Other questions relate to the economy of operating such lines, the use of motor cars and trailers in city tramway systems, etc. A number of communications on such subjects are expected from leading engineers.

An automobile postal wagon has been built for the Munich post office by the Schuckert Company. It carries a 1.5-horse-power motor which works at 1,200 revolutions per minute. The motor drives the rear wheels by a double reduction gearing and differential. The storage battery consists of thirty cells of the Tudor pattern, which are contained in a box in the

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rear of the wagon. A large box for the mail occupies the rest of the space. The total weight of the automobile is 1,750 pounds, and it carries a net load of 250 pounds. The average speed is ten miles an hour, and the automobile is expected to cover sixty or seventy miles in a day's run. The controller gives five positions for the forward movement, two for the rear, and two for the electric brakes. The expense of running is estimated at $0.011 per mile.

The leading manufacturers of electrical apparatus in Russia are taking steps to secure an increased consumption of home products and diminish the imports from foreign countries. At present a large quantity of imported electrical apparatus is used in different parts of the country, to the detriment of the manufacturing interests of Russia. In the hope of diminishing the imports a petition has been addressed to the Minister of the Interior and the Minister of Finances at St. Petersburg by fourteen of the leading establishments, including the metallurgical, machinery and electrical interests, and representing a total capital of $125,000,000 and 76,500 employés. In this petition the government is asked to require the municipalities of St. Petersburg and Moscow to order all machinery and electric apparatus from Russian factories. The present petition applies especially to the material which will be used for the construction and extension of the electric tramways in these cities. In this way the manufacturers hope that the municipalities will be obliged to cease importing electrical and other apparatus from foreign houses and that the government will require all future contracts to be awarded to the Russian factories. The result of this movement is awaited with considerable interest. C. L. DURAND.

Paris, October 31.

The research laboratory of physical chemistry at the Massachusetts Institute of Technology, which was recently opened with a staff of eight research associates and assistants and two graduate scholars, working under the direction of Professor A. A. Noyes, H. M. Goodwin and W. R. Whitney, has now in progress, it is reported, numerous interesting investigations, some of which are as follows: "The Electrical Conductivity of Aqueous Solutions at High Temperatures (up to 306 Degrees and Higher);" "The Conductivity of Fused Salts," by Mr. R. Haskell; "Electrical Transference Determinations with Nitric Acid," by Mr. Y. Kato.

FREIGHT DEVELOPMENT BY INTERURBAN ROADS.[1]

BY E. F. SEIXAS.

"The transportation service performed by the railroads includes the movement of freight, the carriage of passengers, and the transmission of mail and express matter. Each of these services merits careful consideration. Whether viewed from the standpoint of public benefit or considered with regard to the volume of business done and profits received by the company, the transportation of freight is the most important service performed by the railroad. The income from the passenger business is about one-fifth of the total income and earnings of the railroads in the United States, while the receipts from the freight amount to seven-tenths. Moreover, the social welfare is more dependent upon cheap and unfettered movement of commodities than upon inexpensive and speedy means of travel; however important it may be that the relatively few people who may at any one time desire to take a journey should be able to reach their destination promptly and comfortably, it is of incalculably greater consequence that producers should be able to dispose of the commodities upon the sale of which their livelihood depends and that consumers should have the power of drawing upon distant as well as near sources of supply for the satisfaction of their wants and the gratification of their desires.

"The volume of freight transported increases rapidly with the progress of civilization and the diversification of men's wants. The freight business is carried on to enable men to secure what they want; and the more complex their demands the more goods will be produced and transported. The growing demand for the freight service has furnished a most powerful stimulus to inventors and engineers to lessen the obstacles to the movement of commodities by improving of tracks, cars and locomotives, and making other changes in the railroad mechanism whereby the costs of transportation have been reduced to their present small amount. Whether the endeavor of railroad companies to increase the speed of their passenger trains or their efforts to lessen the cost of freight movement have been the more potent incentive to mechanical improvements, it would be impossible to say; but the results accruing to society from these improvements have come more largely from the greater facilities for the shipment of goods."

So writes Professor E. R. Johnson in his very excellent review of American Railway Transportation. So much for our friends the steam roads. The conditions that have caused such signal success in the passenger business of interurban lines that depend on electric energy for their motive power are to a great extent responsible for the hearty greeting with which the average shipper, be he merchant or farmer, hails the advent of the trolley, and for the great complaisance with which he views the humming, whizzing cars that frighten his team of colts and send clouds of dust into his wife's otherwise immaculate parlor.

The first condition that tells in favor of the interurban line is the frequent service and the frequent stopping places. The second is that the interurban line is more or less of a local affair, and for that reason is more intimately cognizant of local necessities. In the battle between the piston rod and the trolley pole passenger rates have suffered to a more or less extent, while freight rates have pretty generally remained where they were. The interurban lines have not found it necessary to inaugurate a rate war to get freight business from the steam roads, for they receive and are justly entitled to their proportion of the business on account of the increased facilities.

The present Niagara, St. Catharines & Toronto Railway was originally a steam road, constructed in 1886, and changed to electricity in 1899 and 1900, the first electric car running July 19, 1900, from Niagara Falls, Ontario, to St. Catharines. Prior to the change in 1900 the road had, through poor management and consequent poor patronage, fallen into the hands of a receiver, and was sold by the courts under the hammer, the present stockholders purchasing and converting it into an electric line; afterward extending the line to Port Dalhousie, and establishing communication with Toronto by steamers, which are also owned and operated by the company. A track connection had by the original company been arranged with the Michigan Central Railroad Company at Niagara Falls, Ontario, which has been since maintained, and which affords free interchange of cars to and from all points in Canada and the United States, thus forming a line in competition with the Grand Trunk Railway system in the territory covered by the line and its steamers, for

[1] Presented to the eleventh annual convention of the Street Railway Association of the State of New York, Syracuse, N. Y., October 6-7.

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which purposes the original line was intended. The gross annual freight earnings of the line prior to 1900, or during the operation by steam, was less than $20,000, and the freight handled was confined to low classes of carloads, such as coal, this being in fact the principal traffic handled. Very little attention was paid to the higher class traffic, such as package merchandise, and it was not until 1901 that any marked increase was shown. This upward tendency was caused by an energetic and persistent endeavor on the part of the management to increase the development of the facilities which were practically dormant, in taking care of higher class traffic and leaving low class to itself. The methods of handling had to be improved, system organized, and particular attention paid to the despatch of business taken hold of. There was no attempt made to reduce rates, the traffic being carried on exactly the same conditions as steam lines under all circumstances. It was found that accommodation to patrons had a great deal more effect than any benefits derived from useless rate-cutting could afford. Cars are placed at convenient points for shippers to load, they are picked up at convenient hours, and shipping receipts are given at the counter of the business firms by a responsible man who has the freight train in charge, thus saving the customer the trouble and time of going to the railway station to make shipments. All this tended to increase popularity and consequently, by increased shipments, revenue, until for the year ending August 31, 1903, we are able to show an earning of 120 per cent greater than in 1900, and an operating expense of fifty-two per cent as against a previous loss. The package freight must stay with the electric roads, as their methods will, if properly organized, hold it against steam roads, unless congestion is allowed, when the great advantage of quick handling will be lost. The handling of low class freight involves the expense of terminal facilties which in large cities is practically prohibitory, and unless there is assured enough freight to keep a regular competitive service against steam fully alive, it is better that electric roads confine their business to the higher classes of package merchandise. With us it is found also that switching service is a source of revenue which if facilities are available is remunerative, we having arrangements to switch loaded cars to and from the Grand Trunk Railway, our competitor, and industries located on our tracks. This service is easily performed and at a very little expense, the distance usually being short and quickly handled, and it pays because ordinary power is employed at times when we can afford it without detriment to our other interests. There is, in our opinion, ample revenue in the development of freight service for interurban lines provided, as above, that low class traffic is not sought after too closely and only taken care of when it involves the higher classes. No freight can be handled at a profit that pays less than one cent per ton per mile, and even at that figure there is not enough revenue to warrant short haul lines seeking it. To sum up, all that is necessary to make electric lines a factor in freight traffic is seeking high class freight, quick handling, and promptly attending to customers' requests, to secure success.

We have found that working arrangements can not well be based upon a mileage pro rate unless a constructive mileage is allowed the smaller line, and it is not practicable to do this in our case (although conditions with other lines may be different and groupings may be obtained from connecting lines affording a pro rate) because we are a lake and rail line, peculiarly situated, breaking bulk, and our connections do not favor percentage arrangements. We therefore have worked almost our entire traffic on an arbitrary basis, receiving as our proportion on classes one to six under the official freight classification the following figures, *viz.*:

Class ..	1	2	3	4	5	6
Cents....	.8	7	6	5	4	2½

per hundred pounds for our haul, whether long or short, and not participating in any reductions made by connections due to competition from various causes. We therefore submit that interurban lines are in a better position on an arbitrary basis than percentage, although the disadvantage of having no voice in rate-making without consent is apparent by reason of non-participation in the reduction of rate asked, but this is only a matter of correspondence, we find, and is generally acceded to readily by connections upon representation of facts. The classes shown above do not cover the low class or commodity traffic which I have alluded to in the first part of this paper, which are carried only by special arrangement between lines interested and generally calls upon the short line to reduce their earnings to merely what it costs to handle, hence the assertion that it is better to leave it alone except where it may carry other higher traffic with it, when it can not profitably be turned down because the manufactured product might be lost, and as this is high class it is profitable. We unfortunately had to take hold of an existing line, with its rates and obligations fixed, and were unable to alter the existing divisions of rates, although we have from time to time endeavored to do so. Initial errors are costly, and upon interchange being arranged care should be taken to have all traffic arrangements thoroughly arranged by competent men, fully conversant with such subjects. The earnings per ton per mile should be fixed as high as possible, and never allowed to be less than what steam lines earn. Short mileage allows fair revenue, such as our earnings being not less than twenty-five per cent minimum of through rates, and upon extension of line minimums could be increased correspondingly. Conditions of traffic in Canada differ, however, from the United States in many respects. For instance, we have in large centres cartage to perform which is forced upon us by an old existing arrangement made by the Grand Trunk Railway when it was practically the only line in Canada, and which was inaugurated by it to take care of friends. This is a burden, because the expense is not covered by extra charge made above freight rates, part being absorbed in the rate. Another factor of expense in handling is the freight car equipment which costs interurban lines a per diem rate of twenty cents for every calendar day if foreign lines permit the use of cars. No line should be dependent upon equipment belonging to others, nor should they undertake to do more than deliver on cars at convenient points, unless the circumstances are very exceptional, as every transfer or movement necessarily costs money and increases the operating expenses materially. Rates should be maintained, and although steam roads are liable to cut with a view of forcing the business from electric roads, the public soon find that the competitor is being neighborly enough to try such tactics to force the electric road out of the business and then put up its rates with all the old disadvantages of slow time and poor service, that they will not patronize the line adopting such practice. Another commanding advantage to interurban lines is that their business is done on main roads in a number of cases where there are no terminal expenses, unless they endeavor to enter into active competition with steam lines, when terminals must be provided.

The handling of fruit is an important item in our season's business, Toronto being the central market. To handle our heavy freight traffic with the quickest des-

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patch at a minimum cost has brought us to a point of efficiency whereby we find it necessary to allow our boats only thirty minutes at terminal points to load and unload from five to seven carloads of freight. To meet the requirements of our traffic we built a number of four-wheeler platform trucks, the platform of which is similar to express trucks seen on steam lines, and capable of carrying two tons. On these we load all merchandise and package freight, ready to run aboard the boat on her arrival. The freight she brings in is run from the forward gangway, and the freight for her is run in the after gangway. To handle our fruit traffic with despatch we have erected at points along the line fruit platforms, on which we keep a supply of these trucks. The farmer drives to this platform, loads his fruit on the trucks, and this is picked up by our fruit train, which consists of flat cars the same height as the platforms, and are run to make connections with each boat. This train is manned with three men who run the loaded trucks from the platform on the cars. At Port Dalhousie they are run directly from the cars on the boat. This prevents handling, which is very damaging to the fruit, and also permits the fruit-grower to use a cheaper grade of baskets, thereby effecting a great saving for him.

On the whole, therefore, freight business of interurban lines will pay if confined to the higher class of traffic and particular attention is paid to despatch and accommodation to the public.

NOTES ON X-LIGHT.

BY WILLIAM ROLLINS.

NOTE CLXXI—ON X-LIGHT TUBES IN WHICH AN INTERNAL TARGET IS COOLED.

Several makers have adopted the plan originated during these experiments of cooling an internal target in an X-light tube, but owing to want of experience they have failed to copy the more efficient types, making inferior forms of the earlier and less valuable, in which the target was cooled by a small reservoir of water attached to the X-light tube, instead of by a constant discharge of air or water against the target. The tube illustrated in Fig. 1 is a type of what a water-cooled tube should not be. It is selected because in the most recent work on X-light this statement is made in regard to it, "Of the water-cooled tubes this is unquestionably the most effective."

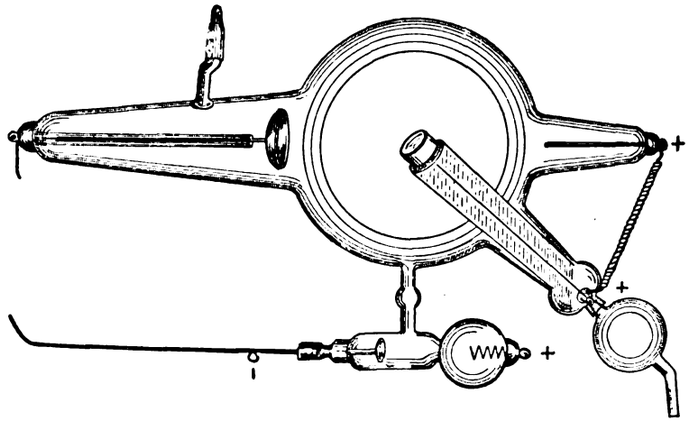

FIG. 1.

When this tube is excited by a powerful current the water is driven from the target, which the heat then melts, or the tube cracks at the seal. A second objection to this tube is the impracticability of sending the X-light in some of the required directions. No tube is suitable for medical use unless the X-light can be sent up, forward or down at any angle. With this tube the light can not be conveniently thrown upward, as it should be when examining a patient in a horizontal position with the source of X-light below, because the cooling liquid falls away from the target by gravity, allowing the target to heat. If manufacturers of cooled target X-light tubes do not wish to adopt the plan shown in note i of using an air or liquid stream from a source outside the tube, they should copy the idea used in the earlier forms of this tube, for, as shown in Fig. 2, it allows the X-light to be sent in any direction, as the cooling attachment being attached to the tube by a rubber or oak bark stopper permits the reservoir to remain vertical while the tube is turned about its long axis to cause the light to shine up, forward or down at any angle. When electrolytic breaks are used with coils of the type shown in earlier notes, in which a large amount of current can be safely employed, even the better type of cooled target tube illustrated in note i may require a different arrangement of the cooling devices, if this is a liquid, to diminish the risk of injury to the seal. In some of the later forms the hollow target was made longer, the glass and platinum at the seal being kept at a more uniform temperature by the arrangement shown in Fig. 3. This modification is not required when the target is cooled by an air blast. Some of the experiments have shown the possibility of producing X-light of proper quality in sufficient quantity to show the heart clearly at a distance of ten metres with a current which does not melt a thin uncooled platinum target. Generally a current is used sufficient to convert into vapor the water touching the target, which then melts, admitting air to the tube. The way to prevent this is to discharge the cooling agent in a constant stream directly against the target. Cooled target tubes in which this is not done are not better than those with rotary uncooled targets, such as have been shown in these notes.

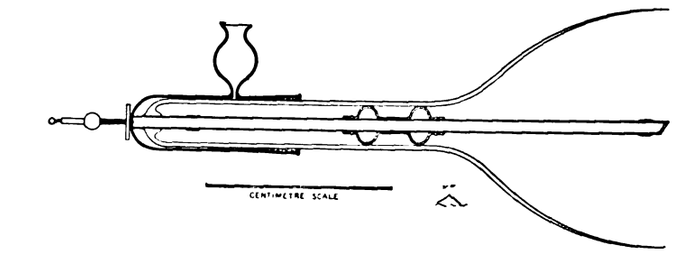

FIG. 2.

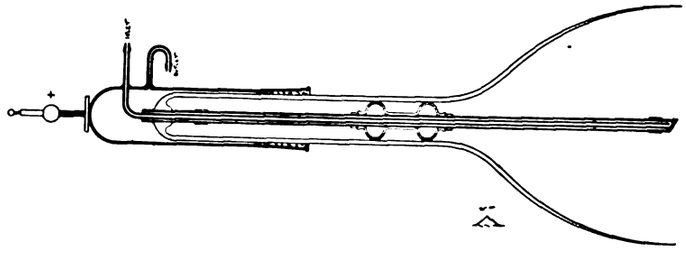

FIG. 3.

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Vol. 43—No. 20

Reviews of Current Engineering and Scientific Literature.

Methods of Measuring Radiant Efficiencies.

It is important in the work of increasing the efficiency of our illuminating agents that an accurate method of determining the efficiency be devised, or, if this is not possible, that the limitations of the methods at present in use be understood. Dr. E. L. Nichols and Mr. W. W. Coblentz have investigated the methods now relied upon, and in this paper show that they are far from accurate. The most general method of determining the efficiency of an illuminant is to measure the total radiation, and then, by interposing a screen which is supposed to cut off the heat rays without seriously reducing the luminous rays, to make another determination. The latter is supposed to be proportional to the luminous rays, and the ratio of this to the first is taken as the light efficiency of the illuminant. The screen most often used is a glass cell filled with pure water, but this does not stop all the heat rays. An alum solution has been used instead of water, but it has been shown not to be as satisfactory as water. Another method is to determine the radiation in the various parts of the spectrum. The radiated energy is then completed by integrating the curve thus obtained. In this method the readings are affected by the width of the spectrometer slit, and correction for this is difficult. Another method is due to Angström, who separates the infra red radiation by interposing an opaque screen in the spectrum, after which the light is reassembled and its energy compared with the total. The authors reach the conclusion that, for satisfactory measurements, recourse must be had to a method based on the principles used by Angström, or a satisfactory screen must be found.—*Abstracted from the Physical Review (New York), October.*

The Central Station Battery.

In the opinion of Mr. R. W. Vicarey, storage batteries are not receiving as much attention as they should from the technical press. Storage batteries are important adjuncts to central station equipments, but they seem to suffer from lack of care, due, doubtless, to insufficient knowledge on the part of the attendants. The demands of a central station vary within wide limits, and it becomes extremely difficult to design and construct a battery which will be uniformly durable and efficient inside such limits. This fact makes the battery somewhat more delicate than it would possibly be otherwise. While a battery may not need skilled attention, yet it needs ordinary and regular attention, just as any other part of the plant installed. Mr. Vicarey believes that voltage readings of cells do not indicate as surely the condition of the cell as determinations of the specific gravity of the acid. By this method a sick cell can be detected readily. Specific gravity readings are equally as important in making tests of storage batteries. In fact, the author prefers such readings to those of voltage. Even a partially short-circuited cell will sometimes give its normal electromotive force while charging, and thus make it difficult to detect, but specific gravity readings will always indicate trouble in any cell. Temperature readings are also important, and the temperature of the room should always be given when reporting upon a test. When a cell is found to be sick, it should be examined at once and the cause removed. If there should be nothing apparent to indicate the reason for its behavior, an analysis of the electrolyte will, no doubt, supply the information required, and in all probability save the cell from being ruined.—*Abstracted from the Electrical Review (London), October 23.*

A New System of Simultaneous Telephony and Telegraphy.

This is the first paper by M. Turchi, describing the system of the simultaneous use of a line for telephonic and telegraphic transmission. The principle involved is that of designing a telephone apparatus that will not respond to the certain frequency employed in sending telegraphic messages. The theory of this principle is first considered and nine possible arrangements of condensers, resistances and inductances are analyzed. A divided circuit is used, in each branch of which is connected one winding of an inductance coil. One branch contains a condenser and the other a condenser and an inductance, the two branches being so adjusted that the currents through the two windings will neutralize each other at that particular frequency which it is desired to suppress. The divided circuit forms part of a local circuit which contains the telephone receiver and transmitter and the necessary ringing apparatus. Connection with the transmitting line is made through a transformer. The calling apparatus is operated by rapid impulses sent over the line from a small induction coil. The current for the transmitter is furnished from storage batteries. The system has been tried over iron lines ninety kilometres long, and over bronze lines 318 kilometres in length. Tests were made in connection with various telegraphic systems with success. The apparatus is so designed that the condensers and inductances can be adjusted to the particular line on which they are installed. This system also provides against disturbances due to parasitic currents such as might be caused by a neighboring trolley line.—*Bulletin of the Association des Ingenieurs Electriciens (Liege), September 30.*

The Compensation and Compounding of Alternating-Current Generators.

A recent paper by Mr. Alexander Heyland, on the compounding of alternating-current generators, calls forth some criticism from Mr. H. S. Meyer on this method of excitation. In considering the question of first cost, Mr. Meyer does not believe that the new type of generator can be built more cheaply than the old and standard type. The diameter of the armature is chiefly determined by the number of poles, leaving only the width for a saving, and he does not believe that much can be gained there. The cost of a commutator with cross-connections must be set against that of the exciter for the standard machine. For ordinary high-speed machines there may not be much difference in the cost of these two items. For slow-speed machines the conditions will be more unfavorable to the Heyland machine. The cost of operation involves the question of efficiency and attendance. But little can be saved by increasing the efficiency, since in modern machines having an inherent regulation of about six per cent at full non-inductive load, the total excitation should not be more than one per cent of the output of the generator. In regard to attendance, it is hardly probable that the switchboard attendant can be entirely done away with. The cost of maintenance for both machines should be about the same, while the cost for reserve parts will be greater with the Heyland machine than with the standard. The author thinks that self-excitation, except for small machines of few poles, is a step backward, particularly as an initial impulse has to be given before the machine will excite itself. Automatic regulation of the voltage is undoubtedly

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of great value in small plants with lighting and power loads. Here the standard generator can not economically be built for a close regulation, and the attendant, who is at the same time in charge of the engine, can not give the necessary attention to the regulation of the voltage. In larger plants the fluctuations can be taken care of by the switchboard attendant. The author thinks that if automatic regulation is desired it can be obtained in a satisfactory manner in any standard generator, and he describes a system recently brought out by the British Thomson-Houston Company, in which a relay rapidly opens and closes a circuit, shunting the rheostat in the exciter field. The relay is controlled by the voltage of the alternator, and it will act immediately on any change of voltage, whether it be caused by non-inductive or inductive load, or a drop in the speed of the engine.—*Abstracted from the Electrician (London), October 16.*

Technical Education—What It Should Be.

In this article Dr. Louis Duncan first studies briefly the condition of technical education in the important commercial countries; and second, gives his notion of the position of technical education in the United States, its difficulties, its mistakes and its possibilities Technical education in Germany combines with the painstaking acquirement of knowledge typical of German education an idea of research. In America it is the old-fashioned general collegiate education modified by paying special attention to technical subjects, with a veneering of manual training. In England to-day it is chaotic, with a tendency to keep it on a trade basis. The aim of technical education is to apply discoveries to practical work. When a new problem comes up it is attacked from the point of view of a few general principles. The fault of technical education is, in America, that it is too technical and that there is too much instruction. We should not attempt to make mental storehouses of men, but mental factories. The ability of a man to work out any specific problem depends on his being able to make a mental plot of the problem and keep it constantly before him. This requires an imagination that has been developed, and not suppressed. The successful engineers are those who can see the problem as plainly while they are walking on the street as they can see it on the blue-print. Our largest and best-equipped institutions do not show as fair a percentage of leading engineers as some of the smaller, poorly equipped colleges. This is due to two things: first, the larger institutions have presented courses including more instruction than can be given in smaller institutions; second, in the smaller institutions the students are more directly in contact with the instructors, and as they do not have many facilities for work, when an experiment is to be tried, the ingenuity of the student—and not his patience—is exercised. To sum up, Germany is supplying a magnificent basis for engineering research, but is weak in the application of this research. In England there is a tremendous gap between Thomson's theory of electrons and instruction in wood-turning. Here in America we have crowded into twenty years of commercial development the results of two centuries of the world's research, but we are now nearing the end of the researches which we have appropriated, and we must soon either lay down fresh foundations or stop building.—*Abstracted from the Engineering Magazine (New York), November.*

Timber-Treating Plants.

Five years ago when Mr. W. W. Curtis began to write on the treatment of railroad ties, interest in the question was largely academic. He now estimates that during the twelve years preceding 1899, 10,000,000 ties were treated. To-day there are sixteen works in operation, furnishing ties to fifteen or more railroads. Probably more ties will be treated during this year than during the twelve years preceding 1890. At first it was thought advisable to treat only the best ties, thus adding to the expense of treatment the higher price for the finest ties. Now inferior ties, which would ordinarily give a short life, and are therefore cheaper, are equal to the best when treated. Three methods of treating are discussed. In the first method zinc chloride is injected, and where the work is carefully done a tie of soft lumber will have a life equal to that of white oak. In treating the tie, the climate to which it will be exposed should be considered. If it will be exposed to much water, great care should be taken to dry it thoroughly before using it, to prevent bleaching out of the zinc chloride. If water is left in the tie, the chloride is easily washed out. The second method described is the zinc-tannin treatment. This was begun about twenty-five years ago. The tie is treated with chloride of zinc, the glue and tannin forming an insoluble compound, preventing the loss of the zinc chloride. Ties treated in this way give good service, but the records are not very complete. The treatment is said to cost about three cents more than the zinc treatment alone. The third treatment consists in treating with zinc and creosote oil, either together or separately. Creosote is the best timber preservative known, but it is expensive. Chloride of zinc is used to decrease the large amount which would otherwise be absorbed by the wood. The creosote may be used alone, but the cost of the material would be excessive. The following are the costs given for the three processes—zinc chloride, 3.75 cents per cubic foot; zinc-tannin, five cents per cubic foot; zinc-creosote, 7.5 cents per cubic foot. For creosote alone the cost is fifteen cents per cubic foot. Timbers which readily take the treatment, and which, when treated, make a valuable tie, include the inferior oaks, beech, hemlock, pine, spruce, fir and probably gum. The author then describes a good arrangement for a timber-treating plant, showing how the installation should be laid out to get the best results.—*Abstracted from the Journal of the Western Society of Engineers (Chicago), October.*

A Plea for Better English in Science.

In the current issue of *Science,* Mr. P. C. Warman makes an earnest plea for better English in scientific and technical publications, from which we excerpt the following paragraph:

Scientific men, especially the young men, are prone to spend most of their time in observing and experimenting; comparatively little is devoted to studying the accumulated data and their relations, and little indeed is reserved for composition. Phenomena are sought with eagerness, but, once discovered, interest in them wanes. The field and the laboratory are too alluring to be resisted for long, and the time to be devoted to reflection and to writing is minimized. Neglecting what Coleridge termed "ratiocinative meditation," they produce with facility papers consisting of crude raw materials which can but repel persons endowed with a sense of order, strength and beauty. Doubtless these writers are, as Henry James says, "strangers to the pangs and the weariness that accompany the sense of exactitude, of proportion and of beauty," but in many cases it is also true that they are writers who "have been hindered in their course and never knew the reason why." I appeal to the scientific men of America, especially the younger men, to cast off this shameful indifference to the power and beauty of their marvelously rich and adaptable language, and to devote to their writing some of the energy they manifest in the field and some of the patience they exercise in the laboratory.

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INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Motor Starters.

The accompanying illustrations show the motor starters manufactured by the Ward Leonard Electric Company, Bronxville, N. Y., conforming to the United States Navy specifications.

The two levers are pivoted on the same pivot, one lever being that of an ordinary spring-operated positive-release circuit-breaker, and the other arm is provided with the operating handle which has the no-voltage release which brings the starting arm to the off position from any running position on failure of voltage.

The resistance wire or ribbon is composed of high-grade nickel alloy, and is embedded in and held against movement by solid mineral insulating material, such as enamel or silicious sand. This nickel

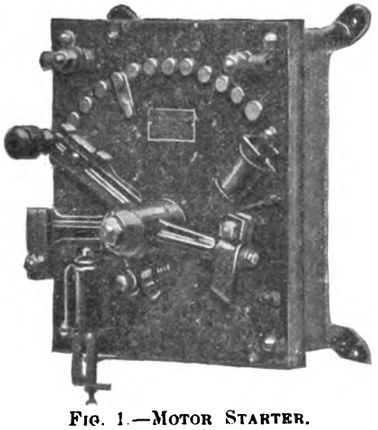


FIG. 1.—MOTOR STARTER.

alloy does not corrode and does not materially increase its resistance with rise of temperature. The insulating material used, either enamel or silicious sand, is non-combustible, non-absorbent and non-damageable by moisture or by heating to 300 degrees centigrade. This resistance is so supported that it will not become displaced or fall out in case it should be melted off or overheated in any part. These characteristics are the special features which conform to the specifications as issued by the United States Navy Department. A bulletin recently issued by the Ward Leonard Electric Company details these specifications and also details a few of the claims in the patents awarded to H. Ward Leonard, showing wherein the specifications and the claims are similar.

Fig. 1 shows the SKE type of motor starter. Fig. 3 and Fig. 4 show a motor panel which the company is building for the government and for motor manufacturers who are building variable speed motors, the speed variations being obtained by varying the field strength. Fig. 2 shows a diagram of the connections of this motor panel.

The experience of the oldest workers in this branch of electrical engineering has shown that at least ten points of field control are necessary to give proper regulation and to prevent jumps of speed be-

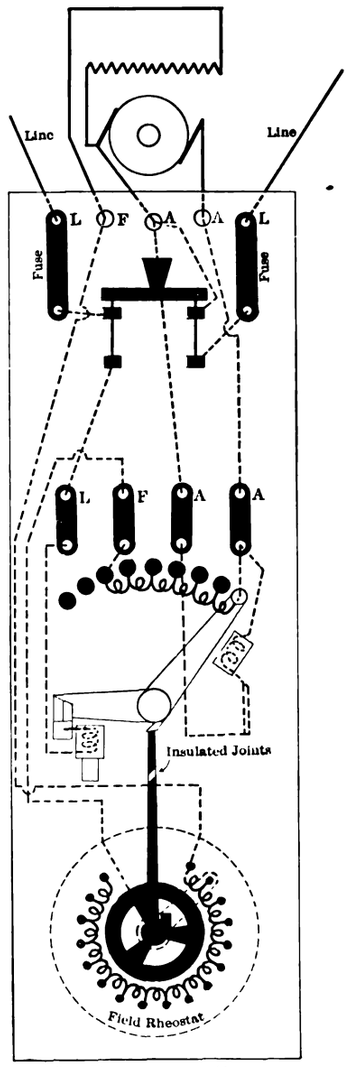
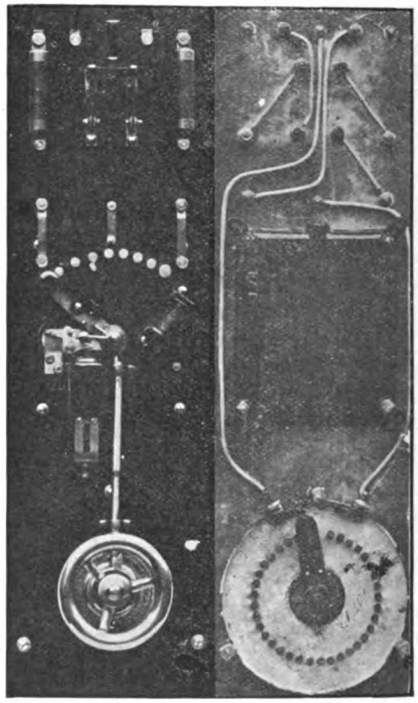


FIG. 2.—DIAGRAM OF CONNECTIONS

tween points. The accompanying illustration of the panel shows that it consists of a motor starter so interlocked with a field rheostat that the motor can not be started under conditions of weak field. This prevents the possibility of overloading the armature in starting with all resistance thrown in on the rheostat, and therefore a very weak field. This rheostat may have anywhere from 30 to 150 steps, and gives the most perfect and even speed regulation. The no-voltage release magnet is independent of the amperes flowing through the field, and therefore will not release the arm of the starter upon weakening the field current. The starter is equipped with an independent interlocking overload circuit-breaker which protects the motor at all times, even during the period of starting.

The illustration will also show the simplicity and freedom from fire risk of this apparatus, as well as its freedom from any chance of short-circuit or destruction due to rust. The resistance of the starter



FIGS. 3 AND 4.—FRONT AND REAR VIEWS OF MOTOR STARTER PANEL.

and the field rheostat has a practically zero temperature coefficient.

No iron or copper resistance is used in the construction of any of the apparatus manufactured by this company. The United States Navy uses this type of panel in large quantities.

Electric Automobiles.

The accompanying illustration shows an electric automobile runabout manufactured by the Studebaker Brothers Manufacturing Company, of South Bend, Ind. This type of vehicle has been on the market for some time now, and while the manufacturing company, which is one of the oldest and most prominent builders of horse-drawn vehicles, could well be re-

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lied upon to produce a carriage satisfactory from a carriage builder's point of view, the performance of the electric vehicle has been such as to warrant its being placed in the same classification as the company's horse-drawn vehicles.

One of the chief arguments which has been advanced against the universal acceptation of electric power in driving automobiles has been the alleged difficulty of securing facilities for charging the batteries, this making impossible tours of any great length. It is now conceded that, in many parts of the country, there are numbers of charging stations which

Electric Runabout for Long Runs.

make a specialty of supplying current to the batteries of electric automobiles, and, in other instances, the ordinary machines found at almost any lighting and power station can be made to do the work by the manipulation of very simple regulating apparatus.

A noteworthy trip made with one of these Studebaker electric automobiles was undertaken by Mr. Peter Dumont, of the New York automobile department of the company, and his wife. They made a very successful two weeks' tour without a single mishap. The parties left their home at Cranford, N. J., on September 1, in a Studebaker model No. 1354 electric runabout, selecting the heaviest sections of New Jersey and eastern Pennsylvania for the trip. Owing to a severe rain-storm just before the trip was commenced, the back country roads were in very bad condition, and there were also a number of very steep grades to be overcome. There was no difficulty experienced in securing charging current, as at every town where stops were made either current was received from the proper apparatus direct, or was taken from the exciting machines, using a water rheostat to regulate the current flow. The route followed took the party from Cranford to Somerville, N. J.: Flemington, N. J.; Doylestown, Easton and Washington, Pa.; Hackettstown, N. J.; and from Hackettstown to Morristown the most difficult bit of riding on the trip was encountered, which necessitated the automobile climbing Schooley's mountain. This is a very steep, long grade, and has proved an impossible obstacle to a great many automobiles. From Morristown the run was made back to the starting point at Cranford, about 300 miles having been covered in all.

The battery used in the Studebaker automobile will give a run of forty miles in one charge. It is located in the rear body compartment, and the motor is hung immediately in front of it. This motor has been especially designed for automobile work, and is built by the Westinghouse Electric and Manufacturing Company. The design is such that small increases in current produce a greater power effect than ordinarily obtains in motors of this class. This cuts down the battery discharges, even in severe service. The motor has been suspended above the springs from the frame of the running gear on which the body rests, and is so arranged that it can be swung backward or forward and fastened rigidly in position, securing perfect chain adjustment.

The power transmission is by roller chain from a countershaft built into the motor head and a balance gear on the rear axle. The pull of the chain is taken by distance rods attached to the side bars of the running gear frame and to the main rear axle bearings.

The controller has four speeds, and its handle is conveniently located at the left-hand side of the seat. The motor reverses by pressing a lever with the heel. The speeds backward are the same as forward, and are equally divided. The highest speed is thirteen miles per hour on a level street.

A cutout switch is provided which can be operated by the foot to throw off the power in case of emergency. It has a removable handle, and the operator can safely leave his automobile standing unattended by taking this out. The same switch, when thrown into the lowest position, makes the proper connections for charging the battery and cuts out all the wiring in the vehicle except that between the charging plug, the switch and the battery. This makes it possible to examine the motor, controller or wiring while the battery is on charge.

The batteries must be charged from some direct-current circuit which will give approximately twenty amperes at a voltage between sixty-five and 115. Each automobile is equipped with a charging receptacle which will fit the standard charging plug.

The automobiles are equipped with indicating meters, showing the condition of the batteries at any time. Two electric side lamps are furnished, operated by switches in the heel board.

The frame of the gear is made of high-grade tubular steel. This is so constructed as to relieve the body of the vehicle of all strains of any nature. The front springs are semi-elliptic, the rear springs fully elliptic. The steering is done by a side lever, which makes the easiest possible control of the vehicle. Two powerful brakes are placed on each

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carriage, both controlled by foot levers. One of these brakes operates on two drums placed on the rear axle, the other operates on a drum mounted on the end of the motor shaft.

The front axle is tubular, reenforced throughout its length. The steering spindles are made of high carbon solid steel. The rear axle is a solid bar of steel, running from one wheel to the other and fitted with a short sleeve on one side to get the necessary differential effect.

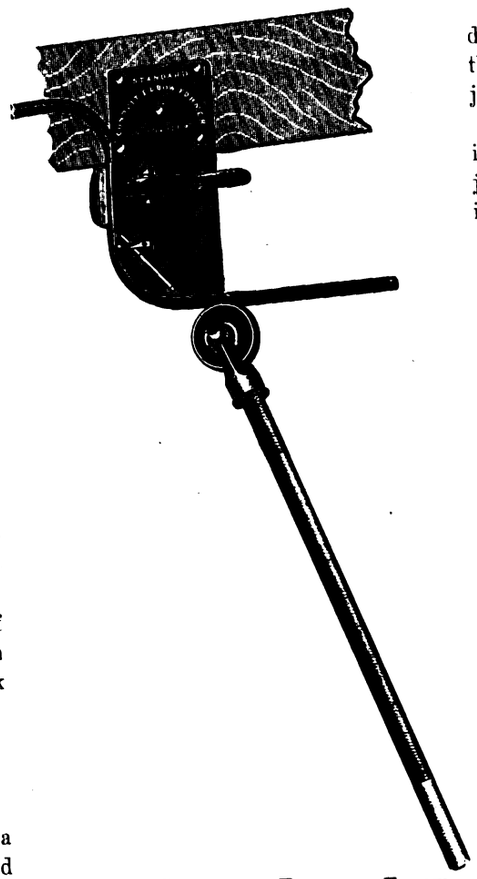
Either wooden wheels or wire wheels are furnished, as specified. The wooden wheels are of the artillery type, and the wire wheels are made with swedged spokes of high tensile strength. The tires are thirty by three-inch double-tube pneumatic of the detachable variety.

Ball bearings are used wherever they are of advantage. These bearings are extra large size, made especially for automobile use.

The Studebaker Brothers company of New York, Broadway and Forty-eighth street, New York city, is the New York branch of the Studebaker company.

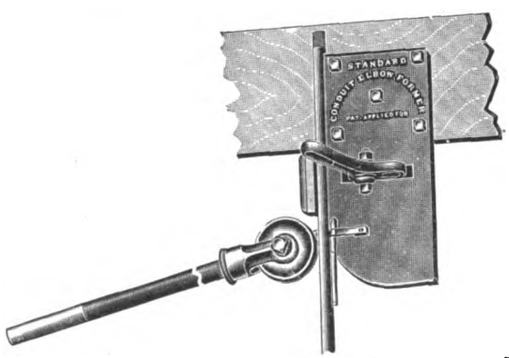
A New Type of Conduit Elbow Former.

The accompanying illustrations show a new type of conduit elbow former invented and manufactured by L. H. Church, 322 Main street, Stamford, Ct. The important feature of this apparatus is the speed with which conduit can be manipulated, and another feature is the absolute accuracy with which the standard elbows can be turned, eliminating entirely all guesswork. As may be seen from the illustrations, the apparatus consists of a heavy cast-iron form, which is bolted to one end of the bench, preferably at the end opposite to the pipe vise. A powerful eccentric and lever manipulate a grooved vise jaw, which, after the conduit has been inserted, clamps it against the form, holding it rigidly. The forming wheel is then brought against the conduit and exerts a proper pressure between the grooved wheel and the grooved form, so that the pipe is bent quickly and accurately, without flattening or kinking in any way.



CONDUIT CLAMPED IN FORM AND ELBOW TURNED.

A gauging device is attached to this elbow former, which makes possible the accurate bending of any elbow. Suppose the turn is desired eighteen inches below the upper end of the conduit. Eighteen inches is then measured off from this end, and the pipe is brought up so as to come flush with a mark on the gauge. It is then clamped against the form, and the grooved wheel and lever brought into operation. There are several other ways in which this apparatus can be manipulated, as will be readily understood by any one making any extended use of it.



CONDUIT PLACED IN FORM, BEFORE BEING CLAMPED AND BENT.

A large demand is being met for conduit formers of this type every day, as the elimination of made-up elbows and joints is strongly to be desired.

The apparatus is being furnished with interchangeable grooved wheels and vise jaws, so that one-half and three-quarter inch conduit may be taken.

Large-Capacity Electrolytic Generator.

The Holtzer-Cabot Electric Company, Boston, Mass., has paid particular attention to the growing demand for large electric generators of low voltage, but relatively high-current output, for the refinement or reduction of metals by electrolytic action. This company has supplemented its line of platers, which has been very successful for a number of years, with some larger generators designed more particularly for electrolytic work.

The accompanying illustration shows a generator with a capacity of 4,000 amperes at an electromotive force of six volts.

In designing these machines the perplexing problem of commutating the enormous quantity of current was solved by the use of a double armature winding, with two commutators and a special conformation of field.

The field ring is of cast iron, and the poles are of wrought iron cast welded into the ring, making an excellent form of magnetic joint. The poles are fitted with a special form of shoe.

The armature core is relatively of quite a large diameter, and is built up of thin discs of soft steel, painted on either side to break up eddy currents. It is mounted upon a spider, the laminations being clamped in a special manner by end-plates, doing away with bolts running lengthwise through the body of the core, thus preventing local currents and reducing heat losses. The spider is provided with a threaded projection which holds the commutator in such a way as to leave an opening between the shaft and the commutator in front. Air ducts are provided in the core, and the air, being drawn into the body of the core and thrown out centrifugally through the ducts and winding, serves to keep the armature cool, notwithstanding the great quantity of current flowing. The cylindrical form of winding is used, making the armature resistance low and permitting of the replacing of a damaged coil without much diffi-

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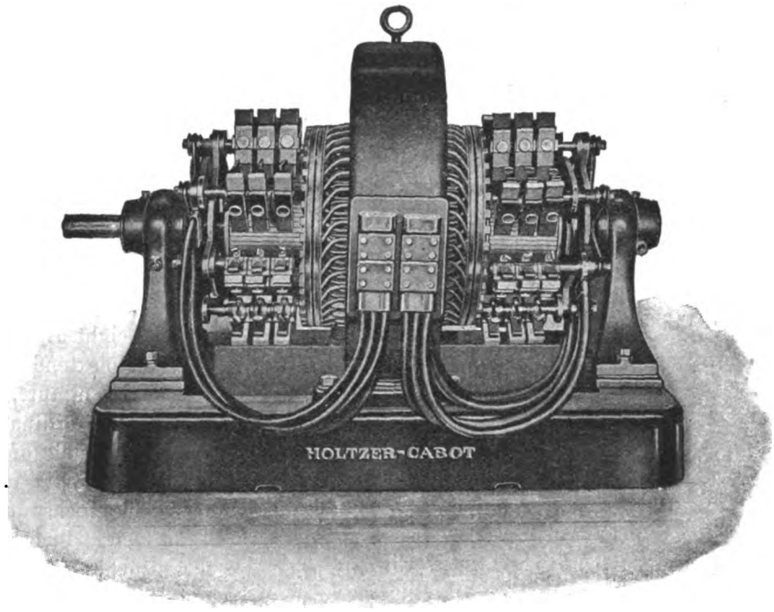
culty. The coils are of bar copper and entirely without joint except where they are soldered to the risers of the commutator.

The commutators are of massive construction. They are made up of hard rolled copper segments, soft mica being used for insulation, and are clamped by bolts in such a way as to entirely prevent shifting of the segments. The section of the copper segments was made unusually large, to take care of heat generated by the flow of the current and the friction of the brushes, and at the same time allow for plenty of wear.

The brush-holder is of the tangent type, such as used on all Holtzer-Cabot platers.

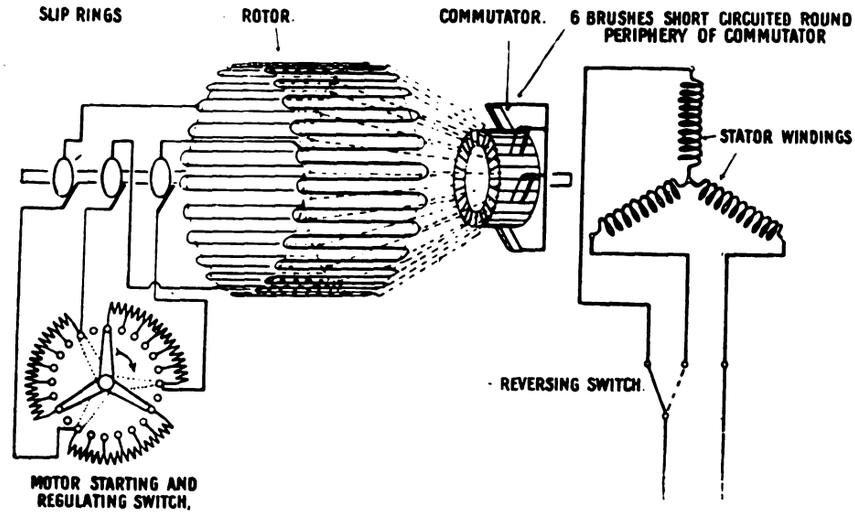


LARGE-CAPACITY ELECTROLYTIC GENERATOR.

A Single-Phase Motor.

A single-phase motor is being put on the market by Ferranti, Limited, of Manchester, England, which is constructed according to the Schueler-Ferranti system. The motor is illustrated diagrammatically in the accompanying drawing. The armature resembles an ordinary continuous-current machine, or rather, the armature of a three-phase synchronous converter, as it has three slip rings in addition to the commutator. The brushes bearing upon the commutator are short-circuited; those bearing on the slip rings are connected together through a regulating resistance. The stator has a three-phase star-connected winding, but only two of the coils are used at one time. The other is put on to make a convenient method of reversing the direction of rotation. As seen from the diagram, by changing the reversing switch, the relation of the two coils in use is reversed, and the direction of rotation will also be reversed. The general idea underlying the design is to combine the properties of the repulsion motor with those of the induction motor, the former giving a large starting torque, and the latter for normal running.

In starting, all the resistance is thrown into the rotor circuit, and the motor starts practically as a repulsion motor. As it speeds up, the resistance is cut out and the current thus shunted around the commutator increases until the slip rings are short-circuited. It is said that the efficiency of this motor is practically the same as that of the induction motor. The starting characteristic is nearly a straight line, and it is said that a starting torque of three times the normal running torque is obtained with a current not exceeding twice the normal current; and the normal working current gives a starting torque of twenty-five per cent above the normal running torque.



SCHUELER-FERRANTI SINGLE-PHASE MOTOR.

BOOK REVIEW.

"American Telegraphy, and Encyclopædia of the Telegraph." William Maver, Jr. New York. Maver Publishing Company. Cloth. 566 pages. 7 by 9¼ inches. 490 illustrations. Supplied by the ELECTRICAL REVIEW at $5.

This is a new edition of Mr. Maver's book, which has become a text-book on this subject. The book takes up, in turn, a description of systems, apparatus, and the operation of these. The chapters embrace electrical testing, primary and storage batteries; dynamo machines; Morse, duplex, quadruplex, multiplex, submarine, automatic and wireless telegraphy; burglar-alarm, fire-alarm and police-alarm telegraphy; the printing telegraph; military and naval signaling; railway block systems; telegraph wires, cables, conduits, etc. The author is too well known as an accurate and comprehensive writer on the subject of telegraphy to need more than a passing comment. The book has been before the public for some time now, and the new edition is a worthy successor to the volumes which have been produced before. Each subject is taken up in detail, and where there is liable to be the slightest difficulty in comprehension, the explanation is full and convincing.

American Institute of Electrical Engineers.

The 181st meeting of the American Institute of Electrical Engineers will be held at the chapter room, Carnegie Hall, 154 West Fifty-seventh street, New York city, on Friday, November 20, at 8.15 P. M. The following papers will be read and discussed: "The Electric Conductivity of Commercial Copper," by Lawrence Addicks; "The Comparative Behavior of Floating and Booster Control Batteries on Fluctuating Load," by Lamar Lyndon.

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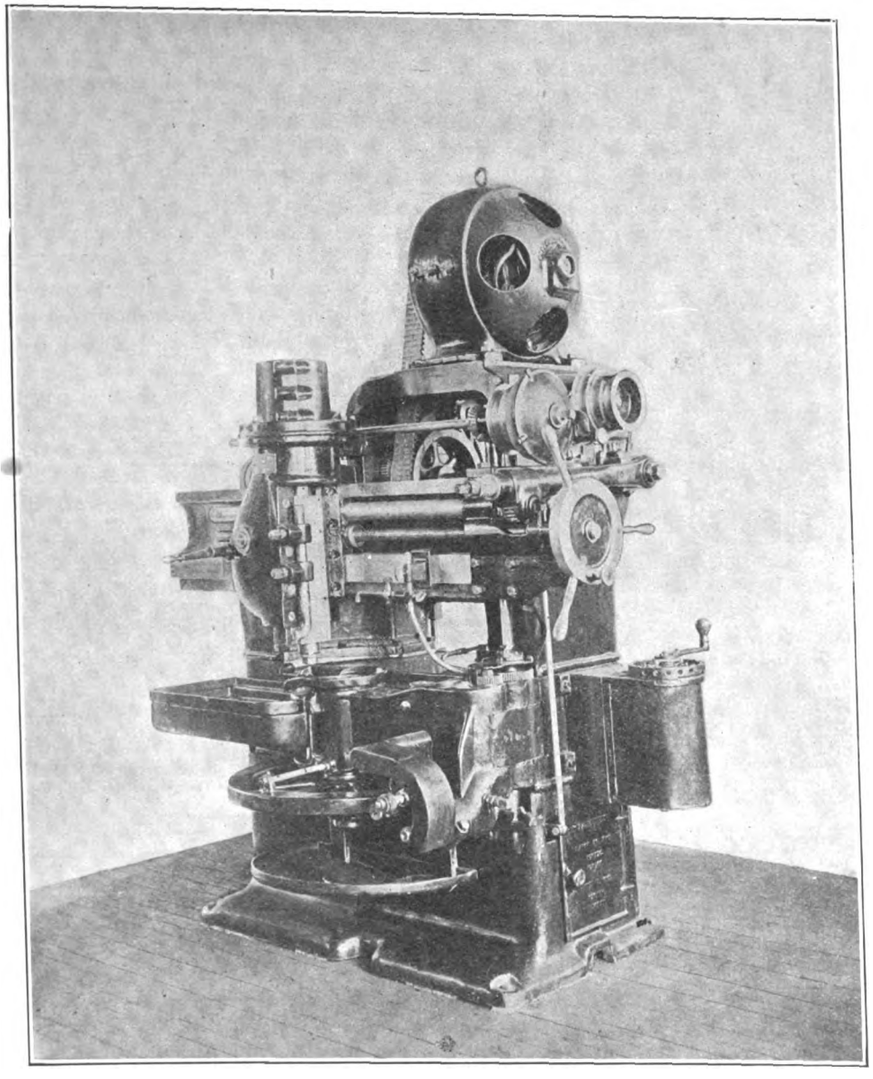
A Gear-Shaper with Motor Drive.

In the few years that the Fellows gear-shaper has been before the public it has achieved widespread recognition for its merits as evidenced most convincingly by the large number now in use. To-day nearly all shops that engage in gear-cutting to any extent have one or more of these machines, so that it is hardly warrantable to enter here into a description of its details. For the benefit of those unfamiliar with the tool it may be said, briefly, that the shaper differs from the other forms of gear-cutting machinery in that it replaces the rotating milling cutter by a reciprocating tool having the form of a spur-gear. This planes the teeth and at the same time is caused to revolve with the blank intermeshing precisely as its finished mate is intended to. In degree of accuracy this scheme compares with the hobbing method of forming worm-wheels, and also corresponds very closely to it in principle. The cutters for both may be produced with extreme precision, especially for involute gearing, the only type now in common use, as both then depend on generation by straight lines. For instance, a hob is cut as a perfect V-thread, and the Fellows cutter is finished by being caused to roll against the carefully trued face of an emery wheel with a motion simulating that of a pinion tooth against a rack tooth.

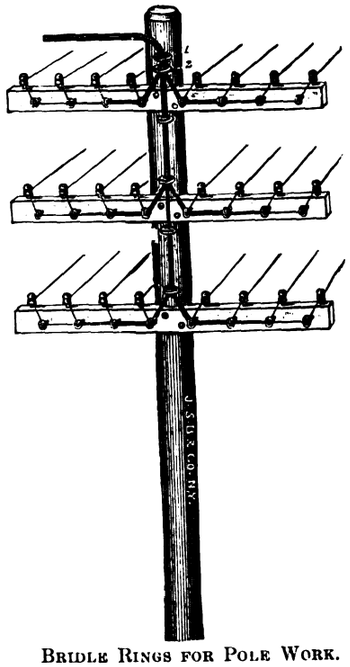
It is the present desire to call particular attention to the machine as now provided with individual motor drive. The only special work necessary was the casting of a plate to span the pillow blocks of the regular driving gear to afford a support for the motor, and the substitution of a sprocket wheel for the cone pulley used with belt drive. With these changes a standard form has been evolved as shown in the accompanying illustration. A five-horse-power Crocker-Wheeler semi-enclosed type motor supplies the power, transmitting it with a reduction in speed through a Renold silent chain to the spindle which normally holds the cone pulley. The speed is further reduced through either of the two regular gear combinations which are used alternately, making two speeds possible mechanically. In addition the motor is supplied with current on the Crocker-Wheeler four-wire multiple voltage system giving it six independent speeds, and with the use of resistance twelve intermediate ones. The upper ten of the motor's eighteen speeds constitute its working range, within which, through the faster gear combination it drives the ram at from ninety-four to forty-five strokes per minute, or with the slower gear combination, forty-three to twenty. The lower eight available motor speeds may be used to extend the range down to six strokes per minute, though twenty is the minimum in ordinary practice. The machine is capable of cutting external gears up to thirty-six inches in pitch diameter by five inches face and internal gears twenty-eight inches in pitch diameter by three inches face, allowing any diametral pitch up to four.



MOTOR-DRIVEN GEAR-SHAPER.

Insulated Bridle or Distributing Rings.

One of the most important conditions in installing modern telephone systems is the proper distribution of bridle wire for both interior and exterior service. There is probably no piece of apparatus which can be used with greater facility than a properly designed bridle or distributing ring. Where this apparatus is correctly used it eliminates entirely the tangled and confused network which has brought so



BRIDLE RINGS FOR POLE WORK.

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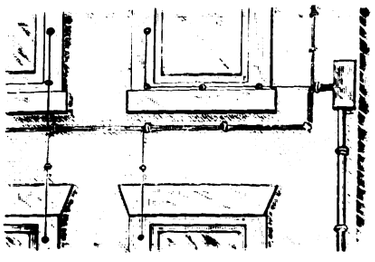
much trouble to telephone companies that have not been far-seeing enough to perceive the justification of the slight additional expense of its free use. The accompanying illustrations show the use of the bridle rings for both house and pole work.



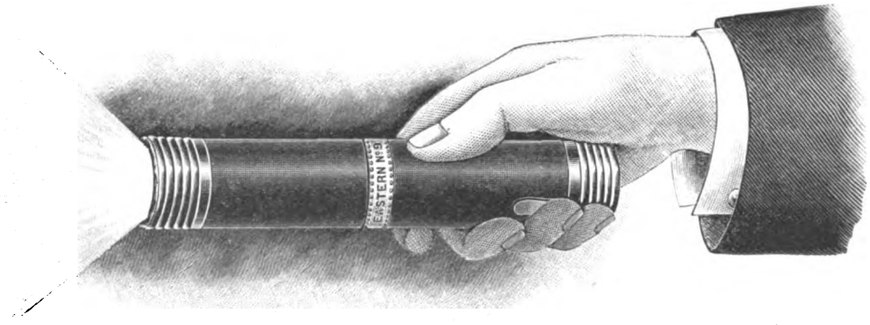
BRIDLE RINGS IN HOUSE WORK.

James S. Barron & Company, New York city, are the manufacturers of the "H. P." insulated bridle or distributing ring. These rings are made of the best quality of iron, heavily coated with tough glass enamel. The wires are readily inserted or removed through openings in the ring, and the enamel prevents rust. The rings are easily screwed in by hand without tools in the most difficult and out-of-the-way places. When desired, they can be unscrewed and used in other positions indefinitely. These insulators are used by some of the largest telephone companies in the country.

A Handy Electric Flashlight.

The accompanying illustration shows the electric flash lamp made by the Eastern Carbon Works, Jersey City, N. J. There are many uses to which these flash lamps are applicable, and it is safe to say that an engineer or electrician would find it an invaluable help in emergencies. There are many conditions about a power-house wherein it becomes dangerous to strike a match or use any form of open flame lamp in case of accident befalling certain parts of the system. This accident may even create a discontinuance of the lighting service so that it becomes imperative to have illumination that the work of investigation may proceed. It is just in such cases as this that the electric flash lamp is of great value.

The lamp illustrated is nine inches long and one and one-half inches in diameter. It is fitted with the Eastern high-grade dry battery, and the company claims that it will give a strong light and possesses a life of great length. The lamp is well made and is put up in an attractive form. The current is turned on by the manipulation of a button on the outside of the casing.



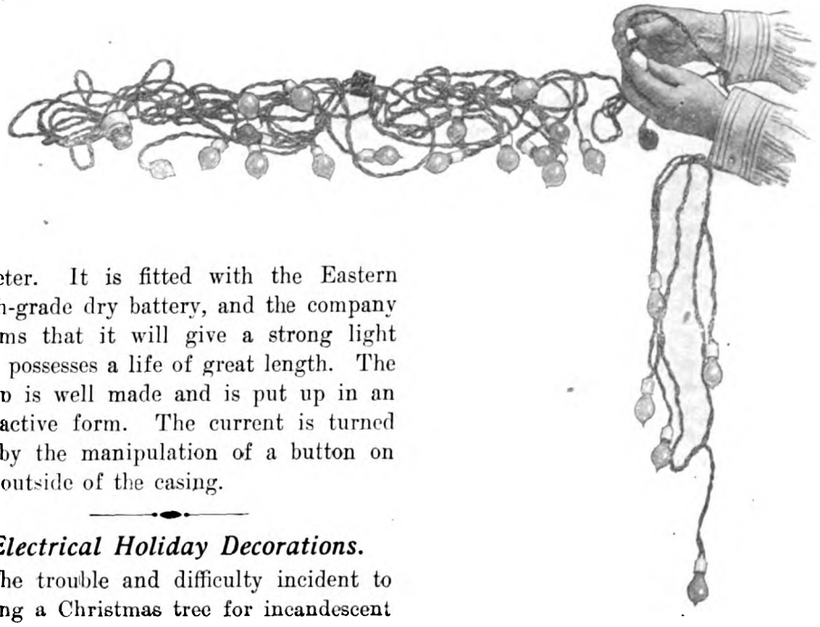
ELECTRIC FLASHLIGHT.

Electrical Holiday Decorations.

The trouble and difficulty incident to wiring a Christmas tree for incandescent lamps have heretofore been a great drawback to their use. To remedy this the General Electric Company has prepared an outfit of sockets and cord, connected and completely made up, ready for immediate use. The cord is simply draped over the tree, the lamps placed in their sockets, the connecting plug attached to the nearest electric fixture and the current turned on. All the lamps are instantly lighted and burn without further attention as long as desired. The outfit is light and flexible, thoroughly well constructed and "fool-proof."

FOR INTERIOR DECORATION.

Each regular outfit comprises some fifty feet of flexible cord with tiny sockets, arranged in three branch festoons, and twenty-eight one-candle-power miniature genuine Edison lamps in plain and colored bulbs, sufficient for the average Christmas tree. The outfit is neatly packed in a handsomely decorated wooden box, and forms a safe and charming Christmas gift for any household. Special outfits containing a larger number of sockets for large trees can be furnished when desired. The outfit is of value not only for Christmas trees, but also for general house decoration—upon the table, about the walls or around columns, over the balustrade or from chandeliers—at all times and seasons. An outfit once purchased lasts for years and can be used repeatedly with no trouble or further expense.



METHOD OF INSERTING MINIATURE LAMPS.

CHRISTMAS TREE DECORATION.

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CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

ANOTHER MEXICAN POWER PLANT—A hydraulic power plant is to be built on the San Pedro river, state of Tabasco, Mexico. Power will be derived from the fall known as El Randal. Amalio Acampo, of Mexico City, is primarily interested in the undertaking. The concession granted by the Mexican authorities permits of the utilization of 5,000 litres of water per second. Plans are now being drawn up for submission to the authorities. The sum of $5,000 in bonds, according to Mexican advices, has been deposited as a guarantee for the carrying out of the project.

STREET CAR COMPANIES MERGED—The City Passenger Railway Company, the Altoona & Logan Valley Railway Company and the Tyrone Electric Railway Company have been merged into one corporation, to be known as the Altoona & Logan Valley Railway Company. A mortgage for $4,000,000 in favor of the Equitable Trust Company, of Philadelphia, has been entered in the office of the register and recorder, John W. Cliber, at Hollidaysburg, against the electric lines of the allied companies. The mortgage was given to secure repayment of bonds issued at interest rate of four and one-half per cent.

NEW GERMAN ELECTRIC RAILWAY—The Westhofen-Hohen-Syburg branch of the Hörder District Electric Street Railway was opened to traffic on September 19, 1903. In the spring of 1899 the Allgemeine Lokal und Strassenbahn Gesellschaft in Berlin (General Suburban and Street Railway Company, of Berlin) began, under a fifty years' concession, the construction of a network of street railways in the Hörder district of the province of Westphalia. With the completion of the above-mentioned line it now has 41.02 kilometres (25.49 miles) of tracks, connecting many important industrial towns in the province. The company, which was organized in 1881, owns, controls and operates street railways in different cities throughout Germany. It has a paid-up capital of 15,000,000 marks ($3,570,000) and a bonded indebtedness of 19,000,000 marks ($4,522,000).

INTERURBAN SYSTEM HAS A NEW NAME—In order to avoid the confusion due to the similarity of the names of the Interurban and the Interborough railway companies, which operate the surface and elevated systems in this city, the Interurban Street Railway Company will in future be called the New York City Street Railway Company. An amended certificate of incorporation making the change of name was filed in the county clerk's office at White Plains. The company operates the Metropolitan and Third Avenue systems, which comprise all the surface lines of Manhattan Borough and the Union Railway Company's lines in the Bronx. The amended certificate is signed by Thomas F. Ryan, Frank S. Gannon, Paul D. Cravath, George G. Haven, W. H. Baldwin, Jr., and Edward J. Berwind. The change of name was made on a vote of 77,060 shares of stock. One of the directors said that the filing of the amended certificate was for the sole purpose of changing the name and had no other significance. There have been rumors recently that negotiations were in progress for merging all of the transportation lines of the city, but it was denied that the adoption of a new name for the Interurban was a move in that direction.

MICHIGAN TELEPHONE SALE—The banking firm of N. W. Harris & Company purchased in Detroit, on behalf of a syndicate of the bondholders, the Michigan Telephone Company. The sale was on foreclosure proceedings, and the price $4,100,000. The syndicate represented by N. W. Harris & Company has in it a number of individual New York interests as holders of bonds, the remainder being held in Boston. The issue is for $5,000,000, made in 1897 to run thirty years, and behind it is an indebtedness on notes amounting approximately to $2,500,000, controlled by the American Telephone and Telegraph Company, which, through its constituent company, the Western Telephone Company, owns the $5,000,000 of Michigan Telephone Company stock. Defaulting interest on the bonds, which were secured by a consolidated mortgage, the Michigan Telephone Company went into bankruptcy February 1 last. At the sale the American Telephone Company was the only bidder besides N. W. Harris & Company, their bid being $4,000,000. A representative of a minority stock interest from Boston made protest that the price did not represent the full value of the plant. It has not been determined as yet whether the new owners of the Michigan Telephone Company will undertake the operation of the property or will reorganize with a view to refunding its indebtedness. Plans for subsequent operations are now under consideration.

AN INDEPENDENT TELEPHONE SERVICE IN TORONTO JUNCTION—Negotiations have been completed whereby the Humbert Power and Light Company, which at present provides the electric light and power service in Toronto Junction, will be merged into the "Stark" Telephone, Light and Power Company. The new company has been formed for the purpose of supplying telephone, electric light and power service on the "Stark" system of distribution in Toronto and district. A franchise for twenty years has been obtained from the town of Toronto Junction, and the acquisition of the Humbert Power and Light Company will enable Mr. Stark to proceed at once with the construction of a telephone in combination with the existing light and power service. The agreement with the town provides for the supply of a telephone service within a radius of fifteen miles from the centre of the city of Toronto, at $6 per annum, and one cent per outgoing call, with a maximum charge per annum of $25 for business, and $15 for residence telephones. When, however, the system is in operation in the city of Toronto, with 3,000 subscribers, the maximum charge will be increased to $40 for business and $20 for residence telephones. Three hundred subscribers have already been obtained in Toronto Junction, and the work of construction will be proceeded with at once. The company has also about 3,000 contracts signed in Toronto, and arrangements will be made at an early date for the establishment of the "Stark" system in that city. It is the intention of the company to develop the Humbert water power to an extent which will enable it to supply all the current necessary for a telephone, light and power service in the city and suburbs. The directorate of the new company will include the Hon. John Dryden, president; the Hon. Geo. E. Foster; Mr. J. Blacklock, manager of the Reliance Loan and Savings Company; Mr. H. Waddington, managing director of the London Mutual Insurance Company; Mr. Gideon Grant, of Messrs. Dodds, Grant & Halliday, and the inventor, Mr. Alex M. Stark, who will be the managing director.

NEW CHICAGO TUNNEL COMPANY—Enlarged powers and capital form the basis of a new incorporation of the Illinois Telephone and Telegraph Company at Springfield. The new concern, which succeeds to all the rights and privileges of the old company, is known as the Illinois Telephone Company. It has $30,000,000 capital, against $5,000,000 capital of the Illinois Telephone and Telegraph Company, which was organized and licensed June 23, 1898. For the purpose of incorporating, the new concern paid $30.040 to the secretary of state in fees. According to Albert G. Wheeler, the object of the new incorporation is to get more money for the purpose of building sixty miles more of tunnels under the streets of Chicago, in addition to the twenty miles already in existence. "We have spent $5,000,000 already," said President Wheeler, "and under the new organization we shall spend $20,000,000 more. All our new work will be done under the ordinances which we already have; they are amply sufficient for our purpose, and we shall not seek any new ordinances. We have already installed 10,000 telephones in the business district of the city, and our plans are for the placing of 250,000 instruments all over the city, as well as doing a substreet rapid transportation business. Our bonded power under the old company was exhausted and we made the reorganization for financial reasons primarily." The incorporators of the new company are Charles C. Wheeler, a brother of President A. G. Wheeler; Henry A. Wilkening, an attorney in the service of

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the old company, and Thomas A. Moran, Jr., son of the attorney for the company, Thomas A. Moran. According to the articles of incorporation the company has for its objects: "to furnish, transmit, convey and deliver signals, sounds, intelligence, packages, mail matter and general merchandise; power, heat and light by steam, water, air, electricity and otherwise, and to acquire, construct, dispose of, hold, maintain operate and lease to or rent from others all tunnels, instruments and appliances and other property, real or personal, in carrying out such objects." The Illinois Telephone and Telegraph Company was given a franchise February, 1899, under which it has constructed the tunnels now in existence and partly in use. Its capital stock is $5,000,000, and it has out $5,000,000 of bonds, disposed of through its financial agents, J. B. Russell & Company. The bonds are thirty-year five per cent gold securities. The officers of the old company are: president A. G. Wheeler; vice-president, Clarence D. Simpson; secretary, Edwin W. Gearhart; treasurer, H. H. Brady, Jr.; assistant treasurer, J. C. Law. Under its franchise the Illinois Telephone and Telegraph Company is required to construct at least fifty miles of tunnel within ten years. The twenty miles now built have been equipped forty feet below the street level, the trunk tunnels being fourteen feet high and twelve feet nine inches wide, and the laterals eight feet high by six feet wide. These tunnels are equipped with tracks and equipment for hauling heavy cars at fast speed, with the object of building up a profitable business of freight transportation. The railroad yards and depots have been connected with the tunnel and it is planned immediately to extend the service to the outlying stations and the stockyards. No freight is yet being transported through the tunnels, but it is said by the company's officers that this part of the business will begin on or before July 1 next.

OBITUARY NOTICE.

MR. WILLIAM LUKENS ELKINS, the traction magnate and financier, died at his summer home, "Ashbourne," near Philadelphia, on the evening of November 7, of a complication of diseases. Mr. Elkins was born near Wheeling, W. Va., on May 2, 1832. He was educated in the public schools of Philadelphia, and engaged in the commission business. In 1862 he disposed of a good business and invested all of his capital in the oil fields of Pennsylvania, for twenty years being one of the leaders in organizing companies for the oil trade. He built a large refining plant and obtained control of the sale of illuminating oil for Pennsylvania. Other refineries in various sections of the state were also established by him, and in 1875 he became a partner in the Standard Oil Company, disposing of all his oil interests in 1881. The work for which Mr. Elkins was most widely known was in connection with developing and building street railways. He became a power in this direction, and ranked with the leading financiers of the country. In 1873 he invested heavily in the street railways of Philadelphia, and in a few years succeeded in consolidating all the lines into one large company. His first work in this line was the formation of the Philadelphia Traction Company, which acquired possession of the greater part of existing lines; and this work was completed with the formation of the Union Traction Company, which includes every street railway in Philadelphia, one of the largest and best-equipped in the country. His success in Philadelphia led him to reach out for other cities, and he became identified with the street railway systems of New York, Chicago, Baltimore, Pittsburg, Washington and other large centres of population. He was a director of the Metropolitan Traction Company, of New York; the Baltimore Traction Company, of Baltimore; the North and West Side and United Traction companies, of Chicago, and the Consolidated Traction Company, of Pittsburg, and he was also a large stockholder of the North Jersey, Pennsylvania, Philadelphia & Erie, Schuylkill Valley and Fort Pitt railroad systems. In addition to his railway interests, Mr. Elkins was a large investor in gas and electric light companies, particularly in New York, Philadelphia, Boston and Pittsburg. The United Gas Improvement Company, of Philadelphia, was organized by him, and this concern controls sixty plants in many cities, and supplies all the gas for Philadelphia. Mr. Elkins was a member of the Historical, Genealogical and Colonial societies, of Philadelphia; the Union League, Art and Country clubs, of Philadelphia; Maryland Club, of Baltimore; the Manhattan Club, of New York, and the Chicago Club. On January 21, 1851, Mr. Elkins was married to Maria Louise, daughter of Mr. James Broomhall, of Delaware County, Pennsylvania. He had four children—George W., William L., Mrs. George W. Widener, and Mrs. Sidney F. Tyler.

TELEPHONE AND TELEGRAPH.

SAN BERNARDINO, CAL.—A telephone line is to be built from Dale to Amboy.

LITTLE ROCK, ARK.—A telephone line is to be built from Imboden to Black Rock.

TRENTON, N. J.—The Lebanon Telephone Company intends to extend its line to High Bridge.

DIXON, ILL.—A new thirty-year franchise has been given to the Lee County Telephone Company.

HOUSTON, TEX.—The lines of the Northwestern & Beaumont Telephone Company will be extended.

NEWTON, N. H.—The Exeter Telephone Company has asked for right of way to locate poles in the town.

CALIFORNIA, MO.—The California Telephone Company's line has been sold to J. B. Kemper, of Fulton.

WALTON, N. Y.—A telephone company known as the Masonville Telephone Company has been organized.

BOSTON, MASS.—The Citizens' Telephone Company is making arrangements to extend its service to Meredith.

ONTARIO, ORE.—An exchange will be placed in Ontario as soon as the telephone line is completed at this point.

ALLENTOWN, PA.—A number of residents of Armstrong township have organized a local telephone company.

COLUMBUS, OHIO—Articles of incorporation have been filed for the Queen City Telephone Company, of Cincinnati.

ALLENSVILLE, KY.—The Home Telephone Company, Clarkesville, Tenn., will put in an exchange in this town.

FREMONT, OHIO—The Fremont Telephone Company has increased its capital stock from $100,000 to $125,000.

PEKIN, ILL.—The Forest City Telephone Company voted to increase its capital stock from $5,000 to $20,000.

PERU, IND.—The Peru Home Telephone Company has commenced work on the extension of its line to Peoria.

MANCHESTER, VA.—The Bell Telephone and Telegraph Company has acquired the telephone franchise for this town.

DEADWOOD, S. D.—It is stated that the Nebraska Telephone Company will install a $30,000 exchange within thirty days.

BOONE, IOWA—The Boone County Telephone Company will spend $40,000 in this city in the near future on improvements.

GREENSBURG, PA.—The Bell Telephone Company is erecting new poles in this city and making other important improvements.

DURANT, I. T.—The Chicksaw-Choctaw Telephone Company, of this city, has purchased the line of the Western Telephone Company.

PHILADELPHIA, PA.—The business men of Frederick and Zieglersville will construct a telephone line connecting the two places.

SPOKANE, WASH.—The Interstate Telephone Company has filed a petition for a franchise to run its telephone lines through the county.

COLUMBUS, OHIO—The Crescent Telephone Company, of Leesville, Carroll County, has been incorporated with a capital of $10,000.

LINCOLN, NEB.—The Central Illinois Telegraph and Telephone Company is laying out the route for a new through line to Bloomington.

BATESVILLE, IND.—The Batesville Telephone Company has elected the following officers: A. Bloemer, president; O. L. Newman, secretary; Dr. J. T. Ratcliff, vice-president; William Krieger, treas-

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urer. The company decided to put a new line between here and Osgood this fall.

REDDING, IOWA—The telephone line to connect Fall River, Cassell and intermediate points with Redding is now said to be assured.

WILMINGTON, KAN.—The Missouri & Kansas Telephone Company is stringing twenty new lines southwest from Wichita through Mulvane.

FULTON, N. Y.—The Empire State Telephone Company, of Oswego, has let the contract for the erection of a new exchange, to cost $15,000.

SENECA CASTLE, N. Y.—Poles are set for the Seneca-Gorham telephone line between Seneca Castle and the turnpike, and connection will soon be made.

WALTON, N. Y.—Enough money has been raised to build the proposed telephone line from Andes over Cabin Hill to Hamden, and work has been commenced.

BRADFORD, VT.—At a meeting of the West Newbury & Bradford Telephone Company, arrangements were made for the early building of the company's line.

DYERSVILLE, IOWA—The Interstate Telephone Company will extend its lines from Galena to Dubuque and the towns in the southwestern part of Wisconsin.

WINDSOR, N. C.—The town council has granted the Roanoke & Chowan Telephone Company a franchise to establish and operate a telephone exchange in Windsor.

PITTSTON, PA.—A charter has been granted the Northern & Lackawanna Telephone Company, of Fleetville, Lackawanna County, with a capital of $5,000.

NEWBURGH, N. Y.—The Colonial Telephone Company has put in 7,000 additional feet of cable recently, and is now laying a cable from Washington Heights to its central office.

CONNELLSVILLE, PA.—The Tri-State Telephone Company has constructed a line from Scottsdale to Uniontown, and has also in operation a line from Connellsville to Dawson.

HUNTINGTON, CT.—The officers of the new Huntington Local Telephone Company are: President, T. F. Bartlett; vice-president, William Card; treasurer and secretary, D. B. Loverin.

COLUMBUS, OHIO—The Payne Home Telephone Company, of Payne, has been incorporated with a capital stock of $15,000, by C. E. Hyman, J. Woolard, J. W. Venrick and Freo Paul.

PROVIDENCE, R. I.—The sale of the Dixon Telephone Company's system to the Providence Telephone Company gives that company control of all the lines in the state as far as Westerly.

ROCKFORD, ILL.—The Central Union Telephone Company is about to erect a new building at Belvidere, and will also make many improvements to its lines. About $75,000 will be expended.

INDIANAPOLIS, IND.—The Burrows Telephone Company, of Burrows, Carroll County, has been incorporated with a capital of $5,000. The company will operate a line in Carroll and Cass counties.

KEWANEE, ILL.—At a meeting of the Stark Telephone Company the following directors were chosen: E. G. Cole, of Toulon; M. Sparr, of Wyoming; J. H. D. Duncan, of Elmira; F. Price, of Goshen.

COLORADO SPRINGS, COL.—The Colorado Telephone Company is expending nearly $20,000 in additional cable for city use, and is also stringing two extra circuits between the Springs and Denver.

LIVINGSTON, MONT.—The new telephone line between Livingston and Bozeman, which has been under construction by linemen of the Rocky Mountain Bell Telephone Company for over a month, is now completed.

WORCESTER, MASS.—The Conant & Parker Telephone Company has organized and elected the following officers: Clarence Parker, president; Frank Conant, vice-president; Harry B. Parker, secretary and treasurer.

DECATUR, IND.—The directors of the Citizens' Telephone Company have elected the following officers for the next term: Henry Hite, president; J. Baker, vice-president; F. M. Shirmeyer, secretary; Ed. Ehringer, treasurer.

HAMILTON, OHIO—The county commissioners have granted the Willey Elevator Company, of Ross, Ohio, a franchise for the construction of a telephone line in the southwestern part of the county for a period of twenty-five years.

PRINCETON, ILL.—The Bureau County Mutual Telephone Company has been incorporated with its capital stock fully paid up, and has elected officers as follows: J. Stauffer, president; Ed. Swanson, secretary; J. L. Martin, treasurer.

HOUSTON, TEX.—The Northeast Texas Telephone Company, of Sulphur Springs, has been incorporated with a capital stock of $50,000. The company will operate in the counties of Hopkins, Franklin, Delta, Hunt, Rains, Wood and Upshur.

ROCHESTER, N. Y.—The Dundee & Tyrone Telephone Company has been organized, and the following board of directors elected: Philander S. LaFever, Fred Kendall, Eugene U. Bigelow, T. N. Howell, Frank Yost, D. S. Crawford, Charles Losey, E. D. Backer, G. A. Motham.

MONTPELIER, VT.—The Vermont Telephone and Telegraph Company has completed another farmers' line extending through the town of Berlin *via* Berlin Corner, nearly to the Williamstown line. Work has also been begun on another subscribers' circuit to East Montpelier, Plainfield and North Montpelier.

AMITYVILLE, N. Y.—The village board of trustees has granted to the New York & Long Island Telephone Company a franchise to construct and maintain an independent telephone system through the corporate village limits. The terms of the franchise require that a portion of the wiring be placed underground.

FORT WORTH, TEX.—A charter has been granted to the Reservation Telephone Company, of White Eagle, with a capital of $5,000. The incorporators are G. L. Miller, of Bliss; W. Carson and R. S. Steel, of White Eagle; R. M. Bressie, G. H. Brett and J. P. Souligny, of Ponca City; W. H. Vanselous, of Blackwell.

JOHNSTOWN, PA.—The Huntingdon & Clearfield Telephone Company has authorized the construction of a line from Clearfield which will take in Mahaffey, Glen Campbell, Arcadia, Barnesboro, Hastings, Spangler and Carrolltown. It is expected that the company will give service to Pittsburg and possibly Philadelphia, *via* Johnstown.

HAMLIN, N. Y.—The Hamlin Rural Telephone Company has been organized with the following officers: D. R. Singleton, president; Charles Basse, treasurer; H. F. Newman, secretary; Chris Rath, T. O. Swanson, B. J. Snook, James G. Barry, D. R. Singleton, Charles Basse and H. F. Newman, directors. The company will install a first-class telephone system.

NEW BEDFORD, MASS.—The Southern Massachusetts Telephone Company has decided to install a common battery switchboard of the latest type in place of its present equipment in this city. The company estimates that the proposed change will involve the expenditure of from $60,000 to $75,000, and it will probably be a year before the work will be completed.

ALBION, N. Y.—The Rural Telephone Company, which started northwest at or near Lyndonville, in this county, has extended its area, and has been so successful in its operations a reorganization has been decided upon. A sale has been made to a new company known as the Lakeside Telephone Company, with $100,000 capital. The company's lines will soon cover all the territory between Olcott and Brockport and, it is said, will eventually become a part of the independent trunk line in this state. The company has given a mortgage for $40,000 to the Rochester Trust Company, to secure funds to continue the work of construction in this county.

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ELECTRIC LIGHTING.

COLUMBUS, OHIO—The Mt. Victory Electric Light Company has been incorporated with a capital of $10,000.

FLORENCE, NEB.—The council has passed an ordinance granting a twenty-five-year franchise for an electric light plant.

CONCORD, N. H.—Articles of incorporation have been filed by the Greenville Electric Light Company. The capital stock is placed at $2,000.

YORK, PA.—The Edison Electric Light Company's new contract with the city provides that lights shall be furnished at $40.15 per light per year.

LAKE CITY, MICH.—The machinery for the new electric light plant for this village has arrived, and it is expected that the plant will be in operation in about a month.

OMAHA, NEB.—The Electric Light Company, which was recently granted a franchise and a contract for street lighting in Florence, has begun the work of extending its wires to that city.

SARANAC, MICH.—The village board has granted D. G. Hahn, of this place, a thirty-year franchise for electric lights, and made a contract with him to light the streets for ten years commencing December 1.

FREDERIC, WIS.—The village council has passed an ordinance granting Frank McDonogh, of Eau Claire, the right to begin work on an electric light plant, and also contracted for lighting the streets for five years.

STREATOR, ILL.—It is stated that the Streator Street Railway Company will install an electric light system in this city. All the preliminaries have been arranged, and the work will be pushed as rapidly as possible.

WASHINGTON, D. C.—The Universal Light and Power Company has been incorporated by Robert K. Van Mater, Ralph Wormelle, Edwin L. Bradford and Leonard A. White. The company has a capital of $750,000.

NASHUA, N. H.—The property of the Milford Electric Light Company has been sold. It was bid in by an agent for the bondholders for the sum of $53,800. It is stated that the majority of the bondholders are Boston parties.

RALEIGH, N. C.—The Yadkin River Electric Power Company has been incorporated with an authorized capital of $5,000,000. The object of the company is to develop the water power of the Yadkin river in the counties of Montgomery, Stanley, Davidson, Rowan and others.

WOONSOCKET, R. I.—The Uxbridge & Northbridge Electric Company is installing a new 250-horse-power engine, and a new 150-kilowatt direct-connected alternating generator is also being put in. The company is putting up a new line to Douglas, and the new machinery will be used to furnish the power.

SOUTH BEND, IND.—The South Bend Electric Company has been awarded a ten-year contract for street lighting, beginning with January 1, 1905. It will require about one year to install the system. Enclosed alternating arcs will be used, and the electric company is to furnish everything complete, including iron poles and other equipment. The bid was as follows: arc lamps suspended in the centre of the street, $78.75 per year; arc lamps suspended from iron poles, with wires underground, $95 per year; with wires overhead, $83 per year; incandescent lamps, fifty candlepower, $32 per year.

MARSHFIELD, VT.—It is stated that a large central plant to develop power for manufacturing purposes from Molly's brook and Peacham lake is proposed by P. T. Kelley, of Whitefield, N. H., who has leased the privileges of the Molly's Falls Electric Light and Power Company for a long term. In addition to the Molly's Falls property, Mr. Kelley has secured options on all the available property suitable for reservoir purposes on the entire length of Molly's brook, together with additional rights which will permit the raising of Peacham pond. According to present plans about $60,000 will be spent immediately in developing the privileges. It is the intention of the promoters merely to furnish power for manufacturers in the vicinity.

ELECTRIC RAILWAYS.

SEATTLE, WASH.—Right of way for an electric street car line through the Fort Lawton military reservation has been granted to the Seattle Electric Company.

EVANSVILLE, IND.—The promoters of the Mount Vernon and Evansville Traction line state that the work of acquiring the right of way between the two cities has been completed.

JACKSONVILLE, ILL.—The contract for the construction of the Jacksonville & Concord Railway has been let, and the work will commence at once, with the intention of completing the road by January 1, 1904.

ASHTABULA, OHIO—Ashtabula county commissioners have granted a fifty-year franchise for an electric line from Geneva to Meadville, Pa., by way of Harpers Field, Austinburg, Denmark, Pierpont and Linesville.

PAPILLION, NEB.—L. C. Hurd, representing the Omaha, Lincoln & Beatrice Electric Railway Company, states that the work of grading will begin shortly. It is expected that the road will be in running order within a year at the latest.

CINCINNATI, OHIO—The Cincinnati Rapid Transit Railway Company has been incorporated with a nominal capital, to be increased by $2,500,000 at an early date. It is proposed to build elevated and subway lines from Cincinnati to Dayton and to Norwood.

INDIANAPOLIS, IND.—The Indiana Union Traction Company announces that the Indianapolis Northern line from this city to Logansport, the Anderson line to Elwood, and the line from Alexandria to Muncie, will all be in operation by the first of next year.

ARDMORE, I. T.—The Sulphur Springs Railway Company has mortgaged its road running from Sulphur to Scullen, a distance of about eight and one-half miles, to the St. Louis Union Trust Company for $500,000, for the purpose of constructing its line of railway from Scullen to Sulphur.

INDIANAPOLIS, IND.—The Indiana Coal and Traction Company has filed a $5,000,000 mortgage, covering fourteen miles of electric road, operating from here to Plainfield, and 165 miles to be constructed to Terre Haute and Rockville. It is to be operated as an electric coal-carrying road.

MADISON, WIS.—The Chicago and North-Western Lakes Electric Railway Company, Alexander Clark, president, has filed an amendment to its charter with the secretary of state, providing for the construction of a branch line from the south state line, in Kenosha County, into the city of Milwaukee, forty-five miles.

SENECA FALLS, N. Y.—Electric road surveyors are doing the preliminary work on a projected line to Ithaca from Seneca Falls. Options have been obtained in the highway leading through the villages of Fayette, Ovid, Farmer, Lodi and Trumansburg. The plans are for a freight and express road, besides passenger traffic.

MADISON, WIS.—The Eastern Wisconsin Railway and Light Company, to construct and operate an electric line between Oshkosh and Fond du Lac and through contiguous territory, has been incorporated. The location of the company is at Fond du Lac. The capital stock is $500,000, and the incorporators are: Frank B. Hoskins, Benjamin Wild, Sr., and Leander Choate.

GREENCASTLE, PA.—The Greencastle, Waynesboro & Chambersburg Trolley Company is building a railway to unite Franklin and Adams counties. The line from Penmar to Waynesboro has been completed and put in operation, and the line from Waynesboro to Greencastle, a distance of nine miles, is fast nearing completion. It is announced that the whole line will be in use within a month.

ZANESVILLE, OHIO—Estimates for the twenty-two miles of railway which the Southeastern Ohio Railway, Light and Power Company purposes building from Zanesville to Sayer, *via* Roseville, Crooksville and intermediate points, have been completed, and it is reported that the cost of the undertaking will be somewhere between $800,000 and $850,000. Active work is to be started not later than February or March of next year.

BROCTON, ILL.—A number of citizens of Oakland recently held a meeting with a committee of Charleston citizens, for the pur-

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pose of considering the building of an interurban line from Ogden, in Champaign County, to Charleston. Much interest is manifested in the project. The proposed line will extend from Ogden to Charleston, through Homer, Broadlands, Newman, Brocton, Oakland, Hindsboro, Rardin, Fair Grange and on to Charleston.

DAVENPORT, IOWA—Articles of incorporation of the Iowa City, Davenport & Muscatine Railway Company have been filed. The company has a capital of $1,500,000, and purposes to build an electric road from Davenport and Iowa City. The incorporators of the company are the Hon. Milton Remley, Stephen Bradley and H. B. Berry, all of Iowa City; Colonel E. J. Spencer, Thomas W. Crouch, L. S. Mitchell and L. B. Pierce, all of St. Louis.

HARTFORD, CT.—The annual meeting of the Hartford & Torrington Tramway Company was held recently and directors were elected. The officers are: President, M. C. Webster; vice-president, Walter Holcomb; secretary, N. E. Pierce, and treasurer, E. B. Mansfield. The two years' extension of time which was granted by the last legislature was accepted and the expectation of the directors is to build and connect with the line at Terryville within the limit.

WESTBORO, MASS.—It was practically decided at a meeting of the stockholders of the Westboro & Hopkinton Street Railway, held recently, to merge the line into the Boston Suburban Street Railway, which runs from Newton to Hopkinton. No formal vote was taken, but the election of a new board of directors was taken to signify that the lines will be merged, thus giving the Boston Suburban Railway another link in its proposed line to Worcester.

RUSHVILLE, IND.—The Indianapolis & Cincinnati Traction Company has purchased the entire line of the Indianapolis, Shelbyville & Southeastern. Directors have been chosen as follows: Messrs. Ball, of Muncie; Stanton, of Anderson; Hough, of Greenfield; Wild, Gardner and Reed, of Indianapolis, and Claude Cambern, of this place. At a meeting of the directors officers were elected as follows: President, Mr. Ball; secretary, Mr. Reed; treasurer, Mr. Wild.

NASHUA, N. H.—It is stated that a deal consummated here practically makes an electric road certain between this city and Manchester, in the next few months. Officials of the Goffs Falls, Litchfield & Hudson Electric Railway Company have filed a mortgage conveying to the American Loan and Trust Company, of Boston, all the property they may acquire, to secure $300,000 in five per cent, twenty-five-year gold bonds, maturing July 1, 1928. This road will complete a through line from Concord, N. H., to Boston.

MEMPHIS, TENN.—The Shelby County Traction Company has filed its charter, proposing to build an electric railway from Memphis to Collierville, about eighteen miles. The line projected passes through Aulon, Buntyn, White Station, Ridgeway, Germantown, Forest Hill, Bailey's and Neville. It is also proposed to build an electric light plant at Collierville, and furthermore to furnish light all along the line. The incorporators are T. J. Latham, H. C. Williamson, Thomas Wellford, J. M. Goodbar, J. M. Hill and I. B. Hudson.

WEST CHESTER, PA.—To promote a trolley line between West Chester and Pottstown a number of farmers residing along the proposed route have organized the Pottstown & West Chester Improvement Company, with these officers: President, Bayard A. Conard, of Font; vice-president, Frank Green, East Goshen, and secretary, Horace Fetters, Upper Uwchlan. The proposed trolley will pass through Oaklands, Whitford, Lionville, Eagle, Font, Ludwig's Corner, Nantmeal Village and Pughtown, and will open up a country that is not touched by a steam road.

LOUISVILLE, KY.—The Cincinnati Municipal and Securities Companies having recently acquired the rights of way to Versailles through Central Kentucky, has begun work on the construction of a suburban railway from Frankfort to Versailles. This company recently purchased the Frankfort & Suburban Street Railway, and will connect with that line. A new company with $250,000 capital stock to construct the road will be incorporated, with leading Frankfort and Cincinnati people as officers and stockholders. Ample capital is already in possession of the company to complete the construction and equipment.

NEW YORK CITY, N. Y.—The state railroad commissioners of New York are considering the application of a New York city interborough railway company for permission to construct an electric railroad in certain streets and avenues in the Bronx. The Union Railway Company, of the Bronx, is opposed to the plan and submitted a plan of its routes and the projected but unconstructed lines of the People's Traction Company to show that the Bronx is adequately supplied with transit facilities. The plans of the proposed interborough lines show them crossing the Union and People's Traction lines at forty-six points.

AUSTIN, TEX.—The charter of the Wichita Falls & Oklahoma Railway Company has been filed for record in the office of the secretary of state. The purpose of the company is to build and operate a line of railway from Wichita Falls northeast to the Red river, at a point in Clay County, a distance of thirty miles. The general offices of the company will be located at Wichita Falls, Tex., and the incorporators are Morgan Jones, of Denver, Col.; N. Harding, D. T. Bomar, W. E. Kaufman, A. M. Young, J. G. Wilkinson, E. W. Taylor, Ben W. Fonts and H. C. Erdington, of Fort Worth; Frank Fell, of Wichita Falls. The road will be extended north from the Red river to points in Oklahoma, and will connect at Wichita Falls with the Fort Worth & Denver City and the Wichita Falls railroads.

INDIANAPOLIS, IND.—A deal for a valuable piece of ground in the business part of Muncie has been practically closed by the Indiana Union Traction Company. It will probably be used for the site of a large union station for a number of the electric traction lines entering Muncie. The roads that are to use this station, if the project should carry, are the Muncie & Portland Traction Company; the Muncie, Hartford City & Ft. Wayne Traction Company; The Dayton & Muncie Traction Company, and the two lines out of Muncie of the Indiana Union Traction Company. It is stated by officials of the Indiana Union Traction Company that if the new station is had it will not mean that the headquarters of the company will be removed from Anderson. The building will probably cost in the neighborhood of $75,000.

CANTON, ILL.—Stockholders of the Illinois Central Electric Railway Company recently held their organization meeting in the company's general office in the Randolph Building, Canton, Ill. Fred A. Dolph was chosen chairman and D. J. Peffers, secretary. A committee consisting of O. J. Boyer, E. A. Heald and R. F. Henkle was appointed to present nominations for the board of directors. On their recommendations the following board was selected: U. G. Orendorff, W. O. Dean, R. F. Henkle, James A. Lawrence, E. A. Heald, W. D. Plattenburg, George Shawver, William Hanlon, M. W. Rafferty, L. W. Morton, Fred A. Dolph, J. W. Gaddis, C. L. Whitnah, J. L. Andrews, James David. The board then organized and chose the following officers: President, U. G. Orendorff; vice-president, W. O. Dean; second vice-president, R. F. Henkle; third vice-president, J. A. Lawrence; secretary, W. D. Plattenburg; treasurer, E. H. Heald. The term of officers and members of the board of directors will expire at the annual meeting in January.

MARLBOROUGH, MASS.—The Marlborough & Framingham Street Railway Company has been authorized by the railroad commissioners to issue $105,000 new stock at par for the purpose of owning, holding and operating the street railway property formerly belonging to the Marlborough Street Railway Company, and purchased at a receivers' sale. In November of last year the Marlborough company was unable to meet $113,000 damage claims growing out of an accident, and, after offering to compromise for $25,000, which offer was refused, applied for a receiver. The company owned and leased about fifteen miles of road. It has $80,000 of stock and the same amount of six per cent bonds outstanding. It has paid no dividends the last two years. For the year 1901-1902 gross earnings were $64,559; net, $17,544, and interest at six per cent, taxes, etc., $20,421, thus leaving a deficit of $2,877. The Framingham road, which, with the above, forms part of the Boston & Worcester Electric Company's system, has authorized an outstanding $60,000 of stock and $60,000 of five per cent bonds. This is exclusive of the new stock issue authorized. For the year ending September 30, 1902, net earnings were $9,859 and a surplus left, after charges of $4,245, of $5,614. The company operates seven and one-half miles of track between Framingham and Marlborough.

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PERSONAL MENTION.

MR. HENRY SANGER SNOW has resigned the presidency of the Brooklyn Polytechnic Institute.

MR. RICHARD H. RICE has been engaged by the General Electric Company, Schenectady, N. Y., as steam consulting engineer. Mr. Rice is a graduate of Stevens Institute.

CAPTAIN JAY J. MORROW, Engineers, U. S. A., has been detailed for duty as assistant to the Engineer Commissioner of the District of Columbia, succeeding Captain H. C. Newcomer.

MR. N. J. HIGHLEY has tendered his resignation as superintendent of the Belvidere (Ill.) Gas and Electric Company, to accept the managership of the Iowa City Gas and Light Company.

MR. C. F. MACGILL has tendered his resignation as mechanical superintendent of the Canadian General Electric Company's works, at Peterboro, to accept a similar position with the Westinghouse company, Pittsburg, Pa.

MR. JOHN MUSTARD has established an office at 1617 Real Estate Building, Philadelphia, and will represent several electrical specialty manufacturers. Mr. Mustard was formerly with the Wagner Electric Manufacturing Company.

MR. CHARLES T. BISHOP, formerly with Ladenburg, Thalmann & Company, New York, and late paymaster of the U. S. Naval Service, has been appointed auditor of the H. W. Johns-Manville Company, 100 William street, New York city.

PROFESSOR A. MARSTON, of the civil engineering department of the Iowa State College at Ames, Iowa, has been appointed by the government to take charge of the civil engineering exhibits of the various colleges and schools at the St. Louis Exposition.

MR. WILLARD L. CANDEE, manager of the Okonite Company, Limited, New York, accompanied by his wife and daughter, sailed November 4 on the Cedric for Liverpool. Mr. Candee will be abroad for six weeks, making his headquarters at the Hotel Cecil, London.

MR. ALFRED T. CALL, late engineer in charge of tests of torpedo boat destroyers for J. J. Thornycroft & Company, of London, England, is now in Ontario, Canada, investigating a new steam turbine of Canadian manufacture on which he has made some successful tests.

MR. JOHN W. GODFREY, who for the past eleven years has been chief electrician for the United Electric Light Company, Springfield, Mass., has been appointed chief engineer of the New Milford Power Company. Mr. Godfrey entered upon his new duties November 1.

MR. IRVING H. REYNOLDS will shortly retire from the Allis-Chalmers Company, and the duties of chief engineer will be assumed by the engineers in charge of the various departments, these engineers availing themselves of the advice of Mr. Edwin Reynolds, consulting engineer of the company.

MR. T. C. FRENYEAR, for eight years manager of the Buffalo branch of the Westinghouse Electric and Manufacturing Company, has been appointed to take charge of the Toronto office of the new Canadian Westinghouse Company. Mr. T. Frank Dryden will have charge of sales in the Toronto district.

MR. W. H. ZIMMERMAN, M. E., who for the past two years has been on the engineering staff of the Arnold Electric Power Station Company, has been appointed general manager of the De Kalb-Sycamore Electric Company, De Kalb, Ill. Mr. Zimmerman is a graduate of the University of Illinois, class of '97, where he received the degree of mechanical engineer.

PROFESSOR HARRY C. JONES, Ph. D., of Johns Hopkins University, recently delivered a lecture before the Brooklyn Institute, department of chemistry and physics. The subject of his address was "Physical Chemistry." Professor Jones will shortly deliver another address at the same place on "Application of Certain Physical Chemical Generalizations to Organic Chemistry."

M. EMILE GUARINI, the well-known engineer and technical writer, has translated into French a series of articles on wireless telegraphy, originally published in the *Scientific American*. These describe briefly the early work on wireless transmission of signals, in which the translator himself took part. Marconi's work is described in full, and the theory of the propagation of electrical waves is discussed.

MR. H. G. TYRRELL has been appointed chief engineer of the Brackett Bridge Company, with works at Glendale, Ohio, and office at 83 Atlas Bank Building, Cincinnati, Ohio. Mr. Tyrrell is a well-known author and authority on engineering subjects, and has often contributed articles to the engineering press, both in America and Europe. His best-known books are "The Bridge and Structural Index," "Mill Building Construction," and "American Park Bridges."

ELECTRICAL SECURITIES.

It seems probable that within a short time there will come a breaking away of the sentiment that the iron and steel industry is a more or less true barometer of financial and industrial conditions. For a long time, under rush order conditions, the steel industry presented a stable appearance and paralleled the railroad industry, so that these two were allied as indicating the general conditions. At the present time, however, with a persistently declining steel market, the railroads, which appear to be a better index of the general prosperity, are steadily showing increased earnings and an improved passenger and freight movement. No one doubts the importance of a decline in iron and steel products, but this should not be allowed to balance the whole of the industrial community. Retrenchments which have been setting in, and which will, no doubt, be inaugurated, are dictated by good business policy, and the cut in prices of iron and steel will probably have the effect of stimulating new buying and new construction. This, in turn, will put more operatives to work, which, in its turn, will create a better circulation in all quarters.

It is confidently expected that the monetary situation will hold about the same until the end of the year. Banking interests will be forced to execute some probably drastic measures in order to meet the heavy first-of-the-year disbursements, when there is a general settling up of business accounts. The fact that the business community has been able to show up during the waning months of the year in as good shape as it has, augurs well for a resumption of business on a normal basis with the beginning of the year, and at least a reasonable percentage of the prosperity of the last few years can be expected.

ELECTRICAL SECURITIES FOR THE WEEK ENDING NOVEMBER 7.

New York:	*Closing.*
Brooklyn Rapid Transit	35⅝
Consolidated Gas	177
General Electric	147
Kings County Electric	150
Manhattan Elevated	136½
Metropolitan Street Railway	109½
New York & New Jersey Telephone	140
Westinghouse Manufacturing Company	165

Boston:	*Closing.*
American Telephone and Telegraph	126½
Edison Electric Illuminating	240
Massachusetts Electric	76
New England Telephone	122
Western Telephone and Telegraph preferred	75

Philadelphia:	*Closing.*
Electric Company of America	7⅜
Electric Storage Battery common	45
Electric Storage Battery preferred	45
Philadelphia Electric	5⅞
Union Traction	43⅞
United Gas Improvement	79¼

Chicago:	*Closing.*
Chicago Telephone	115
Chicago Edison Light	140
Metropolitan Elevated preferred	56
National Carbon common	17½
National Carbon preferred	87
Union Traction common	7
Union Traction preferred	30

Northwestern Elevated for October carried daily an average of 71,617 passengers, an increase of 2,055.

The daily average of passengers carried during October on the South Side Elevated was 85,788, a gain of 2,676.

Metropolitan Elevated carried for October a daily average of 117,387 passengers, a gain of 1,407.

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INDUSTRIAL ITEMS.

THE ELECTRIC APPLIANCE COMPANY, Chicago, Ill., is sending out samples of its "O. K." duplex telephone wire. This wire is made in three colors—brown, maroon and black. Samples and prices may be had on application.

THE NATIONAL CARBON COMPANY, Cleveland, Ohio, is distributing an attractive folder entitled "There Is Light Within." This company will be pleased to send a sample shipment, subject to return at its expense, to any consumer who has not commenced the use of this carbon.

THE HAWKS ELECTRIC COMPANY, 156 Pearl street, Boston, Mass., has on hand a complete equipment of electrical apparatus for a modern factory plant. This includes generators, switchboards, motors, etc. In addition to this there are several bargains in engines, generators, etc.

THE SIMPLEX ELECTRIC HEATING COMPANY, Cambridgeport, Mass., has just issued a catalogue descriptive of electric laundry and tailor's irons. The catalogue deals with the subject of electric pressing irons in a manner which will be appreciated by the progressive manufacturer who is seeking advanced ideas and methods. Copies will be sent on request.

THE WHEELER REFLECTOR COMPANY, 156 Pearl street, Boston, Mass., will be pleased to send on request its catalogue No. 25. This is descriptive of reflectors, shades, clusters, large chandeliers, headlights, lanterns, street fixtures and other electrical specialties. The catalogue contains illustrations, sizes and prices, and covers every condition where plain or ornamental lighting is desired.

THE THERMO-ELECTRIC COMPANY OF AMERICA, Indianapolis, Ind., has been incorporated with a capital stock of $1,000,000, under the laws of Nevada. This company has been formed to promote the invention of H. Barringer Cox. This is a thermoelectric generator which not long ago was given considerable notoriety in the daily press. This apparatus, it is stated, transforms heat vibrations into electricity.

THE NATIONAL ACME MANUFACTURING COMPANY, Cleveland, Ohio, is distributing a very useful catalogue and price list of its product. This consists of milled screws, and set and cap screws in both V and United States standard threads, in both iron and steel. The catalogue is indexed so that it is possible to locate immediately any distinct type of screw or other article. This catalogue will be sent on request.

THE ANDERSON ELECTRICAL SUPPLY COMPANY, Anderson, S. C., has been organized to do a general business in electrical supplies and construction. The company is composed of Mr. E. S. Moorer, manager of the Anderson Telephone Company, and Mr. G. W. Evans, a business man of Anderson. This company will carry a full line of electric light and telephone supplies, and will do all manner of electrical repairs and construction.

THE GENERAL ELECTRIC COMPANY, Schenectady, N. Y., has added another series of bulletins to its advertising literature, all of which are of great interest and of practical value. These are bulletins 4339 and 4344, respectively, and describe and illustrate in detail automatic circuit-breakers, type M, for 600-volt direct-current circuits; Meridian lamps; standard photometer lamps; list of polyphase power plants, and slow and moderate speed motors, type M. P., form H.

THE EDISON ELECTRIC ILLUMINATING COMPANY, Boston, Mass., in the November number of *Edison Light*, gives a number of interesting sketches on the use of electric illumination in and around Boston. A description is given of the new chimney at the L street station. The extreme height of the chimney is 250 feet 6 inches. The diameter from the outside walls at the base is twenty-four feet eleven and one-quarter inches. The diameter from inside walls at base is nineteen feet six inches.

THE BRYAN-MARSH COMPANY, New York and Chicago, has issued an attractive booklet entitled "The Views of the Electrical Editors." This contains several reprints of the descriptive articles which have recently been written, calling attention to the new Bryan-Marsh "Imperial" lamp. This is a new type of lamp which the Bryan-Marsh Company is placing on the market. It is so designed that, after reaching the eighty per cent line of candle-power, it burns out, so that there is no possibility of a dim lamp.

HENRY R. WORTHINGTON COMPANY, New York, is building a centrifugal pump of novel design and great capabilities for exhibition at the St. Louis Exposition. This pump is a departure from the usual centrifugal practice. It will be capable of delivering about 500 gallons of water per minute against a head of 250 pounds per square inch, and with high efficiency. This pump is of the type known as the multi-stage, turbine centrifugal, and differs in a number of respects from the centrifugal pumps with which engineers have been familiar.

THE H. B. CAMP COMPANY, Chicago, Ill., will be pleased to send upon application a circular describing the Lake divided conduit. A patent has been issued for this conduit under date of October 27, 1903, to Mr. Edward N. Lake. The goods are being manufactured under this patent by the H. B. Camp Company. This form of tile, instead of having its walls split so that the joints are diametrically opposite with respect to each other, is so divided that the joints in the opposite walls are offset. When the tile is laid, the joints in any one tile will be opposite with respect to the joints in the tile adjacent.

THE NATIONAL OIL BURNER AND EQUIPMENT COMPANY, of St. Louis, is placing on the market the Branch life net for elevator shafts, invented by Mr. Joseph G. Branch, chief inspector of boilers and elevators, St. Louis. This device is placed at the bottom of elevator shafts, so as to catch a body falling down the shaft, preventing fatalities due to such accidents. It consists of a net held on two sides by rods which are supported on each end by strut arms. The lower ends of these arms fit into bearings in pillow blocks, which are bolted to a stout plank. This plank is securely fastened to the bottom of the shaft. The end is held taut by large compression springs acting at the upper ends of the strut arms. The springs are supported and held in place by pieces of large pipe, and are free to move along these pipes. When a falling body strikes the net, the fall is broken by the net, combined with the action of the springs. The net will give and sag, and the arms close up. The pipes are also free to move endwise through proper openings made in the upper ends of the strut arms, permitting them to close in and break the force of the fall.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, Pa., manufacturer of the chloride accumulator, has recently closed a contract through the Canadian General Electric Company, Limited, its representative in Canada, for an installation in the power-house of the Toronto Railway Company; this battery consists of 276 cells, having a capacity of 3,000 amperes. A contract has also been closed with the Bangor Public Works, Bangor, Me., for a railway battery consisting of 264 cells, having a regulating capacity of 160 amperes. This battery has containing-cells of sufficient capacity to allow of a future increase of fifty per cent. The Carnegie Steel Company has contracted for the installation of a battery in its Youngstown, Ohio, works for use in regulating the fluctuations of load, due to the starting and stopping of motors, this battery having a capacity of 1,600 amperes at 260 volts. The Chicago Edison Company has contracted for a battery for its Haddock place station, having a capacity of 16 to 800 ampere-hours at 128 volts. Contracts have also been closed with the United States Government for a battery at Fort Totten, consisting of 62 to 640 ampere-hour cells; the Stevens Building, Detroit, Mich., 140 to 160 ampere-hour cells; the House of the Good Shepherd, Roxborough, Mass., 62 to 160 ampere-hour cells, and Johnson-Kahn Company, 68 to 560 ampere-hour cells; these latter installations being for light and power work.

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CHARLES W. PRICE . . . . . PRESIDENT AND EDITOR
STEPHEN H. GODDARD . . . . . SECRETARY AND MANAGER
WM. HAND BROWNE, JR. . . . . TECHNICAL EDITOR
AINSLIE A. GRAY . . . . . ASSISTANT EDITOR

PUBLISHING OFFICE . . . . . 13-21 Park Row, New York
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TO ADVERTISERS

CHANGES for advertisements should be in this office by *Friday noon* for the following week's issue.

NEW ADVERTISEMENTS should be in the office not later than *Monday noon* to assure publication in that week's issue.

CONTENTS.

EDITORIALS:
British Standards in Electrical Engineering 727
Osmium Lamps 728
Where Philadelphia Leads 728
Interest in Institute Local Sections 728
The Lachine Rapids Power Company, by R. S. Kelsch 729
The Use of Electricity for Glass Manufacture, by John B. C. Kershaw 735
A New Method of Constructing Underground Conduit 738
Book Reviews 738
Hard Drawn Copper Wire, by Francis W. Jones 739
The Automobile Industry in Great Britain 739
Station Economy and Management 740
A Long-Distance Transmission Line - 110 Miles of High-Tension Conductors 747
Philadelphia Branch of the American Institute of Electrical Engineers 747
German Electrical Notes 747
Electrical Patents 748
Light Telegraphy 749
Review of Current Engineering and Scientific Literature 750
Magnetic Experiments on Metals 751
INDUSTRIAL SECTION:
A New Enclosed Fuse 752
A New Form of Steel Tie 753
Slow and Moderate Speed Motors 754
Electrical Vehicles to Handle U. S. Mail in Philadelphia 755
Founder's Day Exercises at the Clarkson Memorial School of Technology 755
Independent Telephone Association of Southern Indiana 756
Electric Railway Tests at the Louisiana Purchase Exposition 756
Electrical Phenomenon 756
American Street Railway Association 756
Lecture before Automobile Club 757
New York Electrical Society 757
The Magnetic Storm 757
Prophecy of Transatlantic Telephony 757
Wireless Telegraph between France and England 757
Society of Chemical Industry 757
CURRENT ELECTRICAL NEWS 758

Electric light companies in the large cities find that the demand for light is increasing. Electric current for lighting and power purposes is developing new uses constantly.

In these times, when over-capitalized companies see their stocks quoted below par, it is gratifying to the electrical fraternity to see how well the electrical stocks hold their own. Lighting and power companies are among the safe investments and are the last to be affected by market panics. There is a regular demand for light and transportation that makes franchise stocks of this nature a particularly safe investment.

BRITISH STANDARDS IN ELECTRICAL ENGINEERING.

The necessity for standardization in all branches of electrical engineering has been recognized for some time, and several years ago the American Institute of Electrical Engineers appointed a committee which reported very fully. More recently the matter was taken up in England more officially, and a committee, representing the various branches of the government interested, the manufacturers, and users of electrical machinery, was appointed to give the matter consideration. The report of this committee deals merely with direct-current voltages and alternating frequencies. The problem was approached from the point of view of those most affected—that is, the users of lamps and motors for power purposes. It was agreed that the standard pressures suggested should be measured at the consumers' terminals. It was also thought advisable to suggest the minimum number of standard pressures and frequencies which would best meet the commercial requirements, and at the same time utilize to the fullest extent consumers' existing appliances.

Report of British Standardization Committee.

After much consideration, the committee decided that the direct-current pressures which would best meet the requirements were 110, 220, 440 and 550 volts for light and power supply. Slight variations from these values will not require redesign of the mechanical parts of the machinery, as by using the standard carcass and by altering the winding alone, a variation of ten per cent above or below the suggested standards can be secured. For tramway service, 500 volts is suggested, and for railways, 600 volts. The frequencies adopted for alternating current were twenty-five and fifty. Although it might seem desirable to have an intermediate value for rotary converters, the committee decided to adopt the two mentioned only. Twenty-five cycles is the standard recommended for systems involving conversion to direct current by means of rotary converters, for large power schemes over long distances, and for polyphase railway work. For mixed lighting and power supply, for factory power plants, and for all medium-sized plants, where rotary converters are not employed, the standard recommended is fifty cycles.

Little Difference between British and American Standards.

These recommendations differ but little from the standards adopted by the American Institute. The corresponding recommendations in the Institute report were 110, 220 and 500 volts for low-voltage supply, and twenty-five or thirty, forty, sixty and 120 cycles for alternating-current supply. The Institute report also recommended generator voltages which were fifteen per cent higher than the terminal voltage, and further recommended certain standards for high-tension alternating transmission lines.

International Standardization.

It is possible that the question of international standardiza-

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tion for electrical apparatus may come up at the meeting of the International Electrical Congress, which will be held at St. Louis next fall. And, after a comparison of the American Institute report and the British Standardization Committee report, it would seem that there should be little difficulty, so far as England and this country are concerned, in coming to some definite agreement.

OSMIUM LAMPS.

The search for a material having a higher luminous efficiency than carbon and which can be used to replace the latter for the incandescent lamp filament has given us the Nernst lamp, the osmium lamp and a number of other types which can hardly be said to have passed the experimental stage. Of these the Nernst lamp stands alone as, due to the peculiar properties of the material used in constructing the glower, the lamp as put out differs greatly from the incandescent lamp which is a simple glass bulb containing a conductor of high resistance that becomes incandescent when a current of electricity is passed through it. The osmium lamp, on the other hand, is identical in form with the familiar carbon lamp, except that the osmium filament is longer. In one attempt to improve the incandescent lamp, the carbon filament was subjected to a treatment which produced a layer of carbide on the surface. This, it was thought, would allow the filament to be run at a higher temperature and hence with a higher efficiency, but nothing has been heard of this lamp for some time.

Difficulties in the Use of Osmium.

The difficulties to be contended with in the development of the osmium lamp are the low resistance of the osmium as compared with carbon; the filament when incandescent loses much of its rigidity and osmium is considerably more expensive than carbon. The low resistance necessitates a long filament and the loss of rigidity makes it necessary to support the filament by insulating stays, a construction which is made more necessary and more difficult by the length of the filament. The cost of the material is of less importance, if osmium can be secured in sufficient quantity to make its use for this purpose possible, as the greater efficiency in the production of light of the osmium lamp as compared with the carbon lamp will soon compensate for the greater cost.

Range of Voltage Increased.

The low resistance of osmium has made it possible to construct lamps for low voltages and large candle-power only. Until recently the lamps were made for not more than forty volts and twenty-five to thirty candle-power. Now, it is reported, the Austrian Gasghühlicht and Elektricitäts-Gesellschaft, of Vienna, supply lamps for fifty-five volts, and it is not improbable that the range will be increased.

Tests of Osmium Lamps.

The life and economy of these lamps are shown by the following figures from a report made by Dr. W. Wedding, professor of the Technical College, of Berlin: Two groups, consisting of six thirty-seven-volt lamps each, were submitted early in January and connected by him in series across a 220-volt circuit. In group one, for the first 3,132 hours the average life of the six lamps was 2,853 hours, and the average candle-power fell from 30.1 to 23.7. The mean consumption per candle-power rose from 1.46 to 1.78. After 520 hours the first lamp collapsed, and after 3,724 and 3,940 hours, respectively, two others gave way, the remaining three still burning after 3,973 hours. In group two, which consisted of six twenty-five-candle-power lamps, the report gives the average life as 1,479 hours, the candle-power dropping in 2,198 hours from 25.1 to 19.9, and the energy consumption increasing from 1.37 to 1.75 watts per candle-power.

Increased Economy Increases the Output of the Station.

If lamps of this character can be turned out in commercial quantities, and at commercial prices, they would form a most important advance in electric lighting, as they would largely increase the possible output of every lighting station. As a mechanism, nothing better than the carbon incandescent lamp could be desired, but as a producer of light it is very far from perfect.

WHERE PHILADELPHIA LEADS.

From time beyond memory the city of Philadelphia, Pa., has, for one reason or another, been inflicted with a reputation of moving in old-fashioned and conservative ways. Probably there was a period in the history of this municipality when it did not seem to fall in with the quick-step at which its neighboring communities were pacing. But mark this! Philadelphia is alive to its opportunities; and its appreciation and utilization of electrical apparatus make this certain. Its street railway systems are equal to the best. We do not hear a grumble as to its lighting facilities. Its telephone system is growing by leaps and bounds, and now it comes to the front, to the shame of other municipalities, and inaugurates the carriage of the United States mail in electric wagons. This service has been established after a careful enquiry, and the results already achieved bid fair to encourage the universal adoption of the electrical vehicle for this service.

INTEREST IN INSTITUTE LOCAL SECTIONS.

A healthy interest is being shown in the various local sections of the American Institute of Electrical Engineers. Twenty-one sections have already been established, the greater number of which holds meetings monthly, and reports show that these meetings have been well attended. At certain sections the work is more active, as meetings are held two or three times during the month.

Although the greater number of these meetings is devoted to the reading and discussion of papers which have been presented at the general meeting of the Institute, some interesting original papers have been contributed to several local sections. This is a desirable move, as at such meetings papers of local interest can very properly be presented, although the sections do not seem to be limiting themselves to papers of this description. As the success of the local sections depends upon maintaining the interest of the members, the outlook is very promising.

The electric railway companies have had little use for snow plows so far this season. But these snow removers should be overhauled and made ready. There will be much use for them yet, and generally when least expected.

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The Lachine Rapids Power-House of the Lachine Rapids Hydraulic and Land Company, Limited, Montreal.[1]

The Original and Present Arrangement of Generators, Exciters and Switchboards, Etc.

By R. S. Kelsch.

WHEN the power-house was projected, plans and designs got out for the generators, switchboards, etc., there existed very little data regarding the operating of such a plant. Furthermore, the three-phase system in this country was not very far advanced, and there was more or less uncertainty as to how the output of this plant would be disposed of.

Under these conditions considerable temporary work was done and the plant was operated under difficulties. However, after operating some time, it was self-evident that a widely different plan for controlling the machinery and electrical apparatus must be worked out.

The disadvantages of the original layout were the poor regulation obtained, because of the exciters being driven direct from the main shaft, the speed of the exciters changing with changes in load, which multiplied the voltage regulation, and made it impossible to obtain good regulation. The switchboard arrangement, consisting of a separate switchboard located with each of the four generators, could be operated only at a great disadvantage. The position of the switchboard was such that the operator could not see the water-wheel attendants.

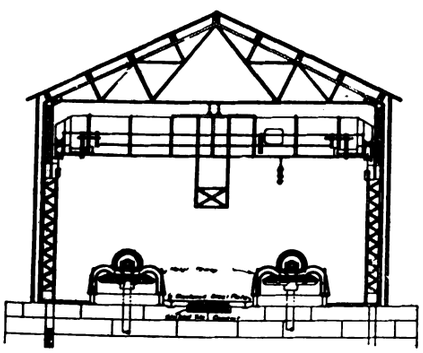

FIG. 2.

Considerable difficulty was experienced in operating the plant so as to give good service with the above arrangement and several changes were made which will be described. Referring to Fig. 1, water-wheel regulator "R" has been changed and a different type installed—the new governors are of the Lombard make, controlled from the switchboard.

The exciters marked "E" have been removed and located midway between the three generator rooms, each exciter being driven by an independent water-wheel, so that any speed change of the main shaft, due to change of load, does not affect the exciter regulation. By referring to the section view, Fig. 2, it is seen that the original wooden floor has been removed. The old hand crane has been replaced by a modern three-motor electric traveling crane and the overhead wires have been replaced by lead-covered cables placed in vitrified tile conduits, which are located below the new steel plate floor. The floor directly under the main shafts has been removed, leaving the flumes open, which permits ready inspection, facilitates making of repairs, and removes the possibility of the floor catching fire from hot bearings, etc. A closed iron fence has been built the entire length of the power-house, as shown, which serves the double purpose of preventing any one from falling into the open flumes and also prevents oil and grease from being thrown from the crown gears out on to the floor.

Instead of the three separate switchboards, one main switchboard has been built in the centre dynamo room, as shown on Fig. 1, and from the operator's position on the top gallery a good view is obtained of the entire power-house, including the generators, water-wheel governors, exciters, etc.

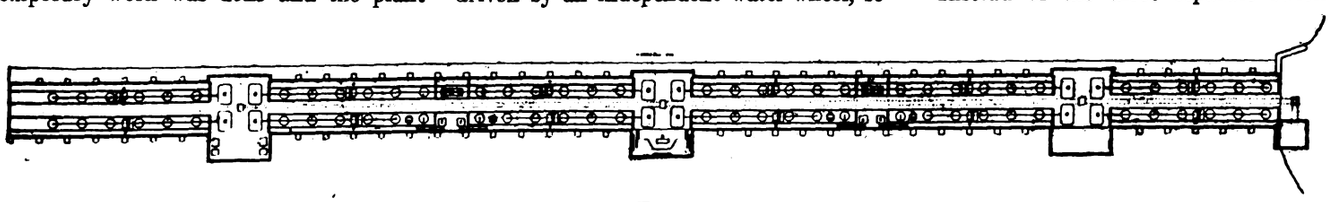

FIG. 1.

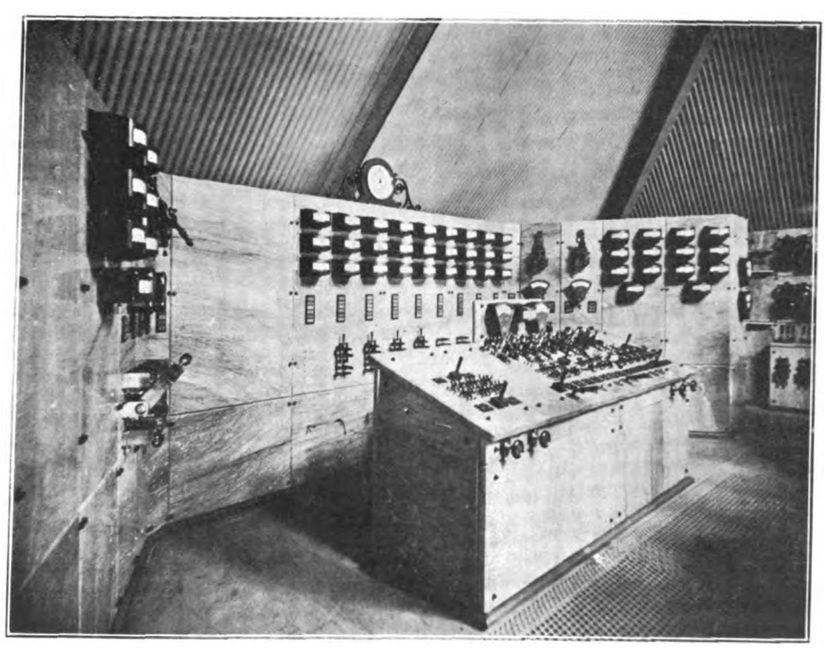

FIG. 3.—MEASURING INSTRUMENTS AND BENCH BOARD, LACHINE RAPIDS POWER-HOUSE.

GENERATORS AND EXCITERS.

The power-house is 1,000 feet long and 50 feet wide. The generator rooms are about 300 feet apart and in each of the generator rooms there are four generators.

[1] Abstract of paper read at a meeting of the electrical section of the Canadian Society of Civil Engineers at Montreal, October 15

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They are the well-known type of revolving field machine, made by the General Electric Company, and are of 750-kilowatt capacity each, having forty poles and a speed of 180 revolutions per minute, the frequency being sixty cycles and the voltage 5,000. In each of the exciter rooms there are two compound-wound seventy-five-kilowatt exciters, furnished by the General Electric Company. They are four-pole and run at 660 revolutions per minute. These exciters are built to operate between 90 and 175 volts. The voltage varies considerably, depending not only on the load, but also on the head of water, which changes with the different seasons of the year. It was found necessary to use several small exciters instead of two of larger capacities, on account of the low head during winter months, and the capacity of each wheel being limited.

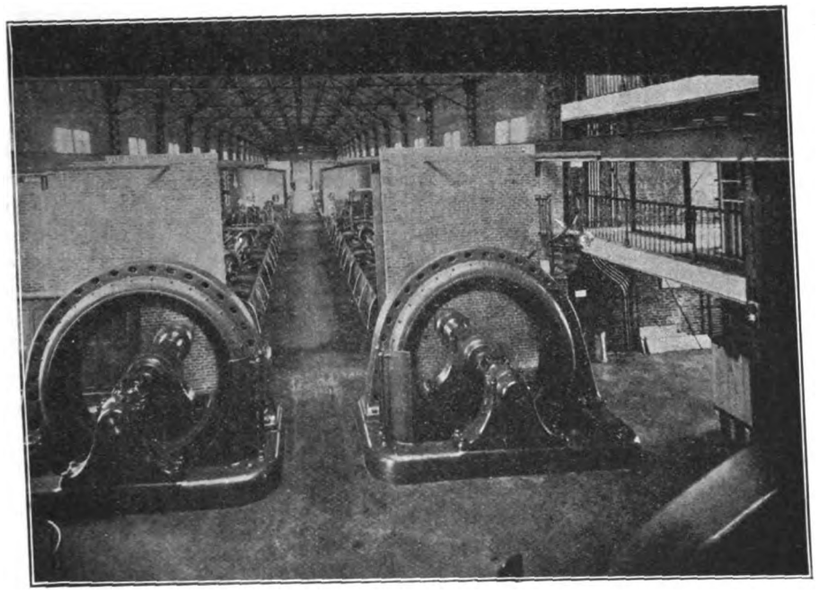

FIG. 4.—ROTARIES, LACHINE RAPIDS POWER-HOUSE.

The generators are constructed so that the fields are about three-quarters saturated under normal conditions, so that in the event of low water in the winter time the full voltage of the generators could be maintained when the head of water is reduced so that the speed of the generators is ten per cent below normal. In addition to these four exciters, there will be installed in the south dynamo room in the space originally occupied by the first temporary switchboard, two seventy-five-kilowatt direct-current generators, direct-connected to three-phase motors which will supply the current for the electric traveling crane, electric heaters, and the station lighting.

The main objects aimed and arrived at in the design of the switchboard were:

First, highest degree of safety and best results of operation.

Second, flexibility combined with the greatest simplicity possible.

Third, the impossibility of any but a wilful mistake on the part of the operator.

Fourth, the control of the entire system, including the turbine governors, to be such as to require only one operator on the switchboard.

Fifth, dividing the switchboard into symmetrical sections and the highest grade of work.

Sixth, fireproofing and insulating of all conductors, etc.

Sixteen feeder circuits are provided for and, as has been shown, twelve generators. It was considered advisable and an advantage to separate them into four sections, each set of three generators feeding four feeders. The arrangement is such that there are practically four different power-houses, each set or power-house being possible of entirely separate operation, or of working in multiple, the bus-bars being tied together or separated by means of electrically operated tying oil switches.

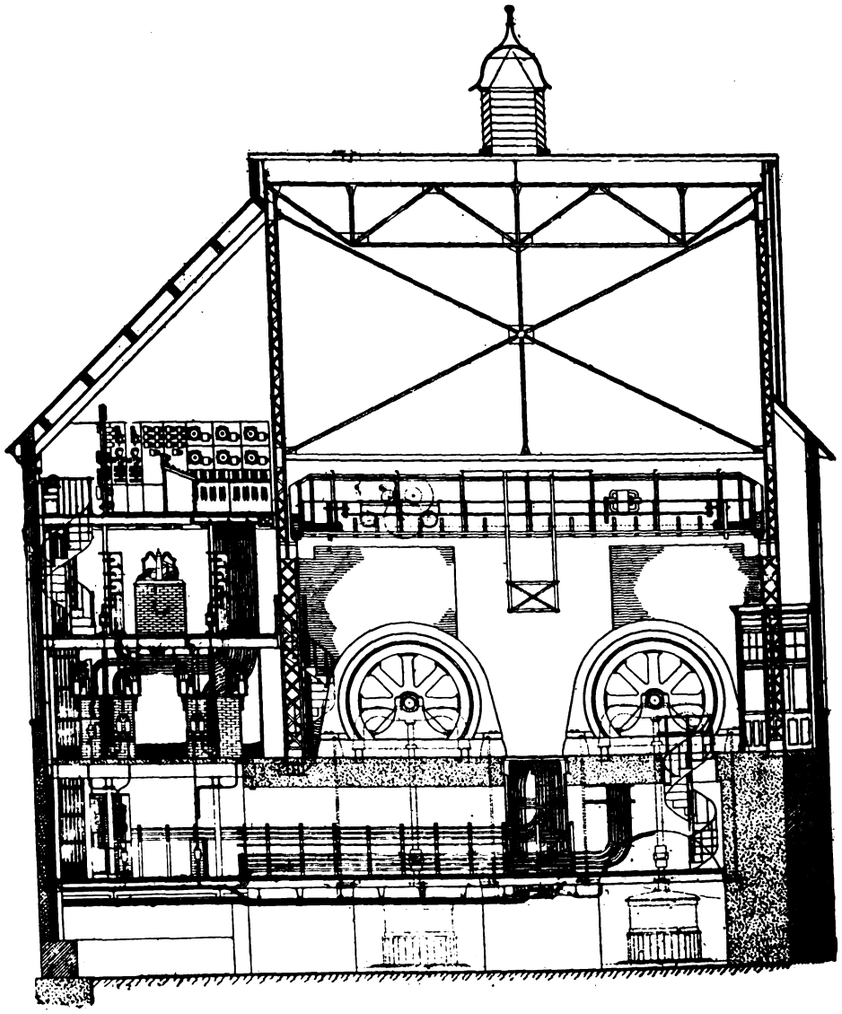

FIG. 5.

For each set of three generators and for each set of four feeders, there

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is a separate set of bus-bars. Each set of generator bus-bars is tied to the corresponding set of feeder bus-bars by means of cables, forming one complete section, the tying switches being tapped off these cables and not off the bus-bars.

Both the generator and feeder bus-bars form separate switchboards and are entirely independent and away from each other. This arrangement permits the entire system to be tied together and run as one system, or it may be run as separate systems.

In the event of an accident to any portion of the system, it can be quickly separated from the rest until repairs are completed. The arrangement is such that during light loads on Sundays and holidays, nights, etc., any portion of the plant can be made dead throughout, permitting any repairs, cleaning, etc., that may be necessary, without the slightest chance of injuring an employé.

Of the four feeder switches on each section only three are for transmission lines to the substations in the city, there being thus twelve lines altogether. The fourth switches are for reserve and for transmission of power to the surrounding neighborhood, etc.

In the plan as laid out, if there should be a compulsory shutdown of one of the feeder bus-bar panels, by disconnecting the cables from the latter the generators on that section can still be utilized. On the other hand, if a generator bus-bar panel be put out of service, the feeders on that section can be fed from the other generators. In the circuits of the tying switches are current transformers which operate overload relays. The latter are adjusted to operate only in case of an unusual and very heavy current such as can be obtained only by a dead short-circuit on the bus-bars. In such a case, the tying switches will automatically cut off the faulty section from the rest and prevent a complete shutdown of the plant.

For the four exciters, there are two sets of bus-bars, each exciter has a double-throw four-pole switch, besides the other switching apparatus on the exciter panels, as will be described later. It may happen that one of the exciters will become disabled, and in such case one of the motor-driven direct-connected generators installed in the south dynamo room will take its place, utilizing the same exciter panel.

THE CABLE SUBWAY.

As has been stated, the power-house is 1,000 feet long and to provide means of conducting the cables through the power-house to connect with the transmission line, a fireproof subway is run through the entire length of the power-house with manholes in each of the dynamo rooms and one outside of the power-house entrance, where the subway enters the tower, this subway consists of vitrified conduits laid in concrete.

THE MAIN CABLES.

The generator and feeder high-tension cables are constructed for 10,000-volt working pressure. They are three conductor No. 0 B. & S. cable, each conductor has seven-thirty-seconds inch paper insulation, and the whole covered with a lead sheeting. These cables run through the conduits to the middle dynamo room manhole, then along the basement corridor walls to the cable-head cells. Wherever the cables are exposed outside of the conduits, they are covered with three layers of asbestos tape, each layer being three-sixteenths inch thick, and the whole fastened on with brass straps. The cable heads are all mounted in brick cells and consist of brass bushings soldered to the cable, and the flared or bell-shaped cast-brass cable heads are then screwed on to the bushings and the whole filled with No. 66 Edison compound. The feeder cables which run into the tower have at the latter place a similar cable head and brick cell construction.

The exciter generator field and signal cables also run to the middle dynamo room through the conduit system, thence along the ceiling below the basement and then up the walls to the second switchboard gallery on to the main switchboard. It will be seen that by putting all of the high-tension cables in the basement and the direct-current cables in the sub-basement, they are entirely separated from each other. The exciter cables are 600,000 circular mils single conductor. The cables for the generator field are two conductor No. 0 B. & S. and the signal cables are multiple conductor No. 14 B. & S. They are all paper-insulated and lead-covered, made to successfully withstand a breakdown test pressure of 1,500 volts alternating current for one minute.

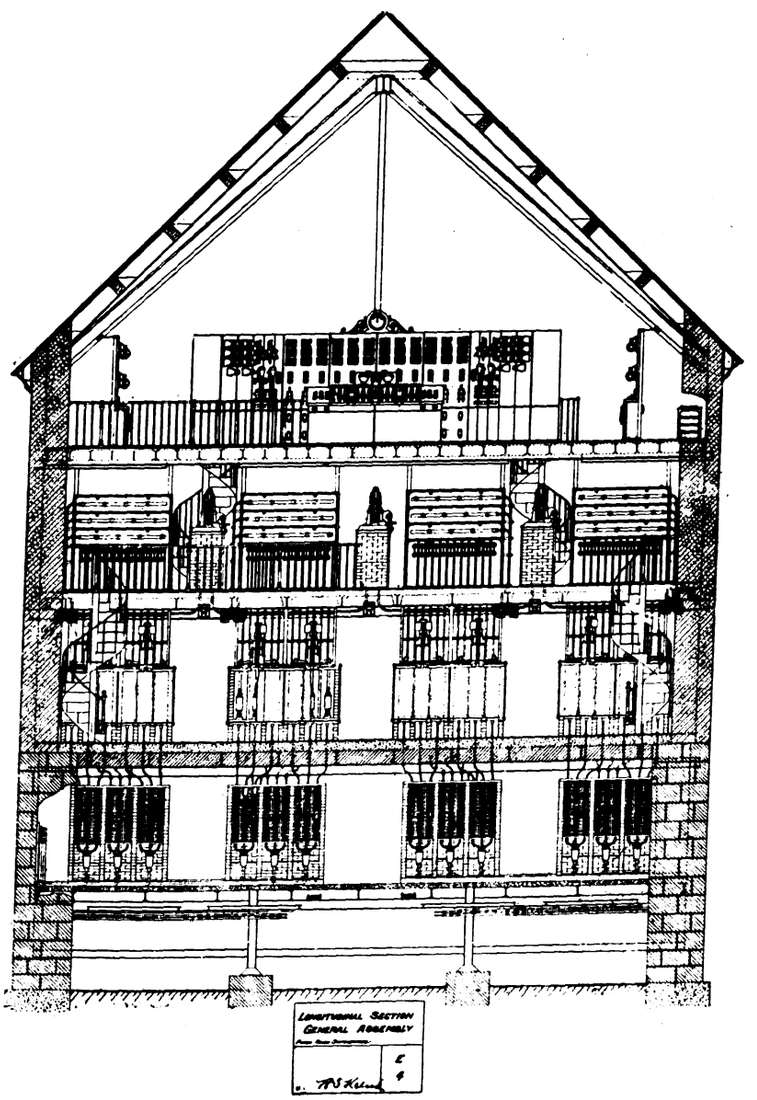

FIG. 6.

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THE GENERAL ARRANGEMENT OF THE SWITCHBOARD, SWITCHES, ETC.

The basement is used principally for the cable heads, static arresters and the potential transformers. These are all placed in buff brick cells with soapstone and brick barriers. From the generator cable heads, single lead-covered conductors run up to the oil switches on the main floor; from these switches, lead-covered leads run up to the bus-bars on the first gallery, passing through the current transformers on the back of the bus-bar panels.

The tying cables which pass through the totality instruments and current transformers connect the generator bus-bars to the feeder bus-bars on the same floor.

The feeder cables connect to the bus-bar panels in the same way. There are on the main floor, twenty-eight electrically operated oil switches grouped together in threes for the generator and in fours for the feeders. Each block of three switches for the generators has two corner cells in each of which is placed a 500-watt potential transformer with its primary and secondary fuses. These transformers are for operating the instruments of that section and are connected to the 5,000-volt bus-bars.

On the first gallery are located the bus-bar panels and also the electrically operated tying switches for the bus-bars. On the second gallery is concentrated the control of the entire power-house. On this floor is located the instrument panels and the operating table. Also on the right and left hand are the two feeder bench boards and adjoining these are the direct-current distributing switchboards for supplying power to all of the auxiliaries.

On this gallery, where the operator is stationed, there will be absolutely no high-tension wiring or apparatus of any description.

MAIN SWITCHBOARD.

The main switchboard (Fig. 9) consists of four generator panels in the centre, two spacing panels, four exciter panels and four total output panels and at each end of the board is a panel for the recording instruments.

On the back of this board are two sets of exciter bus-bars mounted on fibre block insulators, supported by cast-iron brackets and insulated with oil linen and tape.

It is possible to disconnect the exciter bus-bars into three separate sections for repairs, etc. Each panel provides for three generators and each generator has on this board a power-factor indicator, one alternating-current ammet r, one direct-current field ammeter, two reverse current relays and double-pole, double-throw field switch with discharge resistance and an annunciator or signaling device. No overload automatic devices or fuses are provided for the generators.

In case of any short-circuit in the generator cable or in case of the field current failing, the other generators would of course pump back into this disabled machine and thus reverse the current. The reverse-current relays will then automatically cut off the faulty cable or generator from the bus-bars. In case that the generators when in parallel fail to work together, then the power-factor indicator will indicate the trouble, and the reverse-current relays will again operate. On the back of this board are fuses for the field cables, and these fuses are set for three times normal full load, so that they can only operate in case of a dead short-circuit on the field or cables connected thereto.

On each exciter panel there are a triple-pole double-throw switch, a circuit-breaker, a Thomson astatic ammeter and an illuminated annunciator.

On each totality panel are mounted two wattmeters, three ammeters, a frequency indicator and the bus-bar voltmeter.

OPERATING TABLE.

The operating table is divided into sections corresponding with the rest of the system. There are four panels for the generators, between each two of which is a panel for the control of the bus-bars tying switch. A simple inspection shows whether the controlling switch of the tying switch is closed or not, which is indicated by colored pilot lamps.

On the two extreme ends of the table are the panels for the exciters. The operating table contains all the necessary apparatus for the automatic and hand control of the oil switches, for the control of the motor-operated field rheostat switches, of the motor-operated main rheostats for the exciters, of the turbine governor control, the signal system, a synchronizing device and the alternating-current voltmeter for the generators and the direct-current voltmeters for the exciters.

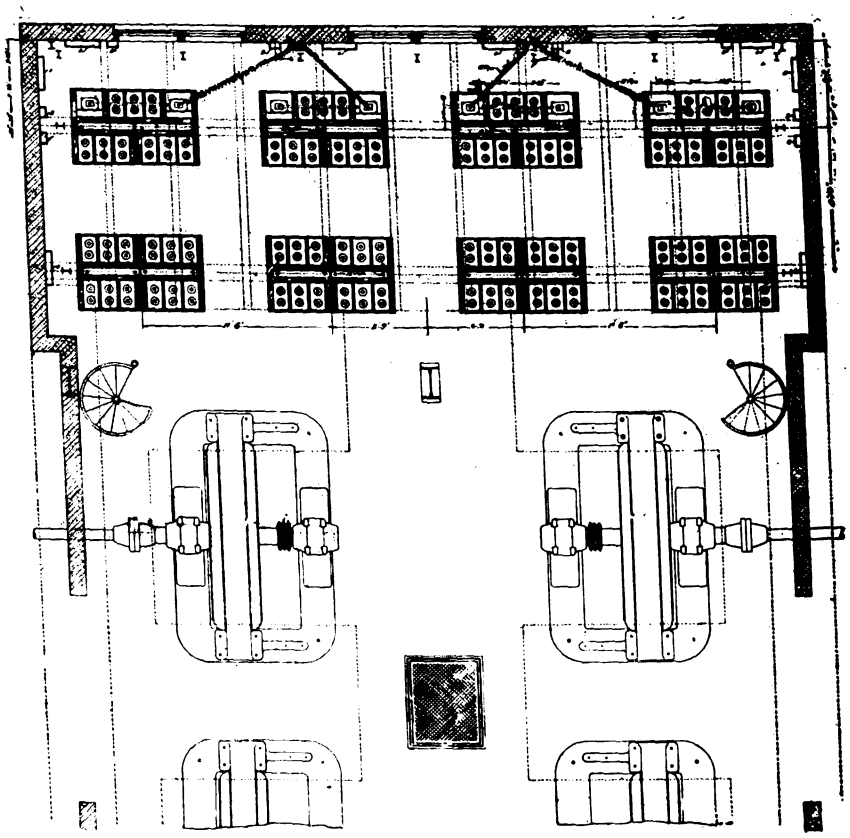

FIG. 7.

THE FEEDER BENCH BOARDS.

On the feeder bench boards are mounted the overload relays, the automatic controlling switches and the red and green pilot lamps for the same. According to whether the red or green lamp is lighted, can be seen whether the oil switch on the main floor is open or closed. No instruments whatever are provided for the feeders, as most of the feeders run to one distributing point, but by means of the terminal board it is possible to put ammeters, wattmeters, etc., in on any feeder and on any phase.

THE DIRECT-CURRENT DISTRIBUTING SWITCHBOARD FOR THE AUXILIARIES.

These switchboards, of which there are two, are mounted alongside of the feeder bench boards. On them are mounted the fuses for all the supply leads of the direct-current controlling or auxiliary devices, the source of energy being from either set of the exciter bus-bars.

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THE MOTOR-OPERATED MAIN RHEOSTATS FOR THE EXCITERS.

These rheostats are mounted on the floor in the rear of the main instrument switchboard. There are two sets of these, one for each set of exciter bus-bars. Each set contains four rheostats operated simultaneously by means of a worm shaft driven by half horse-power direct-connected motor.

By means of special clips, the triple-pole double-throw switch on the exciter panel, depending on its position, throws a rheostat of one of the two sets in series with the hand-operated shunt field rheostat of the corresponding exciter. The latter rheostat is mounted underneath the ceiling floor of the second gallery, and is controlled by means of sprocket chain gearing from the operating table. On the operating table are mounted the controllers for these rheostats. The object is to raise or lower the voltage simultaneously on all exciters which are in multiple, and thus to simplify the operation.

ALTERNATING-CURRENT BUS-BARS.

The high-tension bus-bars (Figs. 10 and 11) situated on the first gallery are mounted on soapstone panels, two inches thick, with soapstone barriers. The current is carried from the oil switches through the current transformers to the knife blade switches and thence to the bus-bars studs by means of copper bars. The knife blade switches serve the purpose of making the oil switches entirely dead for cleaning and for repair purposes. On the back of the panels the connecting strips and terminals are well insulated.

OIL SWITCHES.

On the main floor for the generator and feeder switches, there are twenty-eight compartment type oil switches furnished by the General Incandescent Arc Light Company, of New York. These switches are mounted in a buff brick chamber, divided by soapstone barriers into three compartments, one for each phase. On the first gallery for the three tying switches are three compartment type switches, they being the well-known General Electric Company's compartment switch.

GOVERNING CONTROLLERS.

One of the interesting features of the plant is the controlling device for the Lombard water-wheel governors, by which the speed of the water-wheels driving the generators is electrically controlled from the operating table. Inasmuch as the wheelman in any case is required to start the wheels and to open the valves on the governor, and to bring the water-wheels and generator up to approximately normal speed, it was decided that the best plan would be to let the wheelman start up each unit and after bringing the generator to approximately the right speed, to give the switchboard attendant only such control as may be necessary to get the generator in synchronism.

Two solenoids operate the rachet wheels which are fixed to the spindle or rod which connects the flyball with governor-regulating valve. One of these solenoids operates a rachet in one direction so as to raise the speed, and the other solenoid operates another rachet in the opposite direction, which lowers the speed. On the operating table there is a single-pole double-throw cam switch which controls simultaneously or singly all the governors in the power-house.

FIG. 8.—SWITCHBOARD GALLERIES, LACHINE RAPIDS POWER-HOUSE.

THE SIGNAL SYSTEM.

On the generator and exciter panels, annunciators are mounted. Each annunciator has six compartments with ground glass covers, back of which are two five-candle-power seventy-five-volt lamps, connected in multiple, and on each piece of ground glass is printed certain signals. These lamps are operated from single-pole double-throw cam switches mounted on the operating table. Similar annunciators and switches are mounted at each turbine governor, and the lamps here are in series with those on the main switchboard. At each end relays operate electric bells, thus calling attention to the signals.

THE SYNCHRONIZING DEVICE.

There is only one Lincoln synchronizer

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used and there are four different sets of bus-bars for each generator, and for each bus-bar tying switch there is one four-hole receptacle on the operating table. If the operator wishes to synchronize two sets of bus-bars he inserts the four-point plug on the corresponding tying panel. If he wishes to synchronize a generator with the bus-bars, the plug is inserted in the corresponding four-hole receptacle. The operator need not see that the synchronizer is on the right bus, as the four-point plug takes care of that.

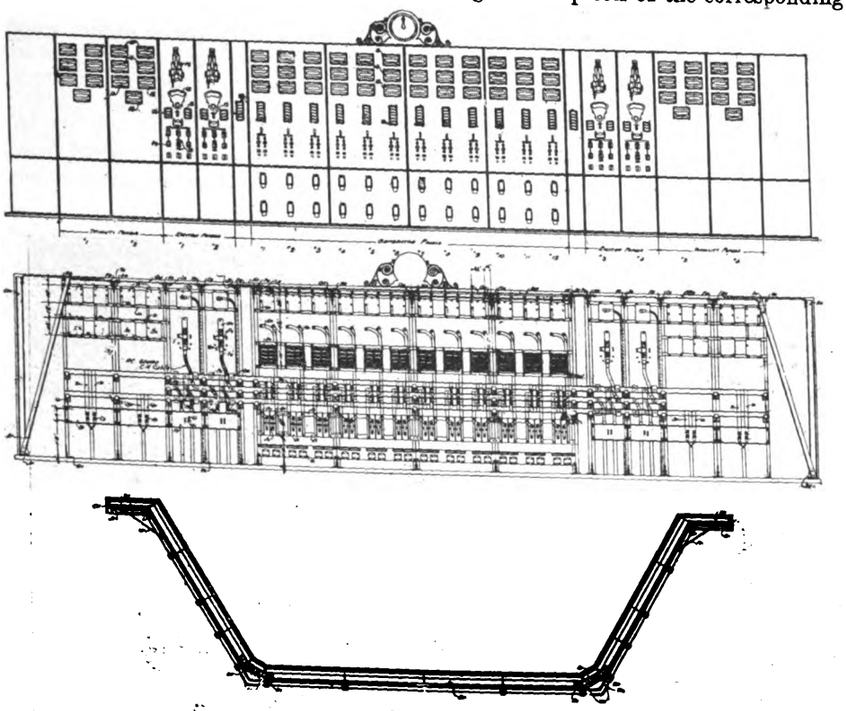

FIG. 9.

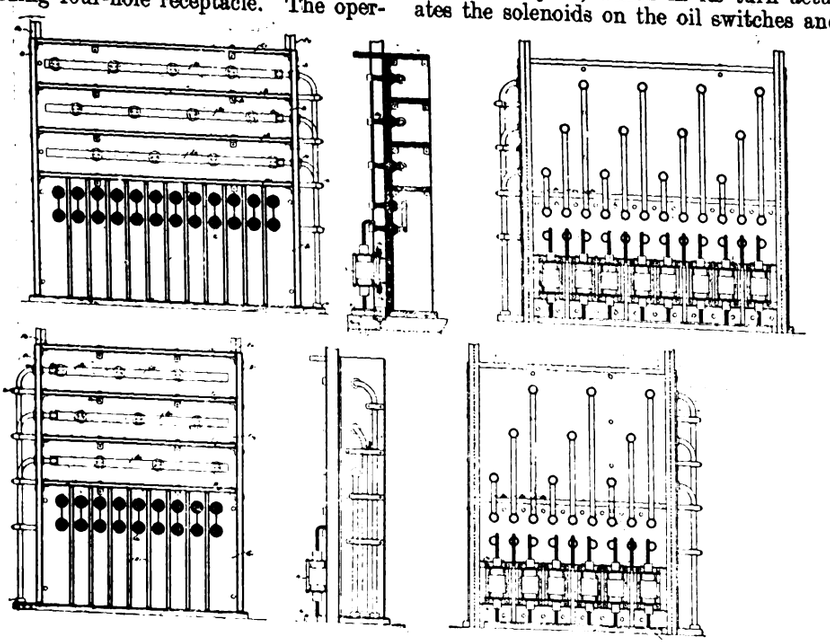

FIG. 10.

GENERAL.

The various diagrams clearly show the methods of operation for the alternating-current and direct-current systems. It remains to be said, that the overload relays for the feeders and reverse-current relays for the generators, when subjected to the automatic controlling switches, on the abnormal conditions they are set to operate at, close a direct-current circuit through the trip coil of the corresponding feeder bench boards or operating table as the case may be, which in its turn actuates the solenoids on the oil switches and opens the latter. With the overload relays for the tying switches, the operation is different. In this case, the trip coil of the controlling switch is under normal conditions short-circuited through the relay contacts. When the overload occurs the contacts are open-circuited, which sends the current from the series transformer through the trip coil and thus opens the main switch. All the current and potential transformers have in either case the secondary wiring grounded, so there is no chance of injury in case the insulation breaks down.

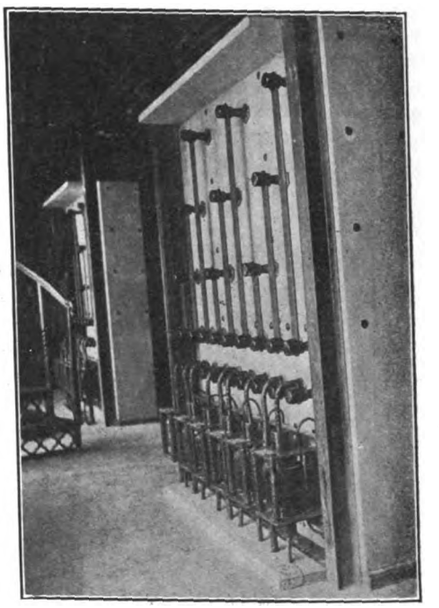

FIG. 11.—HIGH-TENSION BUSES.

As the secondary leads of the current transformers run up to the instrument switchboard, on the floor above, are consequently rather long, the leads are twisted to avoid any inductive effect which might affect the accuracy of the instruments.

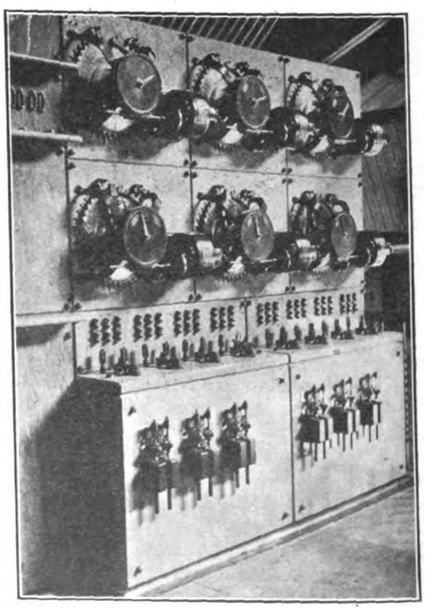

FIG. 12.—MOTOR-OPERATED MAIN RHEOSTATS FOR EXCITERS, LACHINE RAPIDS POWER-HOUSE.

It may be noted that all the wiring throughout the system, except the secondary leads from the current transformers, consists of lead-covered paper-insulated conductors.

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The Use of Electricity for Glass Manufacture.

By John B. C. Kershaw.

Introduction.

THE reported success of electrical heating, when applied to the production of iron and steel, has revived interest in the attempts that have for some time been directed toward the use of electricity as a heating agent in the manufacture of glass. The conditions in this industry are very similar to those obtaining in the production of iron and steel. In each case, the furnace used for carrying out the manufacture by the older process is considered to be the most efficient heating appliance in industrial use. The blast furnace, as an agent for converting the energy of coal into heat or chemical action, finds a worthy rival in the regenerative gas furnace, which is now almost universally employed for glass manufacture. The latter furnace is constructed in such a manner that the heat of the waste gases is employed to heat the incoming gas and air. To this utilization of heat which would otherwise be wasted, and to the exact regulation of the air supply possible with gaseous fuel, the furnace owes its strikingly high efficiency as a heating appliance.

When therefore electricians and engineers propose to substitute electricity for gaseous fuel in the manufacture of glass, it is evident they have a somewhat difficult task to fulfil. A further difficulty as regards the adoption of electric glass furnaces is caused by the fact that the gases liberated and enclosed in the glass when first melted take a long time to rise to the surface and escape. In most glass-works a period of twenty-four hours is required for this "clearing" of the glass, and during the whole of this time the glass must be kept in the molten condition. It is certainly yet too early to say that these difficulties have been surmounted, and that this new application of electric power has proved a financial and practical success. However, two experimental works of this kind are in operation, and the methods and furnaces having thus arrived at the industrial stage of their development a detailed account of the new procedure will no doubt prove of interest to readers of this paper.

Details of Construction of the Electric Glass Furnaces.

No very reliable information can be obtained from those exploiting the new processes for glass manufacture as to the exact type of furnace now being used for the industrial trials. The writer has therefore thought it wise to give brief illustrated descriptions of all the more important furnaces for this purpose patented recently in the names of Becker and Voelker, the German engineers who have acted as pioneers in this new development. It is probable that all of these have been tried, and that the furnaces now being employed at Matrei and Plettenberg contain the best features of each of these various designs. Figs. 1 and 2 show two views (back and front) of the seventy-kilowatt Becker furnace, used for the experimental trials in 1902. The internal construction of this furnace, which has two melting canals of the step-hearth type, and two pots for receiving the molten glass, can be arrived at by a study of the following patents.

It may, however, be remarked that the after-heating of the glass in the furnace, shown in Figs. 1 and 2, was effected by coal; and that the waste gases from this portion of the furnace was utilized to heat the annealing furnace, seen on the right-hand side in Fig. 2.

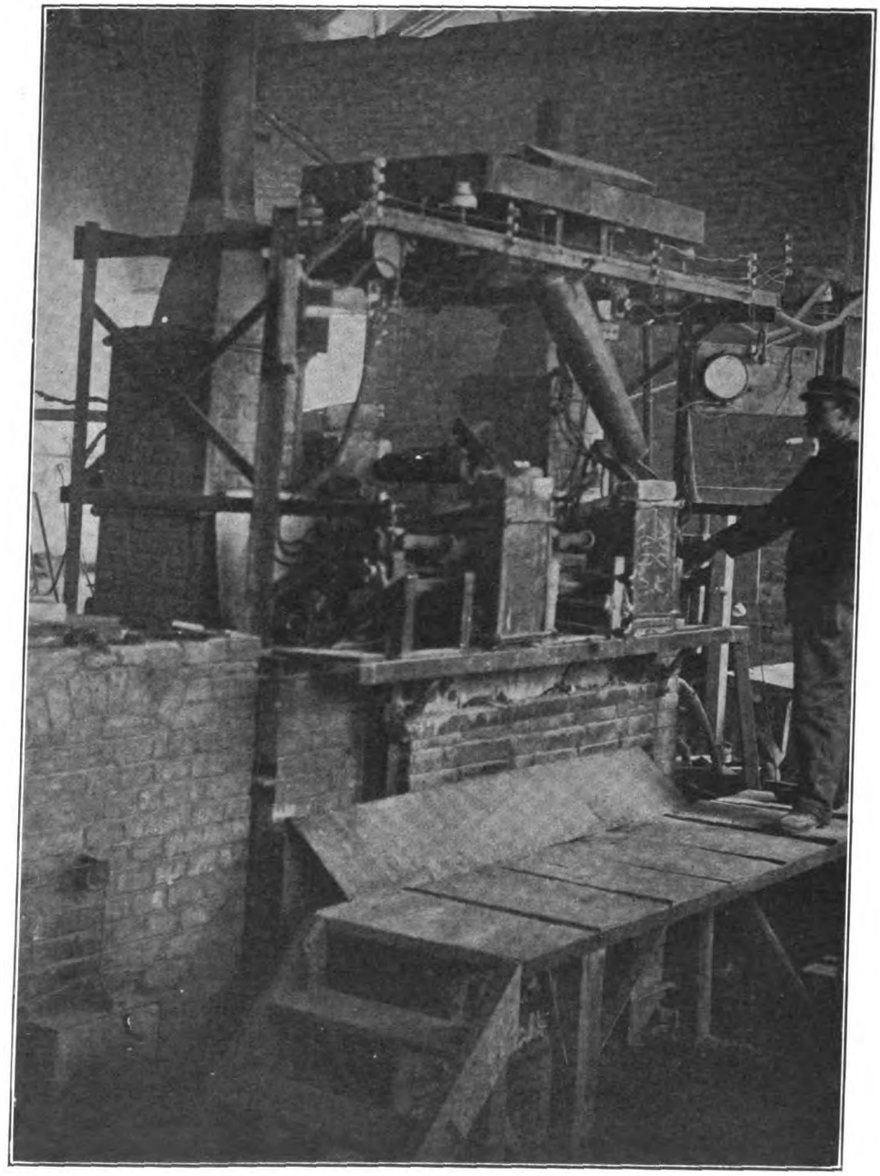

FIG. 1.—AN ELECTRIC GLASS FURNACE—REAR VIEW.

Patent No. 6,944, 1898, Becker and Schreyer.

The furnace described in this patent is shown in sectional elevation in Fig. 4; while Fig. 3 gives details of the series of hearths where the arc-heating of the raw materials occurs. f_1 f_2 f_3 in Fig. 3 and g g g in Fig. 4 represent the electrodes between which the arcs are formed; while c d e in Fig. 4 represent the various di-

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visions of the furnace proper, in which the clearing of the molten glass occurs. The step-hearth formation of this furnace appears to be the only feature which has been retained in the latest form of electric glass furnace.

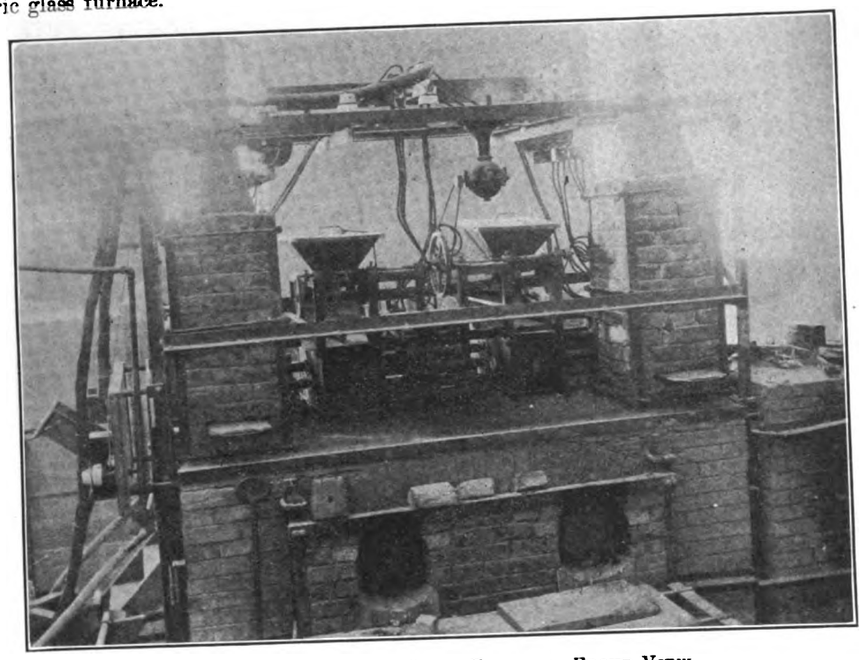

FIG. 2.—AN ELECTRIC GLASS FURNACE—FRONT VIEW.

Patent No. 12,672, 1900, Voelker.

This patent relates to a type of furnace for glass production, in which both arc and resistance heating are employed. The latter method of heating is possible, since molten glass is a conductor of electricity. Fig. 5 is a sectional elevation of the furnace. EE represent the arc electrodes; while *e e* show the position of the electrodes, between which resistance heating occurs. After being cleared in this way in the basin A, the glass flows down into the lower working chamber B.

Patent No. 23,903, 1900, Voelker.

The furnace described in this patent is a modification of that just referred to.

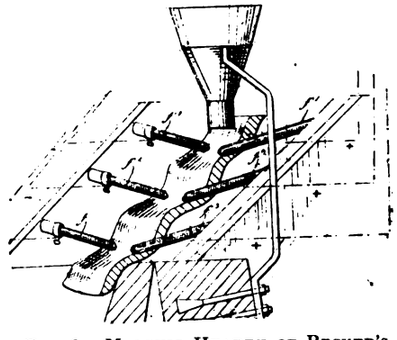

FIG. 3.—MELTING HEARTH OF BECKER'S ELECTRIC GLASS FURNACE.

Fig. 6 is a sectional elevation of the furnace. A number of radial passages, two of which are shown in the diagram CC, convey the raw materials into an equal number of inclined tubes *h h*, where melting by the arcs occurs. Two arcs are formed in each of these tubes, *d d* and *e e* being the electrodes. K is the refining basin, and in this the glass is cleared by aid of resistance heating, *l l* being the two electrodes for this current; *p* is the working pot into which the glass finally passes by the annular ring *n* and openings *o o*.

A feature of this furnace is that the hot gases produced by the melting and reaction of the raw materials are collected, and conducted by the tubes *r r* to the bottom of the furnace, where they are burned with air in the burner S. The heat thus produced is employed to heat the working pot *p*.

Patent No. 17,656, 1901, Soc. Industrie Verriere.

In this patent a radical departure in the method of feeding the raw materials into the furnace from that described in the earlier patents is introduced. The raw materials are ground, formed into a paste with water, or with soluble glass plaster of Paris, etc., and are then passed through a suitable press, and delivered into the furnace in the form of a continuous ribbon or band. When water is used for mixing the band requires a preliminary drying before submitting it to the action of the arc. Fig. 7 is a diagrammatic section of a furnace being fed with raw materials in band form; *e e*, *e e* and *e e* being the three pairs of electrodes, and *d* the melting hearth.

In a letter received in January of the present year by the writer from T. Bronn, the latter, who is one of the directors of the works at Plettenberg, stated that the operation of the furnaces used at that place had been much simplified and improved in the last few months. In Herr Bronn's opinion, these furnaces may now be considered to have entered into competition with the usual form and type of

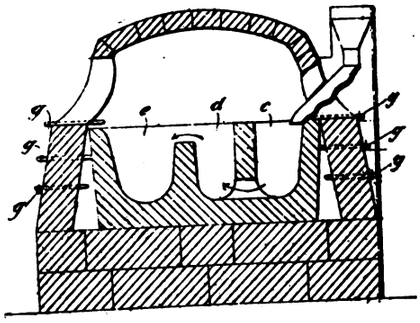

FIG. 4.—BECKER'S ELECTRIC GLASS FURNACE.

glass furnace. The quality of the glass produced was good; and in the latest design, contact with the electrodes did not occur. This overcomes the difficulty caused by disintegration of the carbon of the electrodes, and contamination of the glass with this impurity—a danger which has been referred to by a writer in the paper named below.[1]

The chief American patents relating to electric furnaces for glass manufacture are as follows:

Nos. 664,034; 689,766; 702,081; 706,283; 708,309.

The Industrial Application of Electricity to Glass Manufacture.

As already stated in the introduction

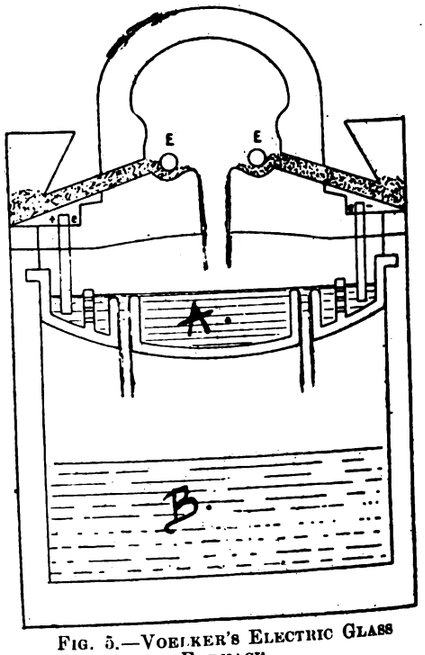

FIG. 5.—VOELKER'S ELECTRIC GLASS FURNACE.

to this article, two works are now in operation where glass is being produced by aid of electrically generated heat. One

[1] *Zeits. f. Elektrochemie*, 1901, p. 811.

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of these works is situated in the Tyrol, the other is in Westphalia. All the information available relating to these works is presented below.

The Electric Glassworks at Deutsch-Matrei in the Tyrol.

The present trials at Matrei are under the control of the Aktien Gesellschaft f. Elektrokeramic, an Austrian company founded in 1902, with a capital of 400,000 krone and headquarters in Brussels. This company was promoted by the Allgem. Carbid u. Acetylen Gesellschaft, of Berlin, by the Akt. Gesell. l'Industrie Verriere et ses derives, of Brussels, and by the Akt. Gesell. Carbidwerk Deutsch-Matrei. The latter company provided 3,000 horse-power and placed its land and buildings at Matrei at the disposal of the new company.[1] Manufacturing operations were reported to have commenced in the summer of 1902 at this place. The Matrei carbide works was one of the large number on the continent of Europe which had to suspend operations owing to the fall in carbide prices in 1900 to 1901,

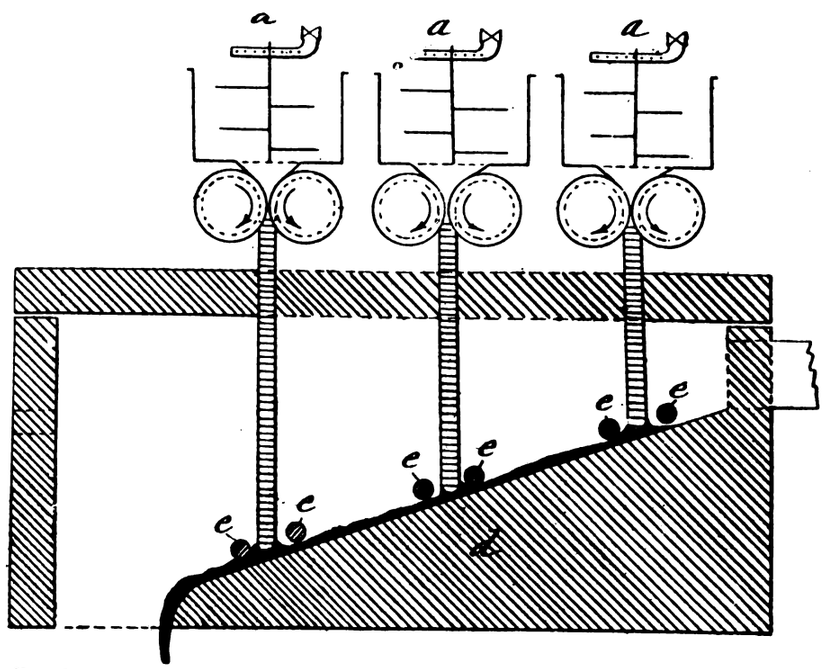

FIG. 7.—SOCIETE ANONYME DE L'INDUSTRIE VERRIERE PATENT GLASS FURNACE.

dently been regarded by its directors as affording the means for utilizing the elec-

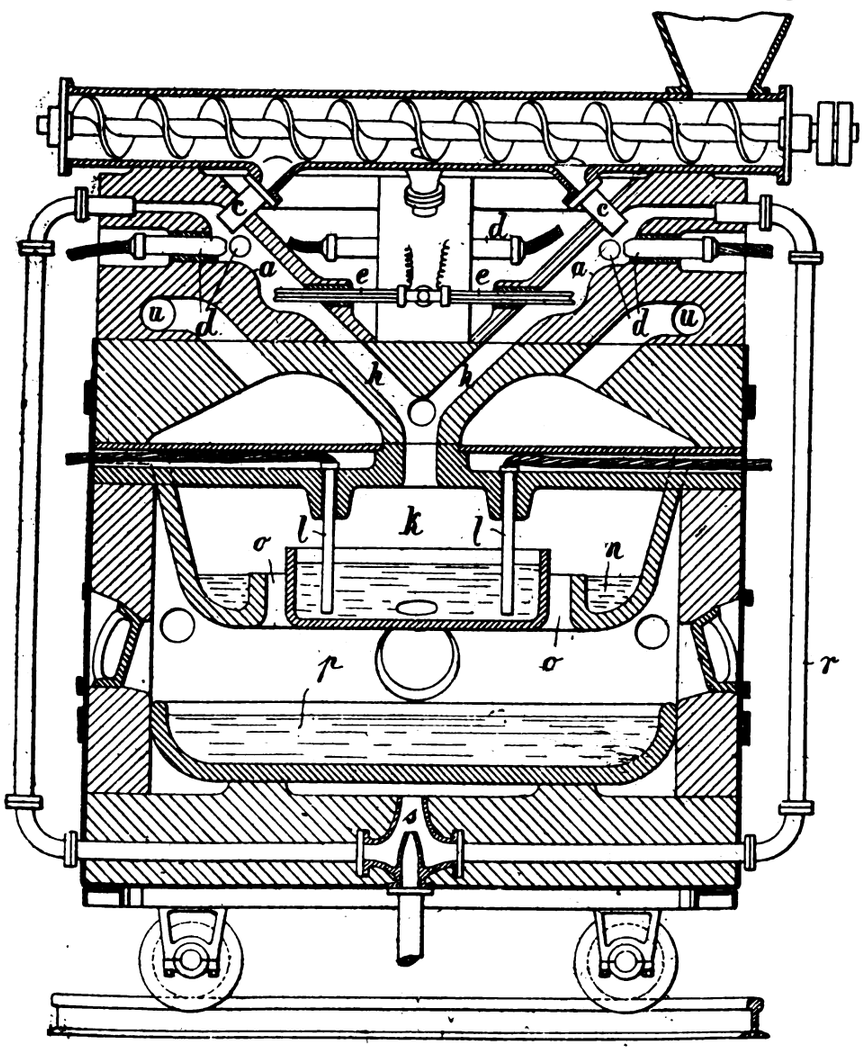

FIG. 6.—VOELKER'S IMPROVED FORM OF ELECTRIC GLASS FURNACE.

and electric glass manufacture has evi-

[1] *Zeits. f. Elektrochemie*, 1902, p. 243.

tric power and plant. The cost of the electrical horse-power-hour at the furnaces with the present generating plant is stated to be about 0.50 pfennig,[1] equal to £18 5s. per electrical horse-power-year. The new process for glass manufacture is therefore not too favorably situated, as regards cost of electric power.

The Electric Glassworks at Plettenberg on the Lenne, Westphalia.

The trials of electric furnaces for glass manufacture at this works were commenced in 1902, under an agreement between the Brussels company, L'Industrie Verriere et ses derives, which had purchased all the Becker and Voelker patents, and the Lenne Elektricitäts-u. Industriewerke.

The latter company had already developed 2,000 horse-power at Plettenberg (1,500 horse-power water and 500 horse-power steam), and it was arranged that portion of this power should be devoted to the manufacture of glass by the new method.

The trials at this place have been carried out with alternating current, and various types of electric furnace have been used. No details of the cost of power at the Lenne works are available, but it is stated that the kilogramme of glass can be produced here with the expenditure of only one and one-quarter to one and one-half electrical horse-power-hours, and that the quality of the glass is excellent.

Conclusions.

No details concerning the financial results of the industrial trials at Matrei or at Plettenberg have yet been published. Doubtless the inventors and their financial supporters convinced themselves

[1] *Zeits. f. Elektrochemie*, 1902, p. 421.

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by the laboratory trials in Cologne in 1900 to 1901 that with electric power at a reasonable cost competition with the older process was possible. It is difficult to understand, however, why the industrial trials have been commenced under such unfavorable conditions as regards cost of power as at Matrei; and if a profit can be earned at this place, the new process of glass manufacture will evidently extend rapidly.

The following details from a recent article by Dr. Bermbach[1] concerning the coal consumption in the older types of furnace and the "estimated" consumption by the electric method will be of interest.

The regenerative gas furnace is calculated to have a heating efficiency of forty-two per cent, as compared with an efficiency of only eighteen per cent in the older form of direct-fired furnaces.

A very large proportion of the heat is, however, lost by radiation in the regenerative gas furnace, and Bermbach estimates that this loss amounts to between sixty per cent and seventy per cent of the heat liberated in the furnace. In the writer's opinion, this estimate is excessive. Using these figures as basis of his calculation, Bermbach has estimated that 1.5 kilogrammes of coal are required to produce one kilogramme of glass in a gas-fired furnace containing pots. With tank furnaces, gas-fired, the fuel consumption may fall as low as 0.50 kilogramme per kilogramme of glass; while with hand-fired pot furnaces, it may rise as high as four kilogrammes.

Bermbach then estimates the yield of electric glass furnaces, by assuming that the same heating efficiency will be attained in them as in carbide furnaces, namely, one of seventy to eighty per cent. Using the same figure for the heat calories necessary to produce one kilogramme of glass, as before (namely, 746), he calculates that 1,320 watt-hours will produce this amount of glass. If steam engines be employed to generate the electricity, using 0.80 kilogramme coal per horse-power-hour, the coal consumption per kilogramme of glass works out to 1.50 kilogrammes.

Bermbach admits that the clearing of the glass in the electrically heated furnace will require further heat; and this is undoubtedly the weak feature of all the electric furnace processes for producing glass. To maintain a bath or pot of molten glass at a red heat for twenty-four hours by resistance heating, means a very large expenditure of current; and it would seem probable that if electricity wins a permanent place in the glass industry, it will only be in conjunction with gas-firing for the clearing or refining operations.

The figure for coal consumption given above, show that the electric furnace methods of glass manufacture can not compete at present with the older method of manufacture by regenerative gas furnaces constructed on the tank principle; and their field of usefulness would therefore appear to be restricted to the production of the special varieties of glass, which at present are made in pot furnaces. For these special glasses, it is probable that the electric furnace method of production may offer numerous advantages; and possibly the very high range of temperature which can be attained by the electrical methods may lead to the discovery and manufacture of glasses with new and valuable properties. The recent production of vessels of quartz is an example of this use of the electric furnace.

Except in districts very favorably situated as regards the cost of developing water power, the new methods of glass manufacture are therefore likely to be restricted to these minor branches of the industry, and in the writer's opinion the bulk of the world's glass will still be produced for many years to come by the regenerative gas furnace invented half a century ago by Werner von Siemens.

[1] *Elektrochem. Zeit.*, September, 1901.

A New Method of Constructing Underground Conduit.

A demonstration was made recently at the Metropolitan power house, Neasden, England, of a new system of underground conduit construction. Iron pipes about four feet long are coated with a one to four mixture of paraffin and graphite, to the thickness of about a quarter of an inch. These were then screwed together to form one piece of any desired length, the joints being made by short sleeves screwed into the pipe, so that the exterior presents a smooth surface. The pipe, as thus arranged, is blocked up on wooden spacers, and then finally embedded in concrete. After the concrete has hardened, steam is passed through the pipes until the paraffin is melted and it is possible to withdraw the pipes, leaving the concrete coated with a mixture which acts as an excellent lubricant and enables the cables to be drawn in with ease and a minimum abrasion. The cost for this construction is given as from twenty-five to thirty cents per yard run of conduit. At the demonstration there was difficulty in withdrawing the pipes, as they cooled very rapidly after the steam had been cut off.

BOOK REVIEWS.

"Fowler's Mechanical Engineers' Pocketbook." 1904 Edition. Edited by William H. Fowler. Manchester, England. Scientific Publishing Company. Leatherette, red edges. Leather, gold edges. 440 pages. 4 by 6 inches. Numerous diagrams and tables. Supplied by the ELECTRICAL REVIEW at 50 cents or 85 cents, according to binding.

The 1904 edition of "Fowler's Mechanical Engineers' Pocketbook" has been issued. This useful little book is well known and contains a good deal of valuable information for the practical man. It is to be regretted, however, that the electrical section is somewhat deficient, containing only a list of the electrical units, a brief explanation of Ohm's law, and a word or two about electric cranes and the use of electricity in mines. At this day the mechanical engineer would be seriously handicapped if he had no other electrical information than is given here.

"Whittaker's Electrical Engineers' Pocketbook." Edited by Kenelm Edgcumbe. New York. The Macmillan Company. Leather. 456 pages. 4 by 6½ inches. 149 illustrations. Supplied by the ELECTRICAL REVIEW at $1.

This pocketbook differs from previous pocketbooks, as it does not merely give a number of formulæ, rules and data collected from various sources, but gives a kind of synopsis of each subject brought well up to date. Each section is prepared by a specialist in that line. Owing to the great specialization which the rapid growth of electrical engineering has necessitated, it is impossible for any one individual to keep pace with all the new methods and systems coming into use in other branches than his own. It is the aim of the present volume to furnish this information, for while the various sections give information quite sufficiently detailed for ordinary requirements, at the same time references are given to various recent papers and publications, where full treatment of the subject can be found. The book gives the usual mathematical and physical formulæ and tables. A chapter on practical mechanics; a discussion of electrical laws; methods of measuring and measuring instruments; electric lighting methods; dynamo-electric machinery, both alternating and direct; methods of testing; power transmission; electric traction; and central stations and accessory apparatus are all satisfactorily presented. The design of direct and alternating-current machinery is treated fully, and a chapter on electrochemistry describes certain of the processes now in wide use.

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HARD DRAWN COPPER WIRE.[1]

BY FRANCIS W. JONES.

The great strength which is obtained in hard drawn copper wire (of over 60,000 pounds breaking strain to the square inch, which is very close to ordinary iron), with over six times better electrical conductivity than iron, with its almost complete immunity from oxidation and corrosion, ensuring a negligible depreciation, and its small electromagnetic inertia as compared with iron, are qualities which have made the use of copper wire very important to telegraph and telephone companies, and to meet the necessity of systems of communication requiring more rapid signals than Morse, the value of copper wire to telegraph companies for overhead construction will be still very greatly enhanced. But the full value of such wire, particularly its mechanical qualities, can only be secured by its most intelligent and careful construction and maintenance, from the fact that the strength of the wire lies entirely upon its surface, and that to secure the utmost tensile strength the wire has to be tempered to the verge of brittleness.

When telegraph wires were first strung upon poles, the length of the spans, the distance of wires apart, and the sags given, were decided purely by mechanical and financial considerations. The length of span having been fixed to require as few poles per mile as possible, the sag was restricted to such a distance that the wires would not swing together in the wind.

Modern construction has been determined largely by the same consideration.

An exception was made by the American Rapid Telegraph Company and the original Postal Telegraph Company, several years ago, in placing their wires farther apart to obviate the effects of electrostatic lateral induction, but on the discontinuance of the rapid systems then used by these companies, the intermediate space on the cross arms was used for other wires, and within recent years the tendency has been to place the wires still closer together, and this has become possible by reason of the shortening of the spans by a greater number of poles necessary to support the increasing load of wires.

Notice was early taken by engineers of the temperature effect upon wires, as it was found that when they were put up in a high temperature, with but little sag, that they would snap during cold weather, so the engineers furnished formula according to which sags should be given to wires of different lengths of span when erected at various degrees of temperature.

It is shown by Mr. John Gavey, the engineer-in-chief of the British Postal Telegraphs, page 336, vol. xxxi of the Journal of the Institution of Electrical Engineers, London, that a hard drawn copper wire, when under a very light stress, acquires a permanent set if the stress be maintained sufficiently long, and that a wire nearly No. 12 B. & S., with a breaking strain of 490 pounds, loaded with 110 pounds, recovered its original length upon removal of the load if it was not continued too long, but if the load was kept on for twenty-four hours a permanent elongation of one-sixty-fourths of an inch was produced in a length of about forty feet and that this elongation was a function of the time the load was kept on, increasing to one-thirty-second of an inch in three days and three-sixty-fourths of an inch in two weeks.

It is shown that hard drawn copper wire will not respond to its natural elasticity after being loaded for a few hours, and that the elasticity has been killed, so to speak, or the wire fatigued and its natural elasticity disappears.

I erected on May 7 last a new No. 9 B. & S. hard drawn copper wire, between fixed supports, 124 feet one inch apart, with a sag of four inches, which equaled a horizontal stress of about 231 pounds, or roughly one-third of the breaking strain of the wire. The temperature at the time was sixty-five degrees Fahrenheit. On July 10, temperature 102 degrees Fahrenheit, the sag was eleven and one-eighth inches, and later in the day, at ninety-three degrees Fahrenheit, the sag was nine and three-eighths inches. On August 6, at a temperature of sixty-five degrees Fahrenheit, the same as when the wire was erected, it showed a sag of nine inches, or five inches in excess of the sag that was given it when first put up.

A new hard drawn copper wire has a natural elasticity which permits it to elongate a very trifling amount (about one-tenth of one per cent), when under not exceeding two-thirds of its normal breaking strain for a short period of time, but when the strain upon the wire, or the period of time increases, then the wire permanently elongates.

When a short piece of the wire has been placed under stress to the limit of its breaking strain, of about 670 pounds, for a No. 9 B. & S. gauge, it breaks, and the two pieces measured will be found to have sustained a permanent elongation which, according to the temper of the wire, generally ranges between one and two per cent, and a piece of the wire, 150 feet long, when subjected to a strain of 670 pounds, at the same rate of elongation, would stretch from eighteen to thirty-six inches before breaking.

If such an elongation were possible to take place between telegraph poles, it would allow the wire a sag of nine feet or over.

Hard drawn copper may be permanently elongated nearly up to its maximum limit of elongation, and it will require as much strain to break such a piece of permanently elongated wire as if it had never been stretched.

What actually happens therefore seems to be this: Suppose a wire, when new, is given a sag of nearly seven and three-quarter inches, between poles 150 feet apart, at eighty degrees Fahrenheit, the wire then has a stress of about one-quarter of its breaking strain and the length of the wire is 150.0072 feet.

Should the temperature fall sufficiently, this wire will contract so that it will be subjected to a very heavy strain which will cause it to elongate unless the wire contains weak spots or kinks or places that have been slightly abraded or indented at the tie wires, in which case the wire will break at such weak points.

When this is the case the weak spots in the wire will, of course, prevent it from becoming permanently elongated beyond what it naturally elongates upon the poles as demonstrated by Mr. Gavey.

Should the wire have no unusual weak spots it will elongate sufficiently to prevent the stress in the wire raising to its breaking point.

It is evident that if linemen were to adopt the practice of taking up the sags by cutting out pieces of wire, that the time would soon arrive when the wire had stretched to the limits of its natural elongation and would break under the first stress imposed by low temperature or other cause.

[1] Abstract from *Telegraph Age*, November 1.

The Automobile Industry in Great Britain.

Mr. S. F. Edge, who is well posted in automobile matters, is authority for the statement that Great Britain is the largest market in the world for automobiles, and that the greater part of those in use there have been imported from the Continent. Last year 3,500 cars, to the value of $5,230,000, were imported, and this year the figures have risen to 5,330 cars, valued at $8,000,000. Mr. Edge points out that the raw material of the motor cars is of inconsiderable value, and that the greater part of the expense goes in wages. The British makers are sparing no effort to compete successfully with the foreign makers, and there are now in England a number of firms who are placing on the market cars of great practical utility and efficiency.

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STATION ECONOMY AND MANAGEMENT.

A SYMPOSIUM OF IDEAS FROM PRACTICAL MEN.

At the recent meeting of the Ohio Electric Light Association, the question of station economy and practice was given considerable thought. The following communications are by the men who have had an active experience in this special field.

STEAM RECORDS.

BY GEORGE HAYLER, JR., VAN WERT GAS, ELECTRIC AND POWER COMPANY, VAN WERT, OHIO.

Every central station has some system of records, in some cases perhaps crude and in others extremely elaborate, yet serving each in its way to cover the daily operation of the plant, with the object in view of keeping track of the cost of production.

Much time and effort have been expended by the engineering departments of the larger electric companies in developing systems of records, covering the physical operation of their respective plants, and thanks to the interest displayed at electrical conventions by the various members and through the explanation of their views and methods these systems have become in a measure uniform, and it is altogether likely that they will be found pretty much the same among the larger stations all over the United States. It is entirely due to the intelligent study of these records and the application of the knowledge derived therefrom that the cost of producing electric energy has reached the almost incredibly low figure quoted by some of the larger central stations.

With the smaller companies, however, this is different, and among the personnel of the average station the question of keeping records is the least of their troubles. This is not as it should be, and although it is impractical and perhaps utterly useless to attempt to keep an elaborate system of station records in a small plant, yet there are some items of expense which must be kept closely in mind, and to do this intelligently a systematic and accurate record of each day's operation must be made.

The cost of operating a steam plant may be roughly divided as follows:

Fuel.
Labor.
Water.
Oil and Waste.
Repairs.
Sundries.

Of all these items fuel is perhaps the greatest and receives the least attention. The management of a small station is usually niggardly in the matter of wages, and a five-dollar raise in the salary of a fireman is an event of some importance and worthy of the attention of the board of directors; yet this same man handles coal monthly perhaps to the value of from five to ten times his salary, and five dollars worth more or less would be something too trivial to take notice of and in most stations impossible of detection.

The amount of money expended for fuel each month is dependent upon a number of considerations, and in order that a close check may be kept on this one great item of the cost of production, a system of records, consistent with the size of the steam plant, should be maintained.

The efficiency of the steam engine depends very largely upon its proper adjustment for the work to be performed and the steadiness with which it is supplied with dry steam. Indicator cards should be taken from time to time, to make certain that the valves are tight and properly adjusted. This is a comparatively simple matter and will often bring to light the cause for an excessive use of steam. Of course in large plants this is done periodically, but many smaller stations never owned an indicator, and would not know how to use it if they had it.

A record should be kept of the steam pressures, either with a recording steam gauge or by entries on the daily log. It is well to have several gauges located in different parts of the plant, so that they may be easily seen by both the engineers and firemen. The steam pressure should be varied according to the load on the engine. This is especially true in small plants, where it is impossible to divide the load among a number of units.

Records should be made of the time of stopping and starting engines; the number of hours run by each and these figures compared with the electric load curve for the same period of time. It will be found perhaps that too many engines are being run for the work performed, and every hour an engine runs unnecessarily is so much loss.

By a little study of the load curves it will perhaps be found that on certain nights the load is greater, and these changes will happen almost periodically for months at a time. If the engineering force is advised of this so that they may know what to expect in the way of a load, it will save firing boilers unnecessarily and leave engines standing idle that might otherwise be put into service when not needed. I have noticed in some large isolated plants large blackboards in the engine room on which are posted each day an extra lighting that will have to be taken care of. This is a great help, and will save money and annoying temporary overloads.

Boiler efficiency is influenced by a multitude of conditions, and it is here that the most serious leakage in the express account is to be met with. The most serious sources of waste in the fire room are:

Improper methods of firing.
Firing too many boilers for the load.
Coal that is too expensive for the work demanded from it.
Dirty boilers.
Cold feed water.
Leaks.

The average fireman has two objects in view; one to keep a sufficient head of steam, and the other to keep plenty of water in his gauge glasses. The idea that he is burning money, and lots of it, never enters his mind. He does his work in the easiest way possible, and the company pays the bills.

There are as many different ways of firing as there are firemen, but there is only one way suited to each individual steam plant. Some of the larger stations keep track of the individual performance of their firemen by the aid of various records and devices, and among the latter a system of testing the composition of flue gases from each boiler breeching is both interesting and valuable, and, where the expense will warrant its use, an almost certain method of detecting waste. It is impractical, however, for small plants, and the only recourse is by a study of records, to determine on the best method of handling the grade of coal being used, and then instructing the firemen accordingly.

In a lighting plant where the load is likely to vary rapidly there is a tendency to keep more boilers in service than are necessary. This is largely due to an effort on the part of the firemen to make their work an easy task, and the result is that for a large share of the time the grates are bare and a considerable column of air simply passes through the furnace and flues absorbing heat and wasting fuel at a tremendous rate. This is something which should be watched carefully, and it can only be done by keeping a record of the boilers in service, the hours run by each and then making an intelligent comparison with the station load curve for the same period.

Burning coal of a grade too good for the work demanded of it is another source of waste. The cheapest coal is the one which supplies the greatest amount of heat

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units for the least amount of money, and not the one that will make the least amount of work for the firemen. Coal should be tested to discover which grades are cheaper. Because one station burns a certain grade of coal economically is no reason why the same should hold good in another plant operating under different conditions. The cost of coal depends largely on the freight rate, and since it costs no more to haul a ton of good coal than a ton of slack, there may be a dividing line beyond which it would pay to use the better grades although they cost more money per ton. There is only one way of determining this, however, and it is to make careful comparison of the amount of work done by each coal in a specified time. The chances are that the engineering force will be prejudiced against the use of cheaper grades of fuel, but it is not wise to rely too much on their opinion of the heating value of a coal.

Coal should be weighed by each fireman on his run. Water should also be measured by a meter. These records should be compared, and while the results will only approximate the evaporation, they will serve as a check, and if one fireman is evaporating more water than another for a like amount of coal there is something wrong.

Boilers should be washed periodically, flues cleaned, dust removed from combustion chamber, and a record made of same both on the daily log and by chalking the date on the boiler front.

Feed-water temperatures should be kept daily and any undue variation investigated at once.

Coal can be easily weighed even in the smallest station, and if it is not done every day, it can be done for several days at a time each month and an idea thus obtained as to what is being done in the fireroom.

Water can be measured conveniently by a meter adjusted for the average temperature of the feed water. The meter can be easily checked from time to time by the aid of an ordinary barrel and a pair of scales, and a correction made for any constant error.

The number of boilers should be carefully proportioned to the load, and only enough kept in service to permit the firemen to maintain a proper head of steam by the exercise of care and attention in keeping his fires as they should be. This will prevent careless firing, and the consequent use of much unnecessary coal, both during the run and in heating up useless furnaces and boiler shells.

The problem of evenly dividing the labor of operating a station among one's engineering force is one that requires a good deal of thought and diplomacy in solving. It will be simplified greatly, however, if there are at hand records showing the number of hours worked by each man, the amount of coal handled during that period, the load on the station, etc. Men get jealous of each other, and each thinks the other has the easiest time of it. A few cold figures will do more to dispel ideas of mistreatment from their minds than whole days of arguing.

Oil and waste are no very important items in the expense account, but all the oil which is used goes somewhere, most likely onto the floor and belts, and it is well to cut the quantity used as much as is possible. Just why one man needs twice the oil to do the same amount of work as another is a problem, but the trouble can perhaps be located by a careful study of the daily record. A good oil filter is an excellent investment. When I say a good one, I mean one that will do something more than strain out flies and bugs. It is surprising how the oil consumption will decrease when men find that they are being watched, and with how much more care they will save oil that has been used if they have some device for putting it into shape where it can be safely used again without danger of stopping cups and oil guides.

Packing is another small item, but when engines and pumps have to be packed too often, something is wrong. It may be the packing and it may be something else. A record will help very materially in deciding just what is best to buy.

Repairs is an item which must not be overlooked, and when repair bills on a piece of machinery commence to assume too large proportions it is well to consider something new.

To sum up; I would suggest that for a small or medium-sized plant a daily record be made up as follows:

The names of engineers and firemen on duty, the hours worked by each.

Readings of the switchboard instruments, giving approximately the load in kilowatts each hour from which a load curve may be plotted.

The number of boilers in service, and the hours run by each.

The number of engines in service, and the hours run.

The amount of coal burned by each fireman or group of firemen during a stated period. Total coal burned in twenty-four hours.

The amount of water pumped into the boilers during the same time.

The approximate evaporation figured from this data.

Steam pressure at stated intervals.

Temperature of feed water.

Temperature and weather.

Amount of cylinder oil used by each engineer.

Amount of engine oil used by each engineer.

Amount of waste and packing.

Some space should be left on report sheet for "remarks"—records of trouble and such other items as might suggest themselves from time to time.

It is very little trouble for the station force to keep a systematic record of this kind. It serves a useful purpose in that to get the data required periodical inspections must be made of one thing and another, and the engineer and firemen thus often notice things that might otherwise be neglected. A careful study of the daily sheets will prove productive of many ideas for betterment, and they are always a valuable record to look back to for the thousand and one little things that one wishes to know concerning the operation concerning the station.

DEVELOPMENT IN THE ENGINE ROOM.

BY J. H. PERKINS, YOUNGSTOWN CONSOLIDATED GAS AND ELECTRIC COMPANY, YOUNGSTOWN, OHIO.

This brief outline of our efforts toward more reliable and more economical operation is not given as showing methods which will apply to all plants, but rather to show what has been accomplished, and to create a discussion whereby we may derive some benefit. I also realize that some of these features are a matter of history to some of the larger companies, but the Youngstown plant being of average size may serve the purpose referred to.

Our present engine room equipment consists of one 350, one 400, two 600 and one 1,000-kilowatt, 2,200-volt, sixty-cycle, two-phase, direct-connected units; four being operated by horizontal, cross-compound, non-condensing engines, and one by a vertical compound engine.

These units are furnished exciting current by two thirty-seven and one-half kilowatt and one seventy-five-kilowatt, 125-volt, engine-type generators, direct-connected to Westinghouse compound engines; two seventy-five-kilowatt, 550-volt, rotary transformers for direct-current motor service.

We have discarded all belt machines and all generators of any kind other than the two-phase alternating-current type.

The remaining commercial series, are light machines have been thrown out and

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constant potential alternating-current arc lamps on meter take the place of the series lamps.

The direct-current series, open-arc street-lighting machines have been replaced by constant-current alternating apparatus.

All possible direct-current power service has been changed by the use of single and two-phase motors, the remaining 500-volt, direct-current service being furnished by rotary transformers that the prime movers may all be of the same type.

The switchboard has seen many changes, but more in the way of detail. All open-type knife or plug switches on high potential have been replaced by oil switches. All fuses on exciters and generators are being discarded. The lighting circuits are being provided with circuit-breakers, and the alternating-current side of railway circuits with fuses.

Recording wattmeters have been provided for all of the generators in addition to those already on the different kinds of service.

Power-factor meters have been added to the generator panels in order that there may be as little cross current as possible between generators running in parallel, and that we may know the character of our load, not only of different kinds, but at different times of the day.

A voltage regulator has been added for reasons as stated later, and although this is not in actual operation, we are expecting good results.

All machines are provided with oil from a gravity feed and pump-return oiling system, and oil cups are not used except where absolutely necessary. This has resulted in more satisfactory oiling at a considerable saving.

Monthly indicator cards are taken of all engines, and cards filed for record, it being our intention to stop any irregularities as soon as possible after they occur.

One of the first difficulties which faced us in this change was parallel operation of the units on alternating current.

As indicated in a previous paper, we had no trouble with belted machines, but considerable trouble with the first direct-connected machine; not when operating with the belted units, but in trying to operate rotary transformers or in trying to operate in parallel with the next direct-connected machine.

We found that the trouble did not lie in the flywheel nor in the variation of effect in the up-and-down stroke of this engine, contrary to our opinion at that time. A good share of the trouble was found in the rotary transformer, and we also found a dash-pot on the governor of the engine was a cure for almost any trouble in parallel operation. The trouble in the rotaries was easily remedied. All of our engines have been equipped with dash-pots on the governors, and we have no trouble as long as these are in good condition. Any engine in the plant will pump and cause all kinds of disturbance if the dash-pots are out of order, and some of them would not work an instant in parallel without a dash-pot. We think it would be very much more difficult to get the same results by the use of heavier fly-wheels.

In the matter of engine regulation, we have decided on about three per cent as the best that can be had, and have good, reliable, parallel operation. Some of the manufacturers say that this should be fully four per cent, but you may make it as fine as you please so long as you are able to take all the kinks out of the governor by dash-pots or otherwise, in order to cause smooth rotation or regular angular velocity.

In the changes referred to we have taken a backward step in only one feature, "voltage regulation," and this seems unavoidable and was anticipated. The main cause has been the greater increase of railway load as compared with lighting. With fifty per cent lighting and fifty per cent railway the service will be entirely satisfactory when operated from the same machines; but if railway load is added in greater proportions the effect will become noticeable, especially if the machines are overloaded. To overcome this, at times when it seems desirable to operate both light and power together, we are installing a voltage regulator of the latest type.

It is safe to say, however, that we at all times get a regulation which should be impossible under the same conditions of load and manner of running on any other systems, except by the use of a storage battery of ample size.

During the time referred to, in this change, 1900, to date, the lighting output has increased 142 per cent. The railway output about 800 per cent. The power-motor output about 200 per cent, and the total output about 440 per cent. Our load-factor has increased from about twenty-five per cent to fifty per cent, and when you consider the earning power of these two conditions it is marvelous.

We have not had a single shutdown, due to the engine room.

The economy in the engine room has increased to a wonderful degree, not only by improving the load curve and by reason of the large output, but by reason of the change in the type of apparatus.

The greater part of the saving has been made in labor and maintenance charges, and we expect to improve further on steam economy.

For an increase of 225 per cent in capacity, we have increased the engine room labor required only fifty-seven per cent. There has been a decided saving in maintenance of electrical apparatus, this account having dropped to almost nothing.

THE VALUE OF STATION RECORDS.

BY A. C. BLINN, SANDUSKY.

It is not the purpose of this paper to go into the details of forms and systems of station records, but to more fully demonstrate (especially to the managers of small stations) the value and vast importance of carefully keeping station statistics. I do not believe that too much weight can be attached to the value of a complete record of each twenty-four hours' operation of your station, regardless of how small it may be. The size of the plant should not enter into the question, as these reports are as valuable to one as to another. To the managers of large central stations, the value of carefully making station records for immediate use, and filing them for future use, is very evident and is demonstrated by the fact that as a rule in stations of even moderate size this work is given very careful attention and it has grown to be an important factor in the skilful operation of modern plants. The attitude of managers of small central stations toward the installation of a station record system is perhaps more or less adverse owing to the fact that the opinion prevails that an enormous amount of red tape will be required, from which little or no benefit will be derived. What station manager is so proficient as to be able to estimate the worth of a system of this kind, especially when it has not been in use? Occasionally we hear the remark, that it will make more work for station employés, and make them dissatisfied, etc. This is decidedly the wrong opinion for several reasons, first, because a certain amount of system is good for any employé; further, an employé who is energetic and ambitious, and who will carefully study station records from day to day, will not only benefit himself but also his employers, and that to a very large degree. It must be understood that this paper refers to complete records and not to mere notes showing output in amperes every hour, and at what time arc circuits and machines were started, etc. The station manager or su-

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perintendent who carefully examines his station records each day, will become exceedingly familiar with the detailed operation of his plant. It is probably the only way in which to work intelligently toward broadening the peak; little loop holes in the consumption of coal, oil and other manufacturing supplies can be discovered, where small economies can be practised, which at the end of the year will make a very material showing in our balance-sheet. The managers of large stations have realized this fact for several years, and while the practice of carefully keeping station records is becoming more general with the managers of small stations, the system has not reached that point of perfection that it should. In a measure this can be accounted for by the opinion "that our station is not large enough" or "our output is too small" or "that we can not have so much system," etc. These and many other excuses are insignificant compared to the value received, not only in a financial way but in the matter of service to consumers, which is a vital point recognized by all. Let us view this matter from another standpoint, let us assume that your company has opened negotiations for the sale of its property, the prospective buyer ordinarily will send his engineer to make a report on the condition of affairs as he finds them. After examining the ledger accounts and the physical condition of the plant he will naturally ask to see your station records for as long a period as possible, and if your plant has had a normal growth and been properly managed, these records will be of great value, not only to the company but in estimating the ability of the manager. On the other hand, if the records are lacking, the prospective buyer will at once underestimate the value of the plant, but will probably not underestimate the value of the manager, and he will have good grounds upon which to base his conclusion. One of the greatest difficulties experienced in the installation of a thorough system of this kind lies in the fact that employés to whom the keeping of these records is assigned will, without close attention, become careless, which is probably caused by the fact that they are not able to fully understand and appreciate the value of such reports. It is utterly useless to inaugurate a system of this kind and not have it kept up as carefully one day as the next. After an employé once oversteps the line without a reprimand, and a severe one, his value so far as keeping station records is concerned is reduced fifty per cent. Employés should be educated if necessary and made to understand that the manager depends on the station records, and must have them accurately kept. They should be taught to understand that the keeping of station records is as important as keeping the general books, which is indeed the case. From the station records we determine our loss from generator to consumer, which is a highly important point that should be carefully watched by every manager of electrical properties. Without the record we are in the dark absolutely as to what we are doing. You may say to your engineer that he has used more coal this month than during the same period last year; invariably his reply will be that the load has been greater. Without a station record it is hardly possible to refute his argument, and the same rule applies to other branches of the manufacturing department. In this department our cost originates, and here is where we should apply economy in every sense of the word, which is not possible without complete knowledge, and such knowledge can not be had without complete station records. The cost of the installation of a complete system is not large and when compared to the benefits derived is, practically speaking, much less than nothing; these benefits, of course, can only be determined by practice, and it is a matter that rests entirely with the manager as to whether he will, or will not, be benefited. It must not be expected that any great value can be derived from station records if they are not watched from day to day and comparisons made with the work done, one, two or three years previous, when you are able to make such comparisons you will find them intensely interesting and a great help in future additions and betterments.

ENGINE ECONOMY AND EQUIPMENT.

BY E. J. BECHTEL, TOLEDO RAILWAYS COMPANY, TOLEDO, OHIO.

Steam engineering dates back into ancient history, but for the purpose of discussion before this convention the early records or data are of very little value.

The earliest steam engine was of the turbine type, but was not used extensively, being displaced by the reciprocating engine, which has had almost a clear field until the present time, and upon which many important changes have been made, especially in the valve gear, governing mechanism, etc., to bring it up to the present standard of efficiency. These changes, however, have had a tendency to complicate the mechanism, making constant expert attention essential.

At present there are two or three types of steam turbines on the American market which appear to be very attractive from a central station standpoint, from the fact that they give at least as good economy, are much more simple, require less attendance and maintenance and occupy a very much smaller space than any type of reciprocating engine of the same capacity; and last, but not least, they can be purchased at a less first cost. The high speeds of these turbines have limited their capacity to 500 kilowatts per unit for direct current, but can be built for almost any capacity for alternating current.

Gas engines have only had a place of minor importance, being handicapped on account of size, unreliability and other conditions, which make them undesirable as a commercial product. However, improvements have also been made in the gas engine, and it is hard to predict what the future will bring forth in the line of gas engines and gas turbines. Gas engines are at present in use up to 2,000 horse-power, for purposes other than central station work, but under circumstances favorable to them, which do not represent ordinary commercial conditions.

In designing the engine equipment for a central station all sides of the problem must be considered. It is neither the engine having the best steam economy on the one extreme, nor the engine having the least first cost on the other extreme, which is to be considered the most efficient; but it is the engine which is best adapted to operate under local conditions as they exist, or under conditions which can be brought about. In other words, all conditions, including interest on investment, etc., should be carefully studied before deciding upon the proper equipment, as upon the combination of all conditions depends the advisability of using high-pressure steam, superheated steam, vertical or horizontal, simple or compound, condensing or non-condensing, high or low-speed engines, size of units, with or without steam jackets, reheating coils, superheaters and various other appliances which tend to change the conditions of economy.

The economy of the central station does not depend entirely upon the design of the equipment, but also upon the operating force, which can in a great many cases lessen the efficiency of a well-designed station, or increase the efficiency of a poorly designed one by their method of operation. Thus the importance of carefully selecting an operating force which will give maximum results with the

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least cost is apparent. The force should be carefully made up of men capable of promotion with the knowledge that a defined line of promotion is before them, depending upon their ability and time of service, without any show of favoritism. In this way only will we be able to get the proper grade of help to begin at the bottom and at a salary in proportion to the position.

ELECTRICAL DISTRIBUTION IN THE ENGINE ROOM.

BY W. F. RABEH, MANSFIELD ELECTRIC LIGHT AND POWER COMPANY, MANSFIELD, OHIO.

In a small plant like our own where it is desired to furnish several different classes of service from the same prime movers the distribution of your generating units and the arrangement of your switchboard, so you can cut in and out the various machines and circuits in accordance with the demand upon the plant, means no small amount of manipulation, especially where the units are all small, as is mostly the case, and where the capacity of your plant can only be increased out of the earnings of the plant, and where this is not possible the superintendent or manager is obliged to accept appropriations dealt out to him in "homeopathic doses."

In the earlier days of the business when direct-connected units, yes, even direct-belted units, came in "large packages" for the average central station, we were obliged to fall back on the line shaft and counter shaft to properly distribute the equipment so as to give the maximum power with the greatest flexibility possible, the latter being the most important of the two. While we admit that this only increased one feature of your plant at the expense of another.

The company with which I am connected has gone through a number of these distressing changes, each time to find our apparatus loaded beyond the limit on both our light and power circuits. As a matter of history I might add that we were the first combined light and railway plant in the state.

Only a few years ago we found it necessary to install a new engine to accommodate the usual increase in our light department, as well as supply power to an interurban railway operating four large, high-speed cars. To utilize our old generators of both direct current and alternating current and by adding one of each we found by properly distributing them we could take care of all classes of service with an equal amount of reserve and without going to the expense of duplicating our plant throughout.

Our outfit now consists of three engines, four direct-current, one two-phase and two single-phase generators. To carry our maximum load would require two direct-current and two alternating-current machines, leaving one of each for reserve. Without going into details, these machines with one exception were belted to a single shaft, with clutch and quill pulleys driven by two of the largest engines belted to the same shaft. By a special combination of quill and clutch pulleys we could operate either or both engines on any or all generators.

To take care of the fluctuations in speed of engines due to heavy pull on street railway or power circuit, we installed on each of the single-phase machines a Chapman voltage regulator. These regulators regulate very closely, and for conditions similar to ours too much can not be said in behalf of this part of the installation. Of course, there is a slight change in the periodicity of the alternating-current machines due to rise and fall of the speed of the engine, but not enough to seriously affect the operation of small induction motors and multiple arc lamps.

This method of distribution we do not attempt to hold up to you as the ideal one from an economical standpoint. But with the multiplicity of units which we had and the classes of service we were called upon to give, flexibility and reliability of the service were of the greatest importance in our case.

It is of equal importance to have your switchboard as simple and flexible as possible where you depend upon the regular engineer to do his own switching. In order to keep the engineer from throwing the machines together and burning up everything on the board except the toggle bolts that hold it to the wall, we designed a board so that any of our station attendants could operate it with perfect safety.

Our direct-current board is equipped with a double set of bus-rods and with double-throw switches with an individual circuit-breaker on each outgoing circuit and on each generator in the usual manner.

For our alternating-current board we have four pairs of bus-rods, one for each machine. For each outgoing circuit we have a special revolving four-pole switch which makes it impossible for the operator to throw any two machines together, thus avoiding a great deal of trouble that we used to experience on our old layout.

One who has been connected with the light and power business for ten or fifteen years can see very little of a permanent nature in the engine room, especially in the electrical equipment. Even to the present day we speculate as to the time when the steam turbine outfit will supplant the present direct-connected units.

After summing up the business for another year we find ourselves again confronted with applications for power at a low rate, and it is up to us to serve them at a small profit or open the field and invite competition.

In order to settle the question of municipal ownership for the next ten years we, for the first time in the history of the company, bid on the city lighting and were successful, for which provision must be made in our engine room for another class of service after April 1, 1904.

We have now gone the limit on small machines and we feel we can, by the proper distribution of new generators, serve all classes of customers, including our new city contract, without the use of any shafting and only a minimum amount of belting.

We propose to install a three-phase generator of proper size, direct-belted to each of our Corliss engines, and take from these power for all classes of lighting and small power motors, and install rotary converters for our direct-current power customers and for railway purposes. Also to install a storage battery to float on the railway and power circuits, thus work our engines at an economical point, and depend upon the battery to take care of the peak loads and the fluctuations in speed of our engines, eliminating the use of separate regulators on our lighting circuits.

This far we can go with our present engines, but we must also provide reserve capacity, which we propose to do by installing a steam turbine of ample capacity. It is intended to run this turbine regularly and use our engines for reserve, and, when necessary, to carry the heavy winter peaks on the light circuits.

London Municipal Telephones.

After an expensive battle with the National Telephone Company, the Hull (England) corporation has obtained a victory on the municipal telephone question. The Local Government Board has sanctioned a loan of £43,000 for starting the municipal scheme. The scheme originated about three years ago, and over 1,000 subscribers have promised support.

From the London Electrical Times.

"Our New York contemporary the ELECTRICAL REVIEW has, without a word of warning, changed its type and turn-out in the middle of a half-yearly volume. With one exception the old was well enough, but with no exception the new is rather better. The exception was some index of contents which has long been a needed addition, and is now supplied."

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ELECTRICAL MINING NOTES.

THE AUTUMN MEETING OF THE INSTITUTION OF MINING ENGINEERS.

(Concluded.)

BY SYDNEY F. WALKER.

Another paper in which the inevitable electricity came up, and where one would hardly have expected to have found it, was in that by Mr. Francis Fox, brother of Sir Douglas Fox, past president of the Institution of Civil Engineers, describing some tunneling which had been done under his supervision in the Simplon. The tunnel will be twelve and one-quarter miles in length, and will be made at about double the speed at which the St. Gothard was made. The tunnel has been made largely with a modification of the Greathead shield which was so successful in the London "Tubes;" the modification consisting of the doing away with handling of the material at the face at all. The clay, for which the machine is used, is cut by a series of knives carried by revolving arms, which project in front of the shield, and are, in the machine employed, driven by an electric motor. The dirt which is cut away falls to the bottom of the cut, and is picked up by revolving buckets, also worked by an electric motor, and delivered at the top of the shield to a conveyor, again driven by an electric motor, by which it is carried some twenty-five feet behind the shield. The introduction of the new arrangement with its electric driving has reduced the time of cutting and fixing a ring of iron twenty inches deep, in the direction in which the tunnel is progressing, from two and one-half hours to one hour, and the labor required from thirteen men to eight. Mr. Fox stated that his great object in bringing the matter before the Institution was to call attention to the Brandt hydraulic drill, which he stated worked without making the fine dust which is so dangerous to the health of the miners employed. With the ordinary rock drill, working in the strata usually met with, the atmosphere in the neighborhood of the drill is filled with very fine particles of razor-like dust, which if inhaled brings on miner's phthisis.

A paper by the present writer on "Alternating Currents and Their Possible Application to Mining Operations"—Part 2, "How Alternating Current May Be Used in Mining Work"—was a continuation of a paper read before the Institution three years since, and a further continuation of an earlier paper read before the North of England Institution, the parent of the Institution of Mining Engineers, in the year 1884.

The present writer's experience, which extends over nearly thirty years, in connection with colliery working is that simplicity is one of the essentials of success. Another point that was made was in connection with the starting and stopping of induction motors, and their behavior when overloaded. One speaker, a colliery manager, complained that he was obliged to have a very much more powerful engine driving his three-phase generator than would otherwise be necessary in order to provide for the starting current. He had a 100-horse-power genator and a 100-horse-power induction motor, but it took 185 indicated horse-power to start the motor, and he wanted to know if this was right. He had no starting resistance. The writer's view of the matter is that it was a very wise provision, however arrived at, his having about twice the power in his engine that he needed in his motor. Another of the points which in the writer's experience goes to ensure success at collieries, is the presence of plenty of power, and plenty of strength everywhere. The engine may not work quite so efficiently in the sense that it will use a little more steam, but it will act very much more efficiently in keeping things going without breakdown, and in keeping the repairs bill low. After all efficiency should be measured, not by the steam taken, but by the actual running cost. There was also some discussion as to what current should be taken by an induction motor on starting, and at what overload it should come to rest, and if it was really a benefit its doing so. The writer's opinion is that starting current is purely a matter of construction, in the motor and its accessories, within certain limits. You must have a certain starting current, the latest claimed by the makers is one and one-quarter full load, and it may go up to almost what you like, if you do not employ any devices for reducing it. The action is very largely like that with a shunt-wound motor. If the starting current is too large you can not start at all, because you have neutralized the magnetic field on which you are depending for starting, but short of this you may have almost any value down to the minimum. The question of at what overload the motor comes to rest appears also to the writer to be one of construction. But there is this very important feature in connection with the question, the rotor will come to rest at some percentage of overload, whatever the construction may be, and the rotor, the secondary of the transformer which the induction motor forms, will not burn, though the insulation of the field coils, the coils of the stator, the primary, may burn. But this means that a three-phase motor will go on working under conditions where a continuous-current motor would have had to go to the repairing shop. If, say, a disc coal-cutting machine meets with a heavy overload, as when the coal comes down on to the disc, or when it meets with a ball of iron pyrites—the present writer has met with a case where a coal-cutting machine was taking 100 horse-power under such conditions—if the motor is using continuous currents the armature coils are burnt up almost of necessity, unless a base or cutout relieves in time, and work has to cease till a spare armature is put in. With three-phase induction motors, under similar conditions, the rotor would come to rest, and in the great majority of cases would be unharmed, while the coils of the stator, if the fuse did not blow, would have their insulation singed. But every one with any practical experience in running dynamos and motors will know that a machine will run a long time, and with perfect safety, with its magnet coils very much singed. The carbon that is formed in the extreme case is itself not a bad insulator for the pressure between coil and coil. And so the result is that when the obstruction is removed the motor can go on again, the only time lost being that taken in clearing the coal or the ball of pyrites. Discussion also took place on the question of varying speeds of induction motors. This of course is one of the points that has to be worked out, but the induction motor is no worse off than the continuous-current motor, in this matter.

The other paper on electricity was by Mr. W. Walker, who is manager of one of the Digby Colliery Company's pits in Nottinghamshire, on "Electric Coal-Cutting." The paper was a most important one, inasmuch as for the first time a colliery manager came out into the open and told his actual experiences with coal-cutting machines, and it led to other important results, as other colliery managers were induced to come out also and give their experiences. As a rule, it is difficult to get colliery managers to state their experiences, and it need hardly be said that they are of more value than the statements of the makers of the apparatus. Also the paper was unique in that for the first time in the present writer's experience, in England, a few colliery managers openly avowed a preference for the bar coal-cutting machines.

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The bar machine ought to be the best, especially for use with electric motors. It runs at from 300 to 500 revolutions per minute and can therefore be connected directly to the motor, or, at the worst, requires only a slight reducing gear, an enormous advantage over the disc machines which run at from twenty to seventy revolutions per minute. The bar also can be made to avoid many of the difficulties which the disc has to face. It will work round a nodule of pyrites, where the disc has to go through it, or pull it out. Also there is no large surface for the coal to jam as there is with the disc, if it settles down. In spite of this, the bar has not found favor. At Digby, however, it is pronounced to be the only machine which answered their purpose in a certain seam, after they had tried two disc machines. The troubles which had been met with in the bar machines, from the teeth of the gearing breaking, appear to have been completely overcome. The trouble is stated to have arisen through the use of a series-wound motor. The bar would be cutting easily in comparatively soft material, and would be brought up suddenly by coming to some hard stuff, then, on passing through the hard stuff, would race violently, the speed of the gear wheels rising instantly from 1,200 feet per minute to 3,000 feet, and this naturally led to breakages of the teeth. The series-wound motor has been replaced by a shunt-wound motor, and these troubles, it is stated, have ceased. Probably a better understanding of the machine by its makers has led to the usual results—better construction, and better arrangement all around. It should perhaps be mentioned that the Hurd machine, made by Messrs. Mavor & Coulson, of Glasgow, is the only surviving bar coal-cutting machine at present. There are a few Golden machines still at work in Staffordshire and Durham, but only the Hurd is now manufactured. An important fact which the author of the paper brought out was the use of a parallel bar, instead of a taper bar, reducing the power taken by the machine from 7.77 horse-power per square foot of area holed to 4.66 horse-power. This result, however, was questioned by another colliery manager who was also using the Hurd coal-cutting machine. Mr. Laverick, manager of Wollaton colliery, Nottinghamshire, stated that he used the parallel bar because he found a tendency with the taper bar to climb up into the coal, instead of keeping to one line. He finds that the taper bar running in the same direction with the machine climbs, while the parallel bar running in the opposite direction tends to run downward more into the dirt underlying the coal, but the parallel bar takes as much power as the other. It makes a considerable difference, as will easily be understood, to the value of the coal produced, if the cut is made in the dirt, clay, etc., underlying the coal, and not in the coal itself. Mr. Laverick also asked why the author of the paper only used a four-foot bar. Mr. Leverick used a five-foot six-inch bar, and found that it worked quite satisfactorily. The disc machines, it will be remembered, rarely make less than a five-foot cut, in Yorkshire, where they are most employed. In Scotland a three-foot and a three-foot six-inch cut are common. Mr. Laverick also stated that a Jeffrey heading machine which cost only £300 saved £200 per annum. Another point that was brought out in the paper, and in the discussion, was the fact that, according to the author of the paper and to some of the speakers, the saving in the amount of small coal which had been claimed as one of the principal advantages of machine holing, was not realized in the majority of cases because the coal had to be broken up by the pick after it had come down, in order to load it into the mine wagons; and in breaking it up considerable spall was made. The feeling among the speakers appeared to be that only from three per cent to ten per cent less slack, small coal, was obtained with machine cutting than with hand cutting—as much as thirty per cent less has been claimed. Another point upon which considerable discussion ensued and upon which considerable surprise was felt at the statements in the paper, was the number of men it was necessary to employ with the machine. With the disc machines, of all kinds, three men may be taken as the standard, one controlling the machine, whether the power be compressed air or electricity; one in front of the machine, seeing the rails placed ready for it to run on, and one behind the machine, seeing that the dirt is taken out, and passing the rails over the top of the machine to the man in front. The usual practice also with nearly every machine using rails, is to have three pairs of rails, one pair actually under the machine, one pair in front, and one pair behind. With some machines it is stated that two men only have succeeded in running, and with others four men have been necessary, but three may be taken as the average. The author of the paper found it necessary to employ six men; two road layers, one driver, one shoveling out dirt at the sleeve, one timbering and spragging, and one cleaning out the holing dirt. In addition to these, the author stated that with one machine tried, there was an electrician, and frequently his assistant. It may safely be prophesied that if this is the best that can be done with coal-cutting machines they will not easily supersede hand holing. One of the most important points in connection with coal-cutting machines is the fact that less men can be employed. Where collieries are situated in out-of-the-way places, the question of housing the colliers is often a very serious one. Large numbers of houses have to be built, and one colliery manager in the county of Durham told the writer last autumn that one of the reasons for his firm taking up coal-cutting machines was this fact, that they would have to build so many more houses if they did not.

The inevitable question of cables came up, and different colliery managers detailed their experiences. One interesting case was given where the cables were enclosed in lengths of iron pipes, in the shaft, and the pipes filled with pitch. The cables had been in several years and had given no trouble. Another point should be mentioned which came up in Mr. Walker's papers, as it is of some importance. Mr. Walker found it better not to attempt to make the bar cut its way into the coal. This has been one of the claims in favor of the bar machine, as in commencing a cut with disc machines it is necessary to make a place with the pick for the disc to enter. Some of the disc machines have arranged to get over this difficulty by pushing the disc into the coal, while revolving by means of a jack behind. The bar was arranged, in the Golden and in the Hurd, to cut its way into the coal, the bar being placed parallel with the coal face, and turning on a pivot in the machine, cutting its way till it came into a position at right angles with the machine, when it simply revolved and cut onward. Mr. Walker found that it was better to make a place for the bar to enter with the pick, as it strained the bar to cut its way in. Another point that was cleared up was the matter of the dust getting into the wheel gearing. The reciprocating motion brings a portion of the bar alternately outside the machine, and takes it back into its bearing. This portion being necessarily well oiled, took up a certain quantity of dust, which worked back into the gearing and caused considerable wear, aided as it was by stray currents of electricity. This, according to the author of the paper, has been cured.

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A Long-Distance Transmission Line —110 Miles of High-Tension Conductors.

The Washington Water Power Company, Spokane, is about to begin the commercial operation of its 110-mile transmission line, which is the longest in the Northwest. In the generating station two 2,250-kilowatt, 4,000-volt, revolving field generators, each direct-connected to a Victor turbine, operating under a head of seventy feet, have been installed. The electric machinery, including generators, transformers, switches, lightning arresters, etc., was built by the General Electric Company. The switchboards are installed on a gallery overlooking the whole power-house and all main bus-bars are in separate pottery compartments underneath the gallery. Two sets of bars allow the city service and the transmission system to be separated when necessary. All the generator switches are of the General Electric Company's form H, motor-operated, remote control type. These switches operate so promptly upon closing the relay switch on the switchboard that no difficulty is encountered in synchronizing machines. The exciter is direct-connected to a separate water-wheel without governor. A Lombard governor is installed to operate each of the larger generators; only one of these governors, however, will be used at a time, as a practically constant gate opening on one wheel will be used, allowing the governor on another wheel to regulate for the whole station.

Three water-cooled transformers (with one spare for emergencies) step the voltage from 4,000 to either 45,000 or 60,000 volts, depending upon connections, for the long-distance transmission. There are no high-tension switches other than disconnecting switches installed between the line and the transformer primaries. Lightning arresters are installed, each single-pole arrester being in a separate brick compartment extending from the lower floor of the building to the high-tension wires which are near the roof.

The line is approximately 110 miles long to the furthest power user. A portion of it runs through marshy or boggy country where considerable trouble was experienced last winter from ice forming around the pole butt and finally lifting the pole out of the hole. This difficulty was overcome by putting horizontal cross-pieces on the butts underground. The line consists of three No. 2 solid copper wires, with 60,000-volt Locke insulators and iron pins. These pins are made of about three-inch wrought iron with cast-iron shanks, for insertion in cross-arm, and lead threads.

There are six substations, each equipped with three-phase, step-down, water-cooled transformers, varying in size from 100 kilowatts to 750 kilowatts, with primary taps for 60,000 or 40,000 volts, according to line pressure. Each substation is equipped with an automatic high-tension oil switch mounted in a separate brick compartment above the panel and connected between the transformer primary and line.

The power will be used almost exclusively for mining purposes, the most notable installation being at the Standard and Hecla mines, where four General Electric 300-horse-power induction motors will be used to drive compressors, hoists, etc. One of these motors will be geared direct to a hoist. There is an aggregate of about 800 horse-power in synchronous motors and the balance in induction motors. The synchronous motors will be started direct from the line through low-voltage taps on the transformers.

The plant has already been operated for some time at 60,000 volts, but with no load at the end of the line, and no defects have been encountered. The plant will probably operate commercially within a month.

Philadelphia Branch of the American Institute of Electrical Engineers.

A meeting of the Philadelphia branch of the American Institute of Electrical Engineers was held Tuesday evening, November 10, at the Engineers' Club. A business meeting preceded the reading of the papers, during which a set of by-laws were adopted and new officers elected as follows:

Chairman, Mr. Charles E. Hewitt.

Secretary-treasurer, Mr. H. F. Sanville.

Managers: W. C. L. Eglin, Horatio A. Foster, J. Franklin Stevens, W. L. Hodges, C. W. Pike, A. J. Rowland.

Mr. C. B. Voynow, assistant engineer of the Philadelphia Rapid Transit Company, presented a paper on "A New Method of Track Laying and Bonding." The paper was instructive and interesting, describing as it did the Nichols-Voynow rail joint, which is in use throughout Philadelphia, and which is an entirely new departure from all known methods of track laying. There was a discussion in which Messrs. Pike, Hering, Hodges and Hewitt took part.

Mr. Horatio A. Foster gave to the meeting reminiscences of his experiences in the early eighties when installing and trying to operate the first electric railway in the city of Baltimore for the old Daft company. The talk was very interesting, and in the light of modern practice decidedly humorous.

Mr. Charles E. Hewitt, with the assistance of some lantern slides, showed the development of the railway motor from its beginning to the present time.

The Albert & J. M. Anderson Manufacturing Company sent for exhibition at the meeting their collection of relics of early practice in overhead construction. Some of these relics were very interesting and, placed alongside of the elaborate new devices which were also on exhibition, told better than words of the enormous development in electric traction in the last twenty years.

German Electrical Notes.

It is proposed to connect Teplitz and Klostergrab, two towns in Germany, a short distance from the Saxon frontier, by an electric railroad. As there is already an electric line from Teplitz to Eichwald, it will only be necessary to lay six kilometres of new track.

The Royal Prussian mining office at Rüderdorf in the Nieder Barnin district, province of Brandenburg, has decided to equip the potash mines of that section with electric power. A central plant will be erected to furnish the mines with power for pumping, hauling and loading, work upon which will be begun at once by two Berlin electric companies. It is expected to have the electric equipment in running order by next spring.

At the last meeting of the common council of the city of Sonneberg, Duchy of Saxe-Meiningen, a city of 13,151 inhabitants, it was decided to buy the gas-works of the Sonneberg Gas Company. To accomplish this it will be necessary to raise 600,000 marks ($142,800), which it is proposed to do by a bond issue.

The common council at Zeitz, a city of 28,000 inhabitants, in the province of Saxony, Kingdom of Prussia, has just decided to erect a municipal electric light and power plant.

Arnstadt, a city of 14,585 inhabitants, in the principality of Schwarzburg-Sondershausen, has purchased the Rudolph Levy electric plant and proposes to operate the same in conjunction with the city's gas and waterworks. To do this, however, it will be necessary to make a new bond issue of 240,900 marks ($57,120).

Many German municipalities already own their gas and waterworks and electric and power plants.

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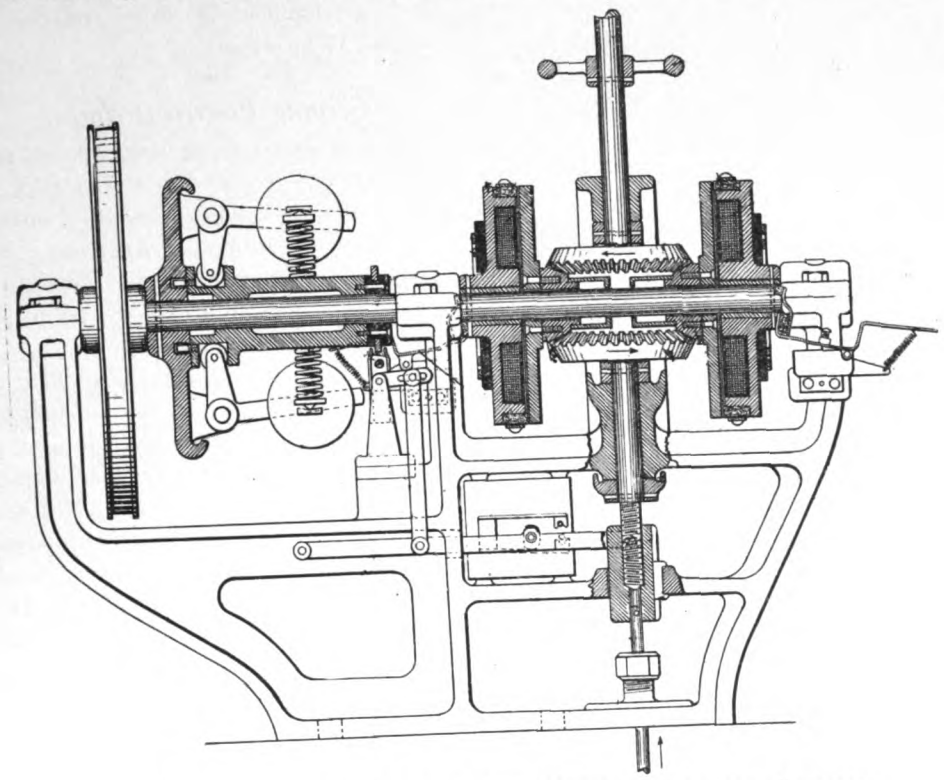
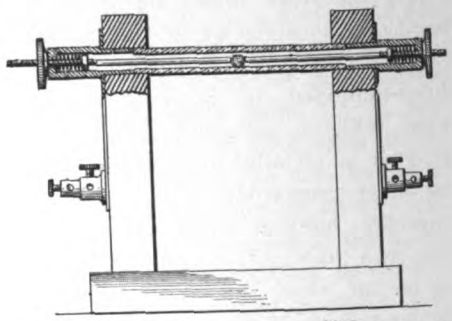
Electrical Patents.

Messrs. William L. R. Emmet and Oscar Junggren, of Schenectady, N. Y., have assigned to the General Electric Company, of New York, a patent recently obtained by them on an electric governor for turbines. In carrying out the invention they subdivide to a greater or less degree the total amount of fluid to be handled, thereby avoiding the use of unduly large parts, which have considerable inertia. On the main or bucket-wheel shaft, or connected so as to rotate in synchronism therewith, is a speed-responsive device which controls the circuit of a pair of electromagnets. A constantly running governor motor is provided, which may with advantage rotate at the same speed as the said responsive-speed device; but the invention is not limited thereto. Each of the magnets controls a clutch coil, by means of which the governor motor is operatively connected to a valve or equivalent mechanism for varying the admission of fluid to the bucket wheel or wheels. When one clutch coil is energized, the controlling valve or valves tend to decrease the supply of energy and when the other is energized to increase the supply of energy. Connection between the source of electric supply and the magnets and clutch coils is made through relatively rotating contacts, so that new contact surfaces are presented when the circuit closes and all danger from imperfect connection is prevented. With a governor of the centrifugal type there is a tendency to overcompensate for changes in load, which tendency is commonly called "hunting." This hunting causes certain variations in speed above and below that desired, which is highly objectionable. To prevent this, there is provided an "anti-hunting" device, which releases the motor after it has performed a certain amount of work and before it has had time to move the controlling valve or valves too great a distance. This releasing action takes place entirely independently of the position of the governor weights. To restate the matter in a different way, the governor weights set themselves in a definite position for a given speed, which causes a movement of the device that controls the admission of fluid to the motor through a suitable intermediary. Now instead of keeping the governor weights and the intermediary in operative connection until the desired position as to fluid delivery to the motor is established, they are disconnected shortly before this condition is reached, and the momentum of the parts is relied upon to bring the parts into the desired relation. In this way objectionable fluctuating is prevented. In order to prevent the governor motor from imparting excessive movement to the fluid-controlled mechanism in either direction, maximum and minimum stop devices are provided, which disconnect the motor when the mechanism reaches either of its extreme positions. It is found desirable to provide circuit interrupters for the pair of magnets which are acted upon by the fluid-controlling mechanism—such as a valve stem, for example—but this can be done in various ways without departing from the invention. The essential thing is to disconnect the governor motor after it has moved the controlling mechanism a certain distance in either direction from a given position and this before it can in any way injure the apparatus.



SIDE ELEVATION OF GOVERNOR AND ANTI-HUNTING DEVICE FOR TURBINES. PRACTICALLY IN SECTIONS.

A new coherer for wireless telegraphic systems has been patented by Mr. Louis Dorman, of Washington, D. C. The object is to provide a coherer which insures a continuity of action without deterioration combined with a strong and clear production of the telegraphic signals in the receiving instrument. The device, moreover, is not easily rendered ineffective by atmospheric electricity or disturbances and requires but a very slight electrical energy to make the receiver respond. It also avoids the necessity of a shaking or tapping contrivance, such as is now employed in many instances. A suitable base is employed having spaced standards rising therefrom, each of these standards being provided with a bore or opening. A glass or other tube is fitted in the openings and extends from one standard to the other. Sleeves are also fitted in the outer ends of the openings and constitute supports for threaded rods or stems that project into the tube and are urged inwardly by coiled springs surrounding them. Within the tube and between the ends of the rods is placed a globule or body of mercury of such diameter that it will move freely therein. The salient feature of the invention resides in coating the globule of mercury first with a mineral oil and then with finely-divided or powdered oxide of iron, fine metal filings, emery-dust, or finely-powdered carbon. The application of these coatings or either of them to the mercury gives to the device the power of self-restoration, thereby doing away with the necessity for a tapper or vibrating device commonly known in wireless telegraph systems. Its use results in a stronger and more distinct production of the signals



A NEW COHERER FOR WIRELESS TELEGRAPH SYSTEMS.

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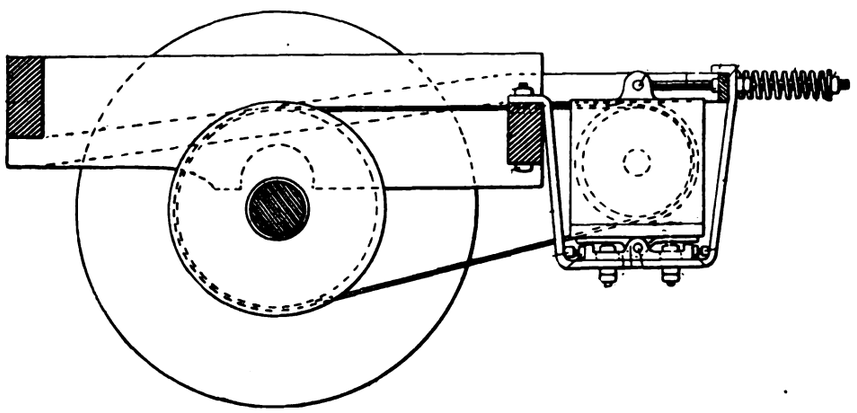
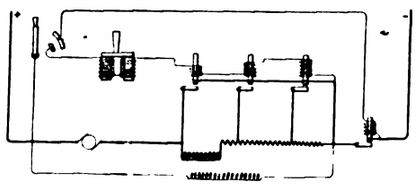
transmitted to the receiving apparatus proper and has the effect of rendering the coherer more durable and less liable to get out of order through the effects of atmospheric electricity or from other causes. It also has the effect of requiring less electrical energy for the operation of the system, which facts were ascertained by actual tests between two distant stations where similar tests had been previously made with similar apparatus without the coating on the mercury.

The Consolidated Railway Electric Lighting and Equipment Company of New Jersey has purchased a patent recently granted to Patrick Kennedy, a mechanical engineer of Brooklyn, N. Y., covering mechanism for driving dynamos on railway trucks. Heretofore it has been the practice to locate the dynamo inside of the cross-beams of the bogie truck or, as an alternative, to suspend it from the car body. Each of these has demerits which greatly impair its utility in practice. For example, when the dynamo is placed upon the truck inside of the cross-beam thereof, the driving pulley on the axle is necessarily brought closely adjacent to the pulley on the armature of the dynamo. This necessitates in its turn a very short belt from the one pulley to the other, with great liability to derangement of the belt and imperfect or uncertain transmission of power. Further, such an arrangement of the parts makes them difficult of access for inspection, repairs, removal or replacement, and as the dynamo and its accessories are bolted direct to the timbers of the truck their weight is caused to fall upon bolts, which are frequently inadequate to their permanent support under the severe usage to which railway trucks are necessarily subjected when in use. When the dynamo is suspended from the car body, the shaft of the armature of the dynamo is in the turning of curves brought to more or less of an angle to the axle on which the driving pulley is placed, in which case there is great danger of throwing the belt from the pulleys and, in any event for the time being, a material reduction in the transmission of power. The object of this last invention is to obviate these practical difficulties in the transmission of power from car axles to dynamos. To this end there is provided certain new and useful combinations of instrumentalities, whereby the dynamo can be placed outside of the cross-beams of the truck to secure the transmission of power thereto through a driving belt of increased length, whereby the apparatus is made readily accessible for examination, lubrication, etc., whereby it may be readily removed from the truck when required, and whereby it is provided and held in place upon the truck with great stability and security, these advantages resulting in a much greater degree of safety, durability and economy in working than has heretofore been attained in the class of mechanisms to which the invention relates.



MECHANISM FOR DRIVING DYNAMOS ON RAILWAY TRUCKS.

A novel controlling device for motor vehicles has been patented by Mr. Joseph Sachs, of Hartford, Ct. Heretofore it has not been safe to leave such vehicles unattended, because mischievous and curious persons have frequently tampered with the mechanism and have caused runaways and serious accidents. Drivers and motormen have also been thrown from their seats upon such vehicles, with the result that the vehicles have continued their movements and accidents have resulted; and the object of the present invention is to overcome these objections and make it nearly impossible for accidents to occur. In carrying out this idea and in addition to the devices employed for operating the motor vehicle and guiding the same, means are provided, mechanically or electrically operated, by which the vehicle can not be started until the driver or motorman occupies his seat upon the vehicle, and which devices go out of action the moment the driver or motorman leaves his position. These mechanically or electrically operated devices must be brought into action before the vehicle can be started, and the moment they go out of action are the medium for causing the vehicle to stop. Thus if a mischievous person were to start the vehicle and be unable to control it and be thrown from it, the said devices going out of action would stop the vehicle instantly and there would be no runaway, and the liability of accident would be reduced to a minimum. Likewise if the motorman should be thrown from his seat the vehicle would be caused to stop.



SHOWING SYSTEM OF MOTOR CONTROL.

Light Telegraphy.

The system of transmitting telephone messages by means of the rays of an arc lamp, which was developed by Herr Ernst Ruhmer, has been extended to the transmission of telegraph messages, in which work it is thought that it will compete with the heliograph. In the telephone system devised by Ruhmer, the sound waves of the voice are changed into electrical waves by means of the microphone, and these waves are used to vary the intensity of the current passing through an electric arc. Variation of the current caused a corresponding variation in the intensity in a ray of light which was projected to the receiving station, where it was received upon a suitable reflector, and thrown upon a selenium cell. The variations in the light received changed the resistance of the selenium cell correspondingly, and thus were made to reproduce the original sounds in a telephone receiver. In the present system the action is practically the same, except that the variations in current are caused by means of a telegraph key, instead of a telephone transmitter. In this way the Morse signals are sent out, and are received in practically the same way as in the telephone systems. It is thought that this system will be particularly useful for military purposes, where secrecy is desired, as the variations in light can not be followed by the eye or with a telescope, but can only be detected with a proper telephone receiver.

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Reviews of Current Engineering and Scientific Literature.

A Polyphase Pumping Station at Bakou, Russia.

At Bakou, on the north side of the Caspian sea, an electric power station has been erected for supplying power to the oil wells in that locality. There are 2,000 oil wells, scattered among a number of villages. These produced last year about 11,000,000 tons of oil. The central station has an output of 1,500 horse-power, and is located near the shore of the sea, so that the water might be used for condensing. There are four tubular boilers, using as a combustible the waste product from the oil refineries. The station contains two 750-horse-power engines, having each three cylinders, and each driving a three-phase alternator which generates 6,500 volts at 100 cycles per second. Each alternator has its own switchboard. The transmission line extends eleven kilometres from Bakou. At substations the voltage is lowered by transformers to 1,100 and supplied to the motors, which have an output of between thirty and fifty horse-power. This type of plant was adopted to diminish as much as possible all fire risks arising from the character of the work.—*Translated and abstracted from L'Electricien (Paris), October 24.*

An Electrolytic Drilling and Slotting Process.

Experiments have been made by Mr. Sherrard Cowper-Coles, with the object of ascertaining whether it was possible to drill and slot holes electrolytically, and at a sufficiently rapid rate to be of commercial value. Such a process would have many advantages, as holes of any shape could be drilled to templet in hardened armor plates, and could be pierced in position without drawing the temper. The process, no doubt, would also be found very useful for submarine work, as holes could be drilled using the salt water as the electrolyte, the only apparatus required being the drilling nozzle or electrode, and the insulating wire for conveying the electric current. The experiments show that, when an unprotected electrode was used, the holes were not sufficiently true. The apparatus finally constructed consists of a vulcanite cone-shaped nozzle, in which is placed a baffle plate extending almost to the tip of the nozzle. To the end of the nozzle is attached a soft rubber washer having the shape of the hole to be cut. A brass cap is attached to the back of the nozzle, and to this are attached pipes for circulating the electrolyte. The negative electrode is a rod extending nearly to the tip of the baffle plate. In operation, a heavy current is passed through from the plate to be cut to the negative electrode, and the electrolyte is kept in rapid circulation. The iron cut from the plate is deposited on the negative electrode in the form of powder, and is washed away by the rapidly circulating electrolyte. Some of the best results in drilling iron were obtained with a solution of sulphuric acid, though good results have been obtained with salt water. By modification, the machine is made suitable for slotting, as well as for drilling.—*Abstracted from the Electro-Chemist and Metallurgist (London), October.*

Heating Effects of Radium Emanation.

To settle the question whether the heat emitted by radium is directly connected with the radioactivity of that element, or independent of it, Messrs. E. Rutherford and H. T. Barnes have carried out the following experiments. The heating effects of thirty milligrammes of pure radium bromide was first measured in a differential calorimeter. The radium bromide was then heated to a sufficient temperature to drive off the emanation, which was condensed by passing through a short glass tube immersed in liquid air, and then the tubes were sealed off. In testing the deemanated radium, the heating effect diminished rapidly during the first few hours; fell to a minimum corresponding to about thirty per cent of the original value, and then slowly increased again. On substituting the emanation tube in the calorimeter, the heating effect first increased for a few hours to a maximum corresponding to about seventy per cent of the original heat emanation of the radium, and then slowly decayed with time. At any time after removal of the emanation, the sum of the heating effect of the deemanated radium and of the emanation was found to be the same as that of the original radium. There is an exact parallel between the variation in radiating power, measured by the α rays, and the heating effect. It is thus seen that the heating effect of radium directly accompanies the α radiation from it, and is always proportional to it; and that more than two-thirds of the heating effect is not due to the radium at all, but to the radioactive emanation which it produces from itself. This result accounts for the variation of heat emission with age, observed by the Curies. The amount of emanation from thirty milligrammes of radium bromide was sufficient to cause a bright phosphorescence in the tube, but it was too small either to measure or weigh. The amount of heat emitted from the radium emanation is thus enormous, compared with the amount of matter involved. The results are explained on the disintegration hypothesis, in which the heat is considered to be derived from the internal energy of the atom. If, however, as held by some, radium gains its heat from an external source, it would be necessary to suppose that less than one-third of the heat is due to the radium itself, and that the other two-thirds are due to the radium emanation which is being continually produced, and the power of which of absorbing from an external source decays with time.—*Abstracted from Nature (London), October 29.*

Treatment of Pulmonary Tuberculosis with High-Frequency Currents and Intralaryngeal Injections of Antiseptics.

High-frequency, low-potential alternating currents have been used by Dr. J. Cunningham Bowie for treating pulmonary tuberculosis, with some degree of success. He found that the passage of a current of electricity through toxins considerably modified and annulled their toxicity, and that the greater the volume of electricity used the more quickly this was accomplished. He concluded that electricity might be of value in the treatment of phthisis or other diseases where bacterial toxins had to be contended with. For this purpose an apparatus which would develop a fairly large current at a high frequency was necessary, and this apparatus should make it possible to regulate the frequency, the voltage and the current at will. An apparatus of this kind was constructed and has been used in a number of cases, the results of which he gives. Almond oil, containing iodine, thymol and other antiseptics, was used for intralaryngeal injection. The current density varied from 300 to 800 milliamperes; the voltage from fifty to seventy, and the time of application from ten to twenty minutes. The arrest of lesion was brought about by this treatment more quickly than by the use of antiseptic oils alone, and the author's experience shows that the high-frequency current promotes healing.—*Abstracted from the Lancet (London), October, 31.*

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Data for a 3,750-Kilowatt Alternator.

The following details are given for the large three-phase alternators which were constructed by Messrs. Dick, Kerr & Company, of Preston, England. One of these, rated at 3,750 kilowatts, has been constructed for the Shawinigan Falls Water Power Company. The rotor spider is of cast iron, the hub being provided with a flange for bolting to the engine flywheel. The spider is pressed on to the shaft in a hydraulic press, and afterward keyed. The laminations are fixed to the spider rim by bolts and cast-iron flanges, the laminations being dovetailed with the pole-pieces. Ventilation is secured by spacers at different positions, the number of these spacers being dependent on the width of the stator. The upper part of the pole-piece is T-shaped. The lower part is dovetailed for fitting on the rim of the rotor. To remove the field coils the pole-piece is made to slide parallel to the shaft, out from the dovetailed groove. The head of the T holds the coil in place. By shaping the pole-face distribution of flux which will produce an approximately sinusoidal-shaped wave of electromotive force is sought. The field coils are of edge-wound strip, insulated by a layer of fibrous material between adjacent turns. The external surface is left bare. The stator frame is built in two parts, the lower being provided with feet which rest upon the bed-plate. In the larger machines the end frame is a special screw for vertically and horizontally centering the stator relative to the rotating field. The winding of the stator is formed of separate coils held in slots by wooden wedges, protected outside the laminations by a perforated cast-iron shield.—*Abstracted from Engineering (London), October* 30.

Comparison Formulae for Dynamo Electric Machines.

In this article M. R. V. Picou studies critically the value of the several comparison formulæ for dynamos which have been put forward from time to time. He first shows that such formulæ have a very limited use, because while one machine may be better than another for one purpose, for any other purpose the second might be better, and the application of the formulæ must always be considered with these limitations. He then takes the expression for the output of the generator, which is equal to the product of the voltage and current. He finds the voltage of the machine in terms of the dimensions of the generator, the speed, flux, density, etc., and he deduces two expressions for the output, one for a toothed armature, and the other for a smooth core. The resulting formula is practically the same as that known as the Kapp formula. He next takes the various formulæ put forward, and introduces physical quantities in place of the usual constant, and he shows that the power is proportional to the volume of the machine, to the speed, and to the electric and magnetic densities. All formulæ which contain these quantities will have a value, but those which omit any of them can not have any value, and it is useless to insist upon the respective merits of these expressions as an empirical definition of the quantities of a machine. The following expressions, which he deduces, for the output, he thinks is somewhat better than the old Kapp formula.

For smooth core armatures, $P = \pi \alpha H \delta d l v$.

For toothed core armatures, $P = \pi \alpha \beta (1 - \beta) B \Delta h d l v$.

P is the output; α, the ratio of polar arc to polar span; H, flux density in air-gap; δ, the linear density of current in ampere-conductors per circular mils of circumference; d, diameter of armature; l, length of armature; v, linear velocity; β, ratio of tooth breadth to tooth span; B, flux density in teeth; Δ, current density referred to total slot area; h, depth of slot.—*Translated and abstracted from L'Industrie Electrique (Paris), October 25.*

A Method of Reversing Influence Machines.

When desirable to reverse the polarity of an influence machine, the usual method of procedure is to ground both terminals, give the machine a few turns in the opposite direction, then remove the grounds and start the machine normally. The effect of this operation is rather uncertain, and Herr J. R. Januszkiewicz has devised a system which is more reliable. In this one pole of the machine is connected electrically to the inducing plate for the opposite pole. The machine is then revolved in the normal direction, and if the connection then be broken, the polarity of the machine will be found to be reversed. If the machine is running at a fair speed, but a momentary connection is needed, while if it is running slowly, it may be necessary to leave the connection for ten or fifteen seconds. Care should be taken that good electrical contact be made.—*Translated and abstracted from the Physikalische Zietschrift (Leipsic), October* 15.

Heating of Railway Cars.

The Western Railway Company, of France, has been experimenting for some time with an electric system for heating its electric and steam cars. Steam heating has been used, but has been found unsatisfactory because of the difficulty of securing an effective distribution of the heat. In the electric system small heaters are placed in the floor between the seats, in such a position that the passengers place their feet upon them, each heater serving for four passengers. For the steam trains the necessary power is collected from a wire carried alongside the track. The voltage for each heater is 110, and the current is one ampere. There are ten heaters to the car. The consumption of energy is 1.1 kilowatts, and the expense is estimated at 3.3 cents per car per hour. The cars are arranged with cross doors, to prevent through drafts. The heaters are eighty centimetres long and forty centimetres wide, and the temperature of the surface is seventy degrees when the exterior temperature is zero, and seventy-five degrees when the exterior temperature is twelve. The temperature of the cars is regulated automatically.—*Translated and abstracted from the Revue de l'Électricité (Berne), October* 15.

Magnetic Experiments on Metals.

From published results of an investigation of the connection between the magnetization and mechanical deformation of ferromagnetic materials, which work has been carried on by Messrs. H. Nagaska and Honda, of Tokio, it seems that in reversible nickel-steel, such as is used for scales, on account of its small expansion, mechanical elongation in the direction of magnetization produces an increase of magnetization. The same substance stretches on being magnetized, especially when it is annealed instead of being hardened. Iron, steel, nickel and nickel-steel increase in volume by magnetization, but cobalt shows contraction. The greatest volume of change was observed in a nickel-steel containing twenty-nine per cent of nickel, in which it has in a strong field forty times that of iron. The twisting produced by the combined action of circular on longitudinal magnetization in iron, nickel and nickel-steel increases with the longitudinal field strongly, and reaches the maximum, whence it decreases gradually, as the field is further increased. The sense of twist in iron and nickel steel is opposite to that of nickel. The transient current produced by twisting a longitudinally magnetized wire, and the longitudinal magnetization caused by twisting a circularly magnetized wire, are reciprocally related to the twist produced by longitudinal and circular magnetization.

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INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

A New Enclosed Fuse.

A novel type of enclosed fuse for light and power circuits has been perfected by Edward W. Anger, Jr., of Chicago, Ill., who has made application for patents on the device. The American Electric Fuse Company has made an exclusive contract with the inventor for the manufacture and sale of this apparatus, and has placed the device in its New York, Chicago and Atlanta offices.

FIG. 1.

The new apparatus is called the "Usable Fusible fuse." It is so constructed that it will fit the standard type of fuse blocks in common use. Later on the manufacturer will fit it to a special block. The fuse consists of two parts—the operating portion, containing the fuse wire, and a holder. The fuse wire is the only part of the device which is destroyed when the fuse operates. The tube containing the fuse wire, the outer shell, with holder, and the terminals, are not affected. The holder and terminals are designed to be permanent.

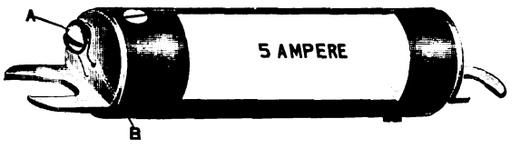

FIG. 2.

The manufacturer states that the initial cost of this fuse will be but slightly higher than the ordinary type, while there will be a decided saving in renewals. In addition to this, the fuse acts as a positive mechanical indicator, which, without exposing any part of the fuse, gives a visual signal which can be seen at a considerable distance. This indicator can be made to close an alarm circuit upon the blowing of the fuse. The renewals after the fuse is operated through an excessive current are made easily, and the design of the fuse eliminates the possibility of making a mistake with regard to the carrying capacity or the fusing point of the renewed or repaired fuse. This is one of the most important features of the apparatus.

The fuse embodies new safeguards and the redesigning of old principles, with special reference to the requirements of the underwriters' rules and specifications. It places new difficulties in the way of the improper use of fuses, and makes easier and more practicable the employment of proper protection. It is stated that the fuse has been tested by the inspectors of the National Board of Fire Underwriters and has been approved.

The indicator of the fuse, apart from the fact that it can be utilized to sound an alarm, has other features of merit. It is placed at the end of the fuse, instead of along the side, and forms no part of the fuse itself. It is operated by a spring, which is released when the fuse blows, and does not make any smoke or flash when operated.

The accompanying illustrations are of a five-ampere fuse with screw contact type of terminals. The fuse is made in any desired carrying capacity, with slight variations in construction for larger sizes, and it is also made with the spring clip type of contacts to fit the standard spring clip blocks already in use.

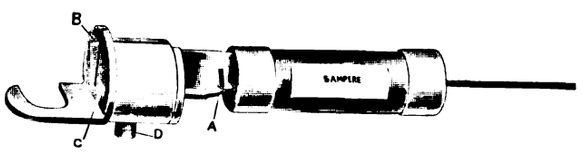

FIG. 3.

In outward appearance this fuse does not differ materially from the types of enclosed fuses in general use. The terminals, as shown in Fig. 1, are of heavy brass of the standard design for the particular size of fuse with which they are used. The fuse cover is of heavy fibre. It will be noticed that there are two distinguishing points of difference in the outward appearance of the fuse. At point A, in Fig. 1, appears a rectangular hole, and just above it a vertical slot, in the end of the fuse. At the opposite end of the fuse there also appears a screw which is not used with other types of enclosed fuses. A better view of this other, or screw end, is shown in Fig. 2 in which the terminals are reversed from the position shown in Fig. 1 and in which a wire will be seen passing through the round hole B and fastened under the head of screw A.

The purposes of these features are not evident from its outward appearance, but they are readily understood by reference to Figs. 3 and 4, where it will be seen that the fuse in reality consists of two distinct elements or parts. Fig. 3 contains all of the operating parts of the fuse, Fig. 4 being merely a cover, to one end of which is fitted one of the terminals.

FIG. 4.

Fig. 3 in its turn is composed of two separable parts, shown in Figs. 5 and 6. Fig. 6 is the fuse proper, Fig. 5 being merely a holder or terminal for one end of the fuse.

The fuse proper (Fig. 6) consists of the copper strip terminal B, the wire terminal C, a fibre tube with a metal cap at each end enclosing the fuse wire, the fuse wire itself and a fire-killing powder surrounding the fuse wire. The fuse wire is not in one piece, as is the case with other enclosed fuses, but is in two separate lengths, which parallel each other, but do not touch, in the middle of the fuse casing. One of these fuse wires is much heavier than the other, that is, it has a larger current-carrying capacity. This heavy or main fuse is made of regular fusible metal and is soldered at its ends to the terminals B and C (Fig. 6) at the point of junction between these terminals and the metal caps at each end of the fuse casing. The smaller or supplemental fuse is made of hard drawn non-stretching copper wire and is soldered at one end to the wire terminal C, inside the metal cap, and at the other end it is not soldered at all, but passes freely through a hole in

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the cap, terminating in the loop A (Fig. 6). The main and supplemental fuse are therefore in multiple or parallel with each other, and combined they have the current-carrying capacity or fusing point required in the fuse.

In order to understand the reason for this arrangement, we refer again to Fig.

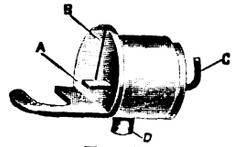

FIG. 5.

5. In this figure the slot B is adapted to receive the strip terminal B of Fig. 6. The hook C (Fig. 5) is one end of a trigger-shaped metal piece which passes through the body of Fig. 5 and terminates in the external projecting point A. This trigger is forced out of the slot in the end of the terminal (Fig. 5) by a spring located inside of the terminal head and not shown in the illustration. When strip terminal B (Fig. 6) is slipped into slot B (Fig. 5) the loop A (Fig. 6) is at the same time passed over the hook C (Fig. 5), and the whole fuse proper (Fig. 6) is drawn back until the end of strip B (Fig. 6) is flush or even with the end of the slot B (Fig. 5). Strip terminal B is then fastened in the slot B by a screw set into the terminal on the opposite side from that shown in Fig. 5, and therefore not appearing in the illustration.

When the fuse proper (Fig. 6) is drawn back preparatory to fastening the terminal B in the slot B, the trigger AC (Fig. 5) is also drawn back by the loop A (Fig. 6) until the projecting end of the trigger is even with the end of the terminal. This presents the appearance shown in Fig. 3, where the trigger appears held in place by the loop A and just flush with the end of the terminal at point C. The fastening screw holding the strip in slot B (Fig. 3), as before mentioned, is on the opposite side of the terminal, and not shown in the illustration.

The two parts (Figs. 5 and 6) having been joined as described to constitute Fig. 3, the cover (Fig. 4) is slipped over the end of the completed Fig. 3 from the right, the wire C (Fig. 6) being passed through the hole in the end of the terminal as shown at point B (Fig. 2). The holder (Fig. 4) is notched at its lower end, and after being passed over the fuse it is twisted, the projecting point D which fits into the notch (Fig. 3) then holding it firmly in place.

The fuse, in position in its block before being blown by an excessive current, presents the appearance shown in Figs. 1 and 2. After an excessive electric current has passed through the fuse and blown out the fuse wire, the indicator, which is concealed during the passage of a normal current, is released in the manner described and the projecting end gives the signal to the inspector or repairman, as stated, that the fuse has been blown; the fuse presenting the appearance shown in Fig. 7. The only difference, as will be seen, between Fig. 7 and Fig. 1 being the fact that the point A in Fig. 7 is visible, whereas in Fig. 1 it is concealed inside the terminal head, indicating that the fuse in Fig. 1 is still intact.

The inspector or repairman, noting that the fuse had been operated, removes it from the fuse block. He then releases the wire held under the screw A (Fig. 2) and pulls off the cover (Fig. 4). When the cover is removed, the operated fuse will present the appearance shown in Fig. 8, in which the trigger B is shown to have been released by the burning out of the supplemental fuse, the end loop of which held it in place under normal conditions. The projecting trigger A is forced out by the spring inside the head of the terminal. The repairman next loosens the screw which clamps the strip into place in the slot and the operated fuse is removed; a new fuse (Fig. 6) of the proper size being inserted in its place and fastened by the screw the same as the fuse which has just been removed. The cover is then slipped back into place and the wire fastened under the screw in the opposite terminal, the renewed fuse being then ready to be placed again in the block.

The fuse (Fig. 6) is furnished with the strip terminal B and the wire terminal C instead of two strip terminals or two wire terminals, in order to prevent the possibility of re-fusing the holder (Figs. 4 and 5) with either an ordinary piece of copper wire or an ordinary copper strip. While a strip would pass easily through slot B in Fig. 5, it would not pass through the hole B in Fig. 2; and conversely, while a wire could be easily placed in the hole B, Fig. 2, it could not be placed in slot B, Fig. 5. This safeguard makes it practically impossible to repair the holder without using the proper fuse designed for it. The various sizes of fuses are arranged with different sizes of holders, slots and holes for the fuse terminals. The fuses themselves or renewable parts are also made in different lengths and diameters for the different sizes. It is therefore impossible to fit a wrong fuse in any holder and the holder on any block, being correct for any particular size of fuse, it is impossible to use any larger size of fuse than the proper one. The use of ordinary bare fuse wire or strip is also absolutely prevented.

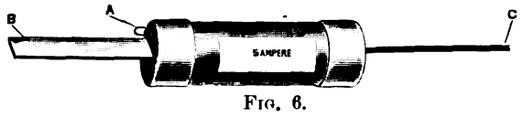

FIG. 6.

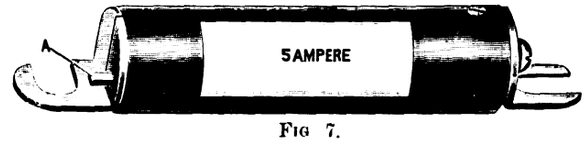

FIG 7.

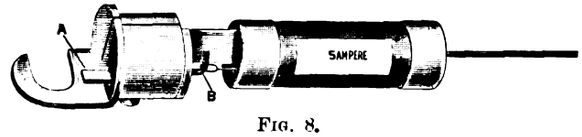

FIG. 8.

A New Form of Steel Tie.

Mr. Cortlandt De Cew, an inventor, of 173 Flatbush avenue, Brooklyn, N. Y., has devised a form of steel tie to take the place of the ordinary wooden tie, as used in both steam and street railway systems. This is a steel tie formed of spring steel, and is made partially hollow, resembling a narrow figure eight in design. The bottom portion is flanged, so that the base is about twice as wide as the upper face. The rail is held against the tie by means of lugs, which work in reciprocating bevels under the action of tie bolts. These tie bolts are inserted in slots from the upper surface of the tie. The beveled lugs are then put in place, and the lag nuts screwed down. It follows that the tighter the lag nuts are screwed, the better will be the hold made by the beveled lugs on the base of the rail.

The inventor claims that this tie will do away with fish-plates, angle irons and cross-bars, and will keep the rail from spreading, no matter how heavy the service or high the speed. The partly hollow construction of the tie, and also the flange on the base, will allow of a firm hold in the ballasting of the road, and will also keep the ties from shifting under severe conditions.

The steel tie can be used in conjunction with the wooden tie, replacing the wooden ties which have become unfit for service, and in this way eventually taking the place of all the wooden ties, at the same time rendering it unnecessary to make the complete conversion from the wooden to the steel ties.

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Slow and Moderate Speed Motors.

The slow and moderate speed multipolar motors manufactured by the General Electric Company include many of the latest improvements attained in the construction of electrical machinery.

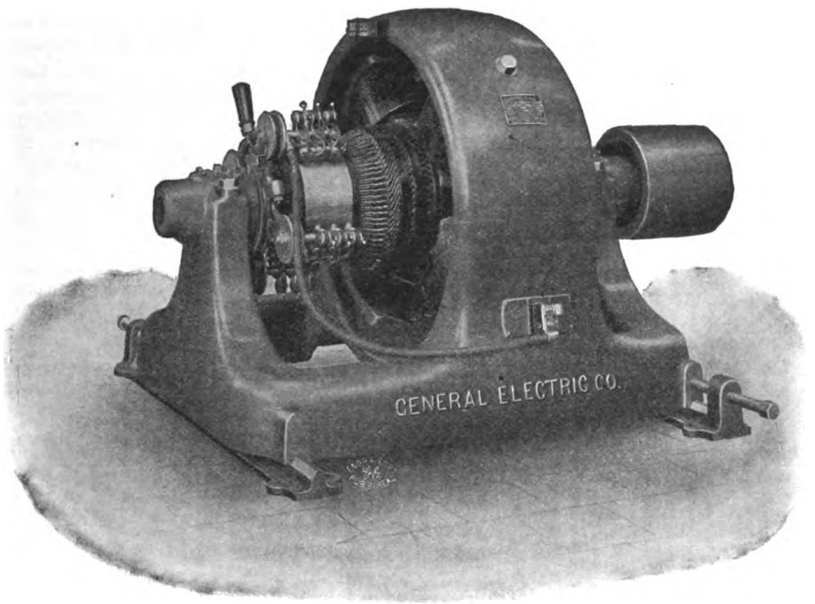

FIG. 1.—FIFTEEN-HORSE-POWER SLOW-SPEED MOTOR.

The four-pole construction is adopted. The magnetic circuits with the four-pole type are shorter and result in reduced exciting current, greater output, and higher efficiency with a given weight and speed.

The standard motors are designed to run at very slow speeds that will suit the requirements of almost all cases. The value of slow speed in machinery is generally understood, but in power motors economy warrants additional outlay to secure slow speed and the resulting diminished wear and friction losses in belt, bearings and commutator. The slow belt speed used with these motors is an advantage of importance, since it permits them to be belted directly to ordinary slow speed line shafting without intermediate counter-shafting.

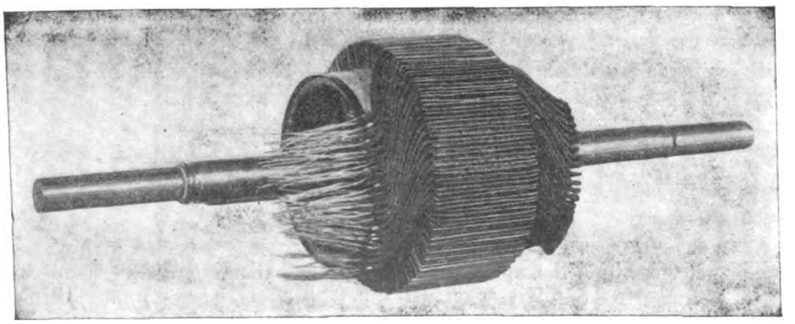

FIG. 3.—ARMATURE PARTLY WOUND.

In motors of any given design, a reduction of speed necessarily requires an increase of weight to obtain the same output and maintain equal excellence of construction. By the adoption of the four-pole type an economy of material is effected which results in a machine of large output but comparatively light weight. The frames of slow and moderate speed motors are made of the best quality of iron, and the pole-pieces of special soft steel, the combination permitting the construction of a motor very much lighter than even higher speed motors of the same output.

These motors, the manufacturer states, are so designed that practically no sparking occurs at the commutator, and changes from no load to overload can be made without shifting the brushes. The only wear upon the commutator is that due to friction, which with carbon brushes employed for all voltages and sizes is so slight as to be practically negligible.

A particular feature of these motors is the low running temperatures of all the parts, secured by so designing the motor that losses are reduced and free circulation of air provided through all moving parts.

After running continuously for ten hours at rated full load, the rise in temperature above the surrounding air will in no part of the machine exceed forty degrees centigrade with the exception of the commutator where the rise will not be more than forty-five degrees centigrade. The motor will also operate for one-half hour at twenty-five per cent overload, and withstand temporary overload of fifty per cent, without injurious heating.

The following are a few of the leading features which the maker calls attention to:

The armature coils are machine made, separately insulated and tested, and are interchangeable throughout each size and voltage of motor. They are embedded in slots in the face of the core and protected from mechanical strain or tendency to abrade the insulation.

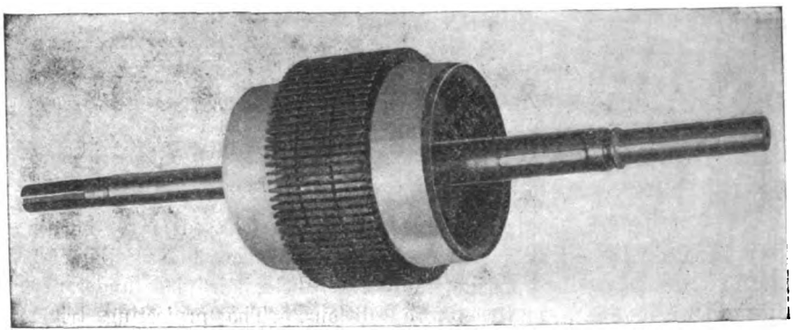

FIG. 2.—ARMATURE BODY, BEFORE COILS ARE PLACED.

The projecting flanges of the spider rigidly support the armature windings, and besides affording additional radiating surface, protect the windings from oil or mechanical injury. The commutator and brushes operate well under all conditions of load. The armature is so constructed that currents of air are constantly circulating through the core and windings, thus cooling all its parts.

The brushes are provided with a flexible conductor which is connected to the brush-holder, and allows a free movement of the brush in the holder and avoids the resistance due to imperfect contact.

The pole-pieces being separable the field coils can be removed without disturbing

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either the frame or the armature. The pillow blocks of the four-pole type are cast with the bed-plate, ensuring the proper centering of the armature in the fields. All bearings are self-aligning and automatically lubricated. The frame is divided in a horizontal plane, permitting easy access to the armature.

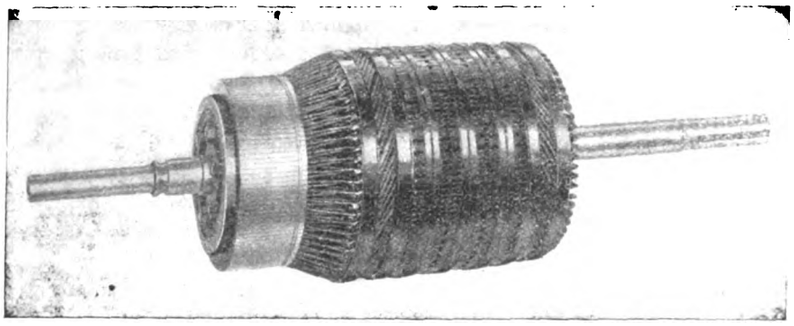

FIG. 4.—COMPLETE ARMATURE WITH COMMUTATOR.

The accompanying illustrations show an armature body before the coils are put in place, an armature partly wound and a complete armature with commutator. It will be observed that the spider castings which hold the sheet-iron laminations in place are extended at both ends of the armature. The armature coils are arranged on the surface, and form a cylindrical winding with the ends slightly tapered instead of projecting abruptly down toward the shaft, according to a construction frequently adopted. The cylindrical winding has many advantages. By its use a very large radiating surface is provided for the armature conductors, and serves to keep the armature cool. The length of wire is reduced to a minimum; consequently the losses due to armature resistance are reduced and the efficiency of the machine is increased. With the cylindrical winding, the removal or replacing of a coil is a matter of simplicity. The coils are embedded in slots punched in the armature discs and are firmly bound in place between the teeth and on the cylindrical extensions by band wires, so that no part of the armature can move or vibrate in the slightest degree. Rigidity is one of the most important advantages of the cylindrical form of armature winding, since without motion no injury or deterioration of the insulation is likely to occur. Connections between the armature and commutator are arranged to prevent the possibility of open-circuiting.

The coils are wound, insulated and tested before assembling on the armature, and any fault of construction, such as imperfect insulation causing short-circuiting of the coil, is practically impossible in the finished armature.

The insulation used is similar to that employed in the General Electric railway motor armatures. It is tough, impervious to moisture, and practically indestructible, except by very heavy overload. It has high resistance to puncture, making injury by lightning improbable.

Since the coils when placed in position on the armature are complete, the danger of abrading the insulation is reduced to a minimum. On the other hand, to wind the wire directly on the armature, as is commonly done, makes it necessary to drive each separate conductor into place, thereby running a great risk of destroying the insulation, and rendering the damage more troublesome because it is hidden.

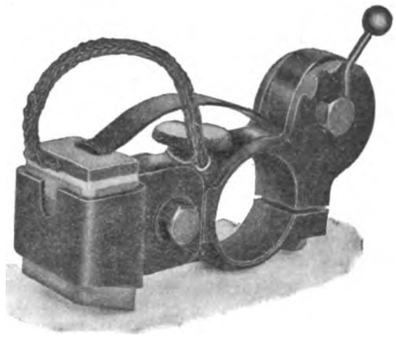

FIG. 5.—BRUSH-HOLDER.

The bearings are of the self-aligning, self-oiling type used with success in all the later General Electric machines. The bearing is so constructed that a continual supply of oil is carried from the reservoir by the revolving rings and swept by the turning of the shaft toward the centre and ends of the bearing. It is there collected and returned to the reservoir, where it has time to settle and cool. In this manner a continual circulation of oil through the bearings is automatically maintained, and the bearings require no attention beyond an occasional examination and renewal of oil.

All sizes and voltages of slow and moderate speed generators are supplied with the General Electric Company's type CS brush-holders. This holder and its attendant parts are as light as is consistent with strength, and therefore they have small inertia and will follow the commutator at any speed. The brush has perfect contact over the entire contact surface. It is so proportioned and supported that it stands firmly on its base and operates without chattering.

Uniform pressure throughout the wearing length of the brush is secured by a spiral spring having many convolutions. With this type of pressure spring, no variable friction is introduced which would tend to change the pressure on the brush after it is in actual operation. The mechanism is so designed that the brush may be removed by simply throwing a spring out of a notch.

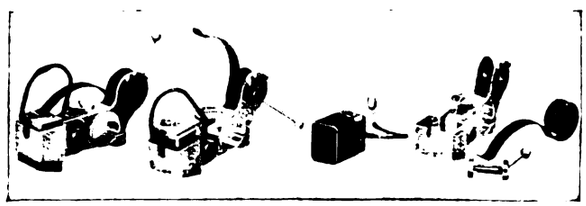

FIG. 6.—BRUSH-HOLDER AND PARTS.

Founder's Day Exercises at the Clarkson Memorial School of Technology.

The trustees and faculty of the Thomas A. Clarkson Memorial School of Technology, at Potsdam, N. Y., have issued invitations to the founder's day exercises, which will be held Monday evening, November 30, at eight o'clock. Dr. F. A. C. Perrine will deliver the address of the day.

Electric Vehicles to Handle United States Mail in Philadelphia, Pa.

The United States Government has decided to make use of electric automobiles to carry the United States mail in the city of Philadelphia, Pa. This service was inaugurated on November 1, and the tests made appear to prove conclusively that there will be a large saving, both in time and money, over horse-drawn vehicles. Second Assistant Postmaster-General W. S. Shallenberger notified Mr. George W. B. Hicks, superintendent of the Electric Vehicle Equipment Company, of Philadelphia, Pa., that the company's bid for the contract was acceptable to the United States Government. It is thought that the introduction of the electric automobiles for the mail service in Philadelphia will be the forerunner of a universal adoption of electric delivery wagons for this service.

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The Independent Telephone Association of Southern Indiana.

The fourth annual convention of the Independent Telephone Association of Southern Indiana was opened with an address by Vice-President Knoefel, in Evansville, November 10. Mayor Covert was not present to welcome the visitors to the city, and his address of welcome was read by W. E. Clarke, of the board of public works. Mr. Knoefel responded. President Kienle was absent from the convention on acount of ill health. Representatives and officials of a large number of the independent telephone companies in the territory covered by the association were present, and the meeting is said to have been one of the most successful ever held.

In his address Mayor Covert called attention to the fact that Evansville was surrounded by a network of independent lines, and that the business interests of the city demand that such connection be given it. He urged the members of the convention to take up the fight to secure the independent service in the city, and thought a concerted effort upon the part of all the members of the association would have the desired effect.

One of the principal speakers of the session was City Attorney Funkhauser, who outlined the telephone situation in Evansville and went into the details regarding the status of the city and existing company. Mr. Funkhauser's remarks were discussed by Mr. Armstrong, president of the Home Telephone Company, of Louisville, Ky., and by several other telephone men, including J. R. Tyler, of Chicago; H. Langrebe, of Huntingburgh; L. G. Davis, Salem; H. J. Cole, Owensboro, Ky.; F. E. Ebersole and T. M. Thom, Lamar, and others.

On the evening of November 10 the visitors were given a banquet which was greatly enjoyed. Mr. E. W. Pickhardt was the speaker of the evening, and he was followed by the Hon. George A. Cunningham and a number of other local and out-of-town men.

The programme for the second day included a paper by Mr. Charles D. Knoefel, of New Albany, on "Independent Long-Distance Lines," followed by discussion; and a paper by the Hon. A. J. Payton, of Rockport, on "The Bell People as Antagonists."

After general discussion and reports of committees, the following officers were elected for the year: president, Charles D. Knoefel, New Albany; vice-president, L. G. Davis, Salem; secretary, E. W. Pickhardt, Huntingburgh; treasurer, T. M. Thom, of Lamar.

Electric Railway Tests at the Louisiana Purchase Exposition.

In view of the growing importance of the electric railway interests of this country, plans are being carried into effect which contemplate a very prominent recognition of the electric railway and electric railway problems at the St. Louis Exposition. The appointment of an advisory commission on electric railway tests of the Louisiana Purchase Exposition has just been announced. The commission is thoroughly representative of each branch of electric railway activity and will, undoubtedly, receive the support of the entire electrical industry in any plans for the promotion of electric transportation which the commission shall devise.

The personnel of the commission is as follows:

Mr. J. G. White, president J. G. White & Company, New York city, chairman; Mr. H. H. Vreeland, president Interurban Street Railway, New York city; Mr. W. J. Wilgus, vice-president New York Central & Hudson River Railroad, New York city; Mr. George McCulloch, president Union Traction Company of Indiana, Indianapolis, Ind.; Mr. J. G. McGraw, president McGraw Publishing Company, New York city.

The commission will act in an advisory capacity in connection with a series of tests on electric railway apparatus to be conducted at the exposition under the auspices of the Department of Electricity.

Electric railway test tracks have been laid north of the Transportation Building on the exposition grounds, and represents a practically level clear double track, 1,400 feet in length. These tracks will connect with the intramural railroad and also the steam railway system serving the grounds. It is said that several important manufacturers have already promised complete equipments for exhibition and test, and the present outlook indicates that all of the new systems of alternating-current propulsion, as well as the old direct-current system, will be offered for inspection and operation.

It is not so much the intention to conduct these tests in a competitive sense as it is to arrange for the accumulation of data which will be valuable in promoting further electric railway undertakings from an engineering standpoint. A very complete equipment for testing apparatus will be provided.

Test of the De Forest System of Wireless Telegraphy.

It is reported that a demonstration of the De Forest system of wireless telegraphy is shortly to take place between Holyhead, Wales, and Dublin, Ireland, and that those interested in the system intend incorporating a British Empire De Forest company upon the completion of the tests.

Electrical Phenomena.

TO THE EDITOR OF THE ELECTRICAL REVIEW:

On the thirtieth of last month a four-mile, high-tension, highly insulated, underground paper cable, while in service, punctured its insulation and became disabled.

After a thorough investigation, the cause of the breakdown could not be accounted for, other than it might have been due to electrostatic surgings influenced by maximum sun spots changes which were then prevalent.

In order to substantiate the theory herein advanced, it is only necessary to learn of others who had similar breakdowns with their cables while in service and under the same conditions.

Between the hours of 6.30 A. M., October 30, and 6.30 A. M., October 31, or thereabouts, every piece of electrical apparatus or system in service throughout the world was affected by these strange phenomena. Any information on the above subject that may be gathered through your valuable paper or sent direct to the writer will obviously admit of the proper solution of the theory herein advanced.

It is announced that the sun spot changes indirectly caused the trolley system of Geneva, Switzerland, to become disabled to the extent of stopping the cars for a time during this period of disturbance.

EDWARD DURANT.

New York, November 11.

[About the end of last month or the first of November, magnetic disturbances were observed in several quarters of the world. These appear to have been coincident with the discovery of several new sun spots, and the matter of several breakdowns was attributed to electrostatic effects.—ED.]

American Street Railway Association.

The report of the twenty-second annual meeting of the American Street Railway Association, held at the Grand Union Hotel, Saratoga Springs, N. Y., September 2 to 4, has been issued. This contains a splendid report by Mr. Jere C. Hutchins, president of the Detroit United Railway Company, Detroit, Mich. The new officers of the association are: president, W. Caryl Ely, president of the International Railway Company, Buffalo, N. Y.; first vice-president, Elwin C. Foster, president New Orleans Railway Company, New Orleans, La.; second vice-president, John Grant, general superintendent St. Louis Transit Company, St. Louis, Mo.; third vice-president, James F. Shaw, general manager of the Boston & Worcester Street Railway Company, Boston, Mass.; secretary and treasurer, T. C. Penington, treasurer of the Chicago Street Railway Company, Chicago, Ill.

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Lecture before Automobile Club.

On Tuesday, November 17, Mr. Lamar Lyndon, the well-known electrical engineer and storage battery expert, delivered a lecture before the Automobile Club of America, at its headquarters, 753 Fifth avenue, New York city, upon "The Storage Battery, Its Underlying Principles, the Causes of Its Action." The lecture was illustrated with lantern slides, and many experimental demonstrations were made.

Mr. Lyndon first defined and explained the fundamental electrical units. He then described the elementary chemical actions which are involved in all batteries. The primary battery was explained and illustrated, and it was shown that the actions taking place there and in the storage battery are analogous; that the storage of energy is a chemical, and not an electrical, reaction, the storage battery differing only from the primary battery in that it is reversible and can be restored to its original condition by passing a reverse current through it. The part played by the electrolyte was fully described, showing how variations in density of the sulphuric acid will produce corresponding variations in the electromotive force.

The two types of battery were then taken up—the Faure and the Planté—and in demonstration a cell of each type was made. The lecture proved to be interesting and instructive, and was much enjoyed.

Mr. Lyndon will deliver a second lecture—a continuation of the first—on Tuesday, December 1, on "The Practical Operation, Deterioration and Management of a Storage Battery."

Telpherage.

The paper by Mr. Charles M. Clark on "Telpherage," which was read before the American Institute of Electrical Engineers, on April 25, 1902, has been reprinted by the Government Printing Office, Washington, D. C., from the Smithsonian report for 1902. This paper is a very complete description of all forms of hoisting and conveying operation in industrial service.

New York Electrical Society.

At the 238th meeting of the New York Electrical Society, which will be held at 19 West Forty-seventh street, New York city, on Monday evening, November 30, Mr. W. D'A. Ryan will lecture on "Practical Problems of Lighting and Illumination."

The Magnetic Storm.

The foreign technical papers which have just come to hand give reliable accounts of the magnetic storm which occurred the last two days of October. In England serious earth currents affected the telegraph system, currents up to sixty milliamperes being observed. This is about four times the average working current for long lines. A similar state of affairs also occurred in France and throughout the other countries. An interesting effect of the storm was that the submarine cables were but slightly affected, the greatest trouble being encountered on the short land lines. The difference in the action is explained by the fact that the submarine lines use syphon recorders and condensers, so that the effect of the storm merely shifted the zero point of the recording pen, but with the land lines, the earth currents were sufficient to hold over the relays and thus stopped communication.

Two interesting communications discussing the storm are given in the London *Electrician*, for November, one of these being from Dr. Charles Chree, superintendent of the Observatory Department at Kew. After an account of the phenomena observed, Dr. Chree says that the storm was remarkable, not merely because of the great range of the magnetic elements, but for the exceptional number of large oscillatory movements. As to the cause of magnetic storms, he thinks that there is no evidence of any connection with earthquakes or other internal troubles of the earth itself. In regard to the sun spot theory, Dr. Chree says: "As to the common cause of aurora and magnetic storms, we are still in the stage of theory. The amplitude, both of irregular and the regular diurnal changes of terrestrial magnetic force is conspicuously larger in years of sun spot maximum than in years of sun spot minimum. It is thus natural to regard the two phenomena as related, but the various attempts that have been made to associate them as cause and effect have not been very successful."

The second letter, from Sir Oliver Lodge, calls attention to the fact that Arrhenius has shown clearly how flying electrons would be deflected by the earth's magnetic field, and carried toward the poles, in such a way as to account for auroræ in a very satisfactory manner. "Furthermore," says Sir Oliver, "the known emission by radium of charged particles at excessively high velocities makes it very easy to suppose that the sun is doing the same sort of thing, though possibly not for the same sort of reason. Everything, in fact, tends to make it almost certain that the old speculations of Fitz-Gerald, as to magnetic storms being due to actual projectiles of minute size certainly, in enormous numbers, flying past the earth at great speed, is a true explanation of the observed effects."

Prophecy of Trans-Atlantic Telephony.

The following cable despatch appeared in the New York *Sun*, Sunday, November 15.

LONDON, November 14—Prophecy is dangerous, but with a full realization of its pitfalls the correspondent of *The Sun* ventures the following prediction: Within three months, probably before New Year's, direct telegraphic communication, without intermediate repeating stations, will be established for the first time between New York and London, and telegrams will be exchanged at a speed of more than four times the previous capacity of any cable.

I am tempted to go a step further and express the strong expectation that within a year it will be as feasible to converse by telephone between *The Sun* building in New York and the *The Sun's* London office as it is across Manhattan.

Perhaps it is as well to confess that it is easy to prophesy when you know. The feat of rapid communication between London and New York as a matter of fact has been greatly surpassed recently in actual practice; in other words, the problem of cheap and rapid long-distance communication has been solved, and the credit for this signal triumph of modern science belongs to England.

I am compelled to await the permission of the inventors before making more than this general announcement.

Wireless Telegraphy between France and England.

The introduction of the first regular wireless telegraph service in France is due to the initiative of the Railway Company of the West, which, together with the Brighton company, of England, will install stations at Dieppe and Newhaven. The system of Octave Rochefort will be used. The installation of the service has been confided to the Mors Society, of Paris, well known for its electrical appliances and automobiles.

Society of Chemical Industry.

The Society of Chemical Industry, New York section, announces the following programme for the session on Friday evening, November 20: opening address of the chairman, Mr. Virgil Colentz on "The More Recent Medicinal Synthetics;" address by C. Baskerville, and T. B. Foust on "Rare Earth Mordants;" address by Oskar Nagel on "Vegetable Protein."

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CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

WATER POWER PLANT FOR MEXICO—It is announced that a large water power plant is to be erected on the river Yaqui, state of Sonora, Mexico. The concession has been granted to Carlos Garza Cortina, of Mexico City. It permits the utilization of 70,000 litres of water per second.

POLICE TELEGRAPH WIRES IN BROOKLYN TO BE BURIED—The police telegraph wires serving the Borough of Brooklyn, N. Y., are to be placed underground, an appropriation of $40,000 having been made for this purpose. The work will be done under the supervision of Mr. Frank C. Mason, superintendent of police telegraphs. It is understood that a new conduit system will be installed.

SCHENECTADY RAILWAY STOCK INCREASED—Announcement is made that the Schenectady Electric Railway Company has received authority from the state railroad commission to increase its capital stock rrom $600,000 to $7,000,000. This company operates in Schenectady, Albany and Rensselaer counties. The increased capital is to be used for improvements and for the absorption of the stock of the Mohawk Gas Company, of Schenectady.

OHIO RIVER POWER—President W. Kelsey Schoepf, of the Cincinnati Traction Company, and a party of capitalists and electrical experts, recently made a trip to Louisville to ascertain how much electricity could be generated in the falls of the Ohio, and whether the amount would be sufficient to warrant its being transmitted to Cincinnati and Indianapolis. It is proposed to utilize the Ohio river falls for power for electric lighting, traction and other plants throughout the Ohio valley.

EXPERIMENTAL TRAINS IN THE NEW YORK SUBWAY—It is now expected that within a very short time an experimental train will be run in the Rapid Transit Subway, New York city, between the City Hall and 104th street, or possibly as far north as 150th street and Broadway. The regular passenger service of the underground road, it is estimated, will begin as early as March or April, 1904. The Harlem river section will not be finished until next spring, nor will the section under Washington Heights be finished before that time. The incompleteness of the power-houses may cause a delay in the opening of the road for regular passenger traffic.

NEW YORK INDEPENDENT TELEPHONE COMPANY WILL NOT BE GRANTED A FRANCHISE—Justice Clark has decided that the Independent Telephone Company can not use the subway built by the Rapid Transit Construction Company, of New York city. The decision is on the motion for a mandamus asked for by the telephone company to compel Commissioner Robert G. Monroe to issue a permit to the corporation. Justice Clark says he does not think the telephone company has proved its right to lay its wires in the subway, but as its case is the first one in which the question at issue has been raised, he denies the application, with the intimation that the point ought to be settled by an appeal to the Appellate Division.

LARGE RAILWAY DEAL—The Public Service Corporation has arranged for the purchase of all the stock of the Central Electric Company, which is located at Metuchen, N. J., and which supplies light and power to that town, besides the municipalities of New Brunswick, Perth Amboy, Rahway, Woodbridge, Raritan Township, Carteret, Bound Brook, Dunellen and South Plainfield. The Central Electric Company has a capitalization of $750,000, with an issue of bonds aggregating a like amount. The company was organized a few years ago by the consolidation of the Middlesex Electric Company, the Edison Electric Illuminating Company, the Raritan Electric Light and Power Company, the Rahway Electric Company, and the Bound Brook Electric Light and Power Company.

NEW POWER SITES ON THE SAVANNAH RIVER—The division of hydrography of the United States Geological Survey has had a party of engineers investigating the power possibilities of the Savannah river. A number of advantageous power sites has been located. Among these are the following: at Little river shoals, where the stream has a fall of four and one-half feet a mile, power can be easily developed, and the high rock bluff on the right-hand bank affords ample protection for a power-house. Scott's creek at this point would serve as a short tail-race. The river is about 2,000 feet wide. At this point it is very shallow and swift, and apparently has a good rock bed over its entire length. There is a narrow strip of bottom land above the dam site on the other side. A number of good dam sites were found on Long shoals, one about half a mile above Kilkrese Ferry. The river here is divided by Price Island, a part of which is under cultivation. A rock ledge runs across the river and gives a fall of two feet in 100; and a solid rock cliff which runs down almost to the edge of the water affords an excellent abutment, and will furnish rock in abundance for the construction of the dam. A forty-foot dam could be built here, though the abutment and local conditions seem more favorable for a fifteen-foot structure. Just above Dorden creek there is a good site for a dam, both abutments being solid rock cliffs. The river is about 1,300 feet wide, swift, shallow, and apparently has a good rock bed. The abutment on the left bank is 100 feet from the water's edge, and below it is an excellent site for a power-house, etc. A twenty-five-foot dam could be constructed at this point, but fourteen feet will develop the rest of Long shoals, and a higher dam would damage a considerable part of the bottom lands above.

ELECTRIC LIGHTING.

HARRISBURG, PA.—The Rockwood Electric Company, of Rockwood, Somerset County, has been organized with a capital of $20,000.

DES MOINES, IOWA—The Nevada Electric Light Company is seeking to have its franchise extended, and if it is successful will rebuild its system.

SANTA FE, N. M.—The Capital Light and Power Company has let the contract for the construction of the pole line from the power site on the Pecos river to Santa Fe, fourteen miles, and to Las Vegas. Ground has been cleared for the construction of the power-house, and excavations for the foundation are under way. At first only 5,000 horse-power will be developed.

BLOCMINGTON, ILL.—At a special meeting of the Normal city council an ordinance was passed providing for the transferring of the charter of the Normal Electric Light and Power Company to the Bloomington & Normal Railway, Electric and Heating Company. The company's contract with Normal is to run for five years, the company to receive $52.50 per lamp per year for the sixty or more lamps furnished by it; and the company agrees to pay the town of normal $2.50 in cash for each light provided for in the contract or hereafter installed. The above agreement is made on the condition that the Bloomington & Normal Railway and Heating Company procure an assignment to it of a franchise granted to the Normal Electric Light and Power Company, which is said to have been arranged for.

TROY, N. Y.—The work of laying the conduits for the wires to connect the power plant at Spier Falls with the Albany electric light station is progressing, and it is expected will be completed shortly. It is thought that the power will be supplied in the city by January 1. The conduit is laid as far westward from the river as possible in order to avoid damage by high water in the spring freshets. The conduits lead to the towpaths, by way of which wires are strung to Mechanicville and Spier Falls. Twelve ducts are being laid, each capable of holding twelve wires. Only six wires will be used for the present. Along the canal the wires will be carried by poles. A new building is being erected at Albany and machinery installed that will cost $40,000. This will consist of three motors, two converters and four transformers. Five thousand horse-power will be furnished as a starter. This will be gradually increased. The entire output of the Spier Falls plant, except 10,000 horse-power, which will go to Schenectady, has been contracted for by the Albany Electric Illuminating, the United Traction and the Troy Gas companies.

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PERSONAL MENTION.

MR. CAPEL HOLLAND has resigned as president and general manager of the People's Telephone Company, Morgantown, W. Va.

MR. H. H. GEARY, sales manager of the Fostoria Incandescent Lamp Company, Fostoria, Ohio, has been in New York visiting during the past week.

MR. E. M. MULLIGAN, city engineer of Warren, Ohio, has been appointed consulting engineer in charge of construction of the Cleveland & Eastern Electric Railway.

MR. WILLIAM F. DURAND, professor of marine engineering, has been appointed acting director of Sibley College, Cornell University, in place of the late Professor Thurston.

MR. J. W. CAMP, general superintendent of the Canadian Pacific Railway Telegraph Company, has been appointed electrical engineer, with jurisdiction over the entire system.

MR. D. A. SCHUTT, superintendent of the Peru Electric Manufacturing Company, Peru, Ind., for the past twelve years, has tendered his resignation, to take effect January 1.

MR. H. M. SHIPE has been appointed fellow in electrical engineering at the Toronto School of Practical Science, and Mr. Silas B. Wass has been made fellow in mechanical engineering.

MR. O. F. FRENCH, who has been acting general manager of the Cuyahoga Telephone Company, Cleveland, Ohio, since the resignation of Mr. Turner, has been made the general manager of that company.

MR. W. McL. WALBANK, formerly general manager of the Lachine Hydraulic and Land Company, Montreal, has been appointed first vice-president and chief engineer of the Montreal Light, Heat and Power Company.

DR. F. A. C. PERRINE, of the Stanley Electric Manufacturing Company, Pittsfield, Mass., will deliver the Founder's Day address, November 30, 1903, at the Thomas S. Clarkson Memorial School of Technology, Potsdam, N. Y.

MR. JACOB CLOOS, formerly technical manager of the Milwaukee Edison Company, has been appointed manager of the Milwaukee office of the Downward Light Electric Company, which will cover Wisconsin and Iowa territory.

MR. EDWARD LYNDON has resigned his connection with the Gould Storage Battery Company, of New York city, and is now engaged on technical work for his brother, Mr. Lamar Lyndon, the well-known consulting engineer, New York city.

MR. F. G. BOLLES, who has for some years been prominently connected with the Bullock Electric Manufacturing Company as manager of the advance department, has severed connections with that company to assume the management of *Cassier's Magazine.*

MR. ROBERT O. CUMBACK, for several years with the Central Railroad of New Jersey, and now located at the Elizabeth shops on special work, has accepted the position of superintendent of the new plant of the Pedrick & Ayer Company, located at Plainfield, N. J.

MR. PHILIP H. DEWITT, member of the American Society of Civil Engineers, has tendered his resignation as assistant engineer of the New York Central & Hudson River Railroad, to accept a position of consulting engineer with G. B. Markel & Company, Jeddo, Pa.

MR JAMES H. FOSTER, formerly secretary of the Evansville Gas and Electric Light Company, has been elected treasurer in the place of Mr. Henry Reis, who has resigned. The office of secretary has been combined with that of general manager, and Mr. W. B. McDonald was reelected.

MR. S. D. CUSHING, son of the late General Samuel Cushing and a graduate of Lehigh University, has been promoted to the office of electrical engineer in charge of the electric power plants and block signals of the Southern Railroad Company. Mr. Cushing's office will be in Washington, D. C.

MR. L. R. ZALLINGER, who has been appointed principal assistant engineer of the Pennsylvania Railroad at Altoona, to succeed Mr. Johnston, is a graduate of Lehigh University. Mr. Zallinger started working for the Pennsylvania Railroad in 1889 as a rodman and has been with that company ever since.

MR. P. WERNER, who has been with the Allis-Chalmers Company, at Milwaukee, for seven years as designer and in charge of some of its works, and who was for one year general superintendent of the Filer & Stowell Company, Milwaukee, has taken the position of chief engineer at T. and C. G. Bolinders, Mek. Verkstad, Stockholm, Sweden.

PROFESSOR H. S. HELE-SHAW, who holds the chair of engineering at Liverpool University, has been appointed, through the Colonial Office, to organize technical education in the Transvaal and the Orange river colony. The appointment is not a permanent one, and Professor Hele-Shaw has been granted leave of absence by the university council until September next.

MR. GEORGE F. MADDOCK, assistant professor of electrical engineering at Stanford University, Cal., has resigned his position to become superintendent of the Ide engine works at Springfield, Ill. He will be succeeded at Stanford University by William R. Echart, Jr., a graduate of Cornell. Mr. Echart has been in San Francisco engaged in central station designing and testing.

COLONEL ROSWELL EATON GOODELL died on October 21 in the city of Denver, Col. Colonel Goodell was a conspicuous figure in the railway world in the early fifties, at that time being superintendent of the Chicago & Alton Railroad. It was he who executed, on behalf of the railroad company, the first contract made with the late George M. Pullman for Pullman sleeping cars.

DR. HANS GOLDSCHMIDT, of Essen, Germany, on the evening of Friday, November 13, delivered an address, illustrated with experiments, upon alumina thermics, or the production of high temperature by burning alumina and the application of this to metallurgy and engineering. The address was given before the Columbia University Chemical Society in Havemeyer Hall, Columbia University.

MR. R. C. VAN NESS, general manager of the Lincoln (Nebraska) Gas and Electric Company, has been asked by President Edgar, of the National Electric Light Association, to report to the twenty-seventh convention of the association, to be held in Boston next May or June, on lost and unaccounted-for current. Mr. Van Ness has been giving this subject considerable study, and hopes to make a valuable and interesting report.

MR. FREDERIC L. THORNE has severed his connection with the Westinghouse Companies' Publishing Department. Mr. Thorne was originally located at Pittsburg with the company, but has recently been associated with the New York office. He will probably not make any new connection before the first of the year, but has in view several attractive propositions. Mr. Thorne has been successful not only in the technical field of literature, but also as a special writer on varied subjects.

MR. JOHN CALDER, who has been with the C. W. Hunt Company, West New Brighton, N. Y., as its executive engineer, left on Saturday, November 14, for Ilion, N. Y., where he will be connected with the management of the Remington Typewriter Company. The members and employés of the C. W. Hunt Company presented Mr. Calder with a handsome silver loving cup, suitably inscribed, Mr. George Humphrey making the presentation remarks and assuring Mr. Calder of the appreciation and esteem of his associates.

PROFESSOR SYLVANUS P. THOMPSON, F. R. S., delivered an address on Tuesday, November 3, at the Hampstead Conservatory, London, England, on wireless telegraphy. The lecturer gave a brief résumé of the history of the science, including the earlier experiments of Morse, Lindsay, Preece, Edison and Tesla. A number of interesting illustrations was shown, and the lecture concluded with the transmission of a message selected by a member of the audience, between a near-by station and the lecture room. The apparatus used on the occasion was that employed in the Lodge-Muirhead system. Dr. Thompson advocated an international agreement with regard to the reception of wireless signals, and said that there was no foundation for the newspaper talk that wireless telegraphy had been the cause of bad weather.

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ELECTRIC RAILWAYS.

COVINGTON, KY.—It is stated that a plan has been revived to build an electric railway from Ludlow to Covington, which will connect the Cincinnati Southern, the Chesapeake & Ohio, and the Louisville & Nashville.

SPRINGFIELD, ILL.—The Mississippi Valley Traction Company has been incorporated with a capital of $600,000. The principal office is to be at Moline. The object is to construct an interurban line from Moline to Geneseo, Ill.

MARION, ILL.—Officials of the Coal Belt Electric Railway system, connecting all principal towns in Williamson County, have decided to extend their line to Johnston City, six miles north, and Harrisburg, twenty-five miles east. Most of the right of way has been secured.

ST. LOUIS, MO.—Plans have been completed by the Suburban Railroad for the building of a large power-house. The building will be a one-story brick structure, 193 by 131 feet, and will cost $55,000. A permit has been issued and building operations will be started at once.

ITHACA, N. Y.—Promoters are investigating the feasibility of a proposed trolley route from Ithaca to Horseheads *via* Enfield Falls, Enfield to county line within a mile of Mecklenburg, and *via* Cayutaville, Cayuta Lake and Odessa. It is estimated the road would cost somewhere in the neighborhood of $800,000.

BANGOR, PA.—The Bangor, East Bangor & Portland Street Railway Company has purchased the plant of the Bangor Electric Light, Heat and Power Company. The trolley company intends making some alterations, after which it will extend the line from the present terminus at Portland to the Delaware Water Gap and Stroudsburg.

COLUMBUS, OHIO—Articles of consolidation have been filed with the secretary of state by the Youngstown & Southern Railway Company, and the Youngstown & Salem Railway Company. The capital stock is $1,800,000. The incorporators are A. W. Jones, John H. Ruhmann, W. H. Ruhmann, J. R. Long, W. S. Andrews and R. L. Andrews.

MORGANTOWN, W. VA.—The Fairmont, Morgantown & Cheat River Railroad Company has purchased of the Union Utility Company its trolley line on the west side of the Monongahela river. The line is two miles long and extends to Granville. The Fairmont, Morgantown & Cheat River Company declares its intention to extend the line into Fairmont at once.

MARION, IND.—Another electric line is being projected to enter Marion, Ind., and it is stated that all the right of way has been secured from Dayton to Celina, Ohio. It is intended to bring the road through Marion from Celina to Portland. From Portland the line would run direct to Hartford City, and then parallel the Panhandle from that city to Marion and then to Kokomo.

DANVILLE, ILL.—Articles of incorporation of the Hoopeston Street Railway and Light Company have been filed in the office of the county recorder. The directors of the company are James H. Dyer, John L. Hamilton, Alfred H. Trego, Charles S. Crary, J. S. McFerren and Charles A. Allen. The charter entitles the company to operate an electric street railway system in the city of Hoopeston.

LIMA, OHIO—The Cincinnati, Hamilton & Dayton Railway has started the work of converting its Findlay-Deshler line into an electric road. Previous to the acquisition of the Findlay, Ft. Wayne & Western, this line connected Findlay with the main road, but such connection is now made *via* Ottawa over the Ft. Wayne branch, and electric cars will substitute steam on the former branch.

YOUNGSTOWN, OHIO—The Salem & East Railway Company has been incorporated with a capital of $5,000. The incorporators are E. S. Cook, F. S. McGowan, A. S. Banner, J. W. Tyler and M. L. Fowler. The company proposes to build an electric line from Sebring to Salem and East Palentine, with a branch to Salem. The capital stock will be increased as soon as the preliminary survey has been made.

GREEN BAY, WIS.—The power-house and car barns of the Knox Construction Company's interurban line between Green Bay and Kaukauna will be located in this city, on the property owned by the Fox River Electric Railway and Power Company and the Buscher property adjoining, which has been purchased for the purpose. The location of the buildings here means the expenditure of over $100,000.

MYSTIC, CT.—The Groton & Stonington Street Railway Company, which is about to build a trolley line from New London to the Rhode Island state boundary at Westerly, has purchased of the Standard Machine Company the so-called Randall wharf property as the site for a power station. The dimensions of the tract are 150 by 225 feet, and the site borders on the Mystic river, whose channel, at low tide, has a depth of sixteen feet.

CADILLAC, MICH.—The Cadillac Traction Company has been organized here and has filed articles of incorporation, fixing the authorized capital at $250,000. The company will operate a street railway and electric light plant. The promoters are: President, W. J. Cornwell; vice-president, J. F. Vosberg; secretary, George S. Stanley; treasurer, Francis O. Gaffney; superintendent and general manager, J. H. Orr. Work on the roadbed will begin soon.

GEORGETOWN, DEL.—J. Stanley Gardner, of New York, who is financing the Sussex County trolley lines, has been going over the route with electricians and Major Calhoun, the engineer. It has been decided to commence work on the Lewes end of the route, and to complete the system before July 1 of next year. The route agreed upon extends from Seafoord to Georgetown, and thence to Rehoboth by way of Hollyville and Midway, connecting also at Midway and Lewes. In addition, there is to be an attractive seashore route from Lewes to Rehoboth.

ANNISTON, ALA.—It is understood here that Birmingham gentlemen will build an electric railroad from Pyriton to Lineville, a distance of seven miles. The road will give Lineville railroad facilities to the outer world, if built, as it will connect at Pyriton with the Eastern of Alabama. The Eastern Railroad has just been completed and runs from Talladega to Pyriton, a distance of about twenty-one miles. Trains were operated over the road the first of September for the first time and connections are made with the Louisville & Nashville trains of the Alabama Mineral Division.

BUFFALO, N. Y.—The actual work of extending the Buffalo & Depew trolley road from Depew to Rochester has been begun. The construction headquarters are at Pembroke, Genesee County, about half way between Depew and Batavia, and the work will be extended both east and west from that point. The line from Buffalo to Rochester will be run through Depew, Lancaster, Looneyville, Wende, Crittenden, Corfu, West Batavia, Batavia, Stafford, LeRoy, Caledonia, Mumford, Clifton and Chili to Rochester. When completed the trolley line will be sixty miles long. It is expected to be finished and in operation about two years from the present time.

GUTHRIE, OKLA.—Articles of incorporation have been signed in Oklahoma City for the Blue Island, Riverside & Hammond Street Railway Company, the home office of which will be in Oklahoma City. It is capitalized at $1,500,000. The directors are William F. Owen, August W. Miller, John F. Noel, Ira J. Owen, W. S. McCaully and Frank E. White, of Chicago; W. F. Harn, J. F. McMechan and John Throadgill, of Oklahoma City. The purpose for which the corporation is formed is to build, operate and own a line of street railway from West Pullman, Cook County, Ill., through Harvey, Phœnix, South Holland, Calumet, Thornton, Chicago Heights, Steger, Crete, Joliet, also a cross line from Blue Mound, through Calumet, Riverdale, Dalton, Thornton and West Hammond.

VINCENNES, IND.—It is stated that the Vincennes-Jasper Electric Railway will be built within a year and will cost about $1,000,000. A deal has been closed with the Cincinnati Municipal Bond and Securities Company, whereby the company takes up the securities of the road. The management will employ a Cincinnati construction company to build the road, and within ninety days proposes to have at least 500 men at work on the road-bed. There will be fifty-four miles of the road from this city to Jasper, the capital of Dubois County. Much hilly country will be traversed, especially in Harrison township, this county, after passing through Monroe City. From Monroe City the road will pass through Petersburg, Pike County, on to Jasper. The road will be the means of developing a rich section of the state. The out-of-town capitalists present were: Smiley N. Chambers, of Indianapolis; Sol Frank, F. E. Campbell and John A. Davis, of Petersburg, and E. F. Cox, of Worthington, engineer of the road.

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LEGAL NOTES.

INDUCTION MOTOR LITIGATION—In the suit of the Thomson-Houston Electric Company, complaint, *vs.* the Dayton Fan and Motor Company and E. O. Waymire, defendants, in the United States Circuit Court, Southern District of Ohio, Western Division, Judge Thompson filed an opinion on November 2, 1903, against the defendants. This is a suit to enjoin the infringement of U. S. letters-patent Nos. 363,186, 399,801 and 428,650, on the Thomson induction motor.

LEGAL STATUS OF A WATER POWER COMPANY—A corporation authorized to develop and use the water power of a river and generate electricity or other power, light or heat, and utilize, transmit and distribute it for its own use or the use of other individuals or companies, is held, in Fallsburg Power and Manufacturing Company *vs.* Alexander (Va.) 61 L. R. A. 129, to be for a private, and not a public, purpose, and therefore not entitled to exercise the right of eminent domain.

NEW INCORPORATIONS.

INDIANAPOLIS, IND.—Whitley Telephone Company. $100,000.

HARRISBURG, PA.—The Gayly Local Telephone Company. $5,000.

MARYSVILLE, PA.—Marysville Electric Light Company. $10,000.

BUFFALO, N. Y.—Robertson Electric Company. Increased from $20,000 to $50,000.

PITTSBURG, PA.—Pittsburg Connecting and Terminal Railroad Company. $25,000.

HARRISBURG, PA.—Pittsburg, Summerville & Clarion Railway Company. $150,000.

ALBANY, N. Y.—The Niagara Falls Power Company. Increased from $9,500,000 to $10,500,000.

AUSTIN, TEX.—The Denison & Sherman Railway Company. Increased from $100,000 to $200,000.

INDIANAPOLIS, IND.—Indianapolis & Northwestern Traction Company. Increased to $3,000,000.

BLANCHARD, IOWA—Blanchard, Coin & College Springs Mutual Telephone Company. $3,000.

RICHMOND, VA.—Montford Telephone Company. $10,000. Incorporators: D. Sharp Butler and Barney Butler.

FULLERTON, NEB.—The Fullerton Electric Light and Power Company has been incorporated. The capital is $20,000.

SAGINAW, MICH.—The Boyne City Electric Company, of Grand Rapids, Mich., capital $10,000, has been incorporated.

TEXARKANA, TEX.—Long-Distance Telephone Company. $200,000. Incorporators: John B. King, W. L. Estes, F. M. Marriatt.

JERSEY CITY, N. J.—Scott Snell Lighting Company. $250,000. Incorporators: S. B. Timmonds, A. B. Eilback, Charles Schegel.

SPENCER, OHIO—The Spencer Telephone Company. $5,000. Incorporators: F. T. Cavin, N. E. Fuller, John Firestone and others.

RALEIGH, N. C.—The Home Telephone and Telegraph Company. $500,000. Incorporators: W. T. Gentry, of Atlanta, and J. P. Taylor, of Henderson.

DENVER, COL.—The Shawnee Light and Power Company. $200,000. Directors: E. A. Paulson, Otto Kaffler, John B. Sibley, D. J. McCannie and J. Cuthbert Sweeney.

ALBANY, N. Y.—Brookhaven Electric Light Company. $50,000. Directors: Charles A. Squires, Orange T. Fanning, Thomas O'Donnell, Charles F. Randall, of Port Jefferson, and H. C. Losee, of Patchogue.

INDIANAPOLIS, IND.—Indiana Central Traction Company. $50,000. To build an electric road from Wabash to Warsaw, *via* North Manchester and Winona Lake, and from Connersville, *via* Liberty, to the state line.

HARRISBURG, PA.—The O'Connell Railroad Company; $40,000; to build a line of railroad in Chester County. The Overbrook, Bryn Mawr & Paoli Street Railway Company; $138,000; to build an electric road from Lower Meredith to Narbeth Station.

BALTIMORE, MD.—A charter for the Virginia Power Corporation, with a capital of $500 to $50,000, has been filed at Staunton. C. Russell Caldwell is president, and Lawrence H. Peyton, Herbert J. Taylor, of Staunton; J. J. Nicholas, of Port Republic, and John Fulton, of Mount Meridian, constitute the board of directors.

ELECTRICAL SECURITIES.

Notwithstanding the fairly good bank statement made Saturday, the bear manipulators in Wall street were able to still further depress stocks, so that the net results for the week show additional declines. The bank statement showed a loss of less than $3,000,000 sustained by the clearing house institutions, and the bank loan account decreased $10,240,500, making an actual small gain in the bank surplus during the week. Previous to the publication of the statement, the stock market had been hard and firm, though with no special activity; but as soon as it was made public, the market was assailed and considerable stock sold off, so that at the close of the market most of the active issues had suffered. A number of industrial corporations, which had either shut down or were contemplating extreme retrenchment in their operations, have decided upon a policy of working as much ahead as possible, this being made more agreeable by large numbers of the employés accepting, without dissatisfaction, a moderate reduction in pay.

The construction of so large a piece of engineering as the Panama canal, which seems very probable in the near future, will not fail to stimulate interest in every industry which is affected by work of this character. This, together with the known value of the completed canal as a commercial factor, should aid largely in sustaining a healthy state of trade until the present apathy shall have been dissipated.

ELECTRICAL SECURITIES FOR THE WEEK ENDING NOVEMBER 14.

New York:	*Closing.*
Brooklyn Rapid Transit	36⅝
Consolidated Gas	175
General Electric	147½
Kings County Electric	160
Manhattan Elevated	138½
Metropolitan Street Railway	112
New York & New Jersey Telephone	140
Westinghouse Manufacturing Company	165

The balance-sheet of the Interborough Rapid Transit Company as of September 30, 1903, is as follows:

Assets—Cost of lease and equipment of subway, $7,080,800; stock and bonds, $13,527,265; real estate, $1,400,176; supplies on hand, $696,147; due by agents, $85; due by others, $8,761; open accounts, $139,059; cash on hand, $10,717,870; Manhattan guarantee fund, $4,018,812; prepaid insurance, $7,999; sundries, $4,813; total, $37,601,790. Liabilities—Capital, $35,000,000; interest due and accrued, $171,413; sundries, $4,704; Manhattan Railway lease account, $409,451; due for wages, $117,159; due for supplies, taxes, etc., $410,459; open accounts, $19,039; interest and premium on capital stock, $404,297; taxes in litigation, $303,000; profit and loss (surplus), $762,267; total, $37,601,790.

Boston:	*Closing.*
American Telephone and Telegraph	124½
Edison Electric Illuminating	240
Massachusetts Electric	76
New England Telephone	123
Western Telephone and Telegraph preferred	75

Philadelphia:	*Closing.*
Electric Company of America	7⅜
Electric Storage Battery common	46
Electric Storage Battery preferred	46
Philadelphia Electric	5⅜
Union Traction	43½
United Gas Improvement	78

Chicago:	*Closing.*
Chicago Telephone	122
Chicago Edison	140
Metropolitan Elevated preferred	55
National Carbon common	17
National Carbon preferred	85
Union Traction common	5½
Union Traction preferred	28

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INDUSTRIAL ITEMS.

THE EUREKA ELECTRIC COMPANY, Genoa, Ill., announces that it has ready for distribution Bulletins 26 and 27. These will be sent on request.

THE MILLER ANCHOR COMPANY, Norwalk, Ohio, manufacturer of the Miller anchors, augers and excavation buckets, will make a fine display at the convention of the Interstate Independent Telephone Association, at the Auditorium Hotel, Chicago, Ill., December 8, 9 and 10.

THE YOST ELECTRIC MANUFACTURING COMPANY, Toledo, Ohio, advises that it is now completing a large addition to its factory and that during the coming season its facilities for manufacturing will be vastly increased. This company now manufactures the Yost socket and other special electrical appliances.

THE ALLIS-CHALMERS COMPANY, Chicago, Ill., is distributing Catalogue No. 62. This gives a list of the foreign users of Corliss engines, pumping engines, hoisting engines, compressors and blowing engines. A number of half-tone illustrations show typical installations of Reynolds engines of every description.

THE ELECTRIC APPLIANCE COMPANY, Chicago, Ill., selling agent for Packard lamps and transformers, is sending out some literature describing the new "Salus" compound, with which the Packard transformers are insulated. The company will be pleased to send this pamphlet and its latest transformer catalogue on request.

THE HOBART ELECTRIC MANUFACTURING COMPANY, Troy, Ohio, is distributing two pamphlets descriptive of its gas engine type of dynamos, and protected and invertible direct-current dynamos and motors. The gas engine type dynamos are suitable for from 8 to 300 lights, and the direct-current dynamos range from one-half to twenty kilowatts, and the motors from one-half to twenty-five horse-power.

THE UNITED TELPHERAGE COMPANY, Westfield, N. J., is distributing a new series of bulletins descriptive of telpher operations in various industries. Bulletin No. 36 describes telpherage in cotton and woolen mills; No. 38, automatic telpher plants; and No. 42, reserve coal storage and the handling of coal, coke and ashes for gas and electric light companies and factories and mills. These bulletins may be had on application.

THE LUNKENHEIMER COMPANY, Cincinnati, Ohio, will be pleased to send its catalogue of brass and iron engineering appliances to any one interested in this material. The Lunkenheimer regrinding valves in screw and flange ends, one-eighth of an inch up, for 200 to 350 pounds working pressure, are largely used on the United States battleships, cruisers, torpedo boats, locomotives, lake and river boats and on high-pressure plants everywhere.

THE VICTOR ELECTRIC COMPANY, Chicago, Ill., in its catalogue No. 21 describes a line of electrosurgical apparatus. This includes cautery transformers, ear and eye masseur pumps, shunt current controllers, air compressors, sinusoidal machines, Finsen ray outfits, wall plates and cabinets, surgical drilling engines, motor-generators, head lamps, vibratory massage apparatus, motors, rheostats, eye magnets, etc. The eastern agent of the Victor Electric Company is the Union Electric Company, Baltimore, Md.

THE CROCKER-WHEELER COMPANY, Ampere, N. J., will be pleased to send any one interested, upon request, an illustrated pamphlet describing the mechanical equipment of the Orange brewery, at Orange, N. J. Two electric generating units are used in this equipment—one of sixty kilowatts, and one of thirty kilowatts. The plant is a model in every way, and makes liberal use of electrical apparatus, all of which has been supplied by the Crocker-Wheeler Company, except that included with machinery under special contracts.

THE DOWNWARD LIGHT ELECTRIC COMPANY, 225 Fourth avenue, New York city, announces that Mr. Jacob Cloos, one of the best-known electrical engineers in the Northwest, formerly technical manager of the Milwaukee Edison Company, has been appointed manager of the Downward Light Electric Company's Milwaukee office, which will cover Wisconsin and Iowa territory. The office will carry a large stock of tipless downward light lamps, as well as oval anchored filament lamps, which are labeled "Sidelight." The Milwaukee office is located in the Matthews Building.

THE JOSEPH DIXON CRUCIBLE COMPANY, Jersey City, N. J., is distributing an attractive booklet entitled "Dixon's Graphite Suggestions." The cover page of this booklet is embellished with a drawing in colors of several ancients marking on the wall with graphite. This attractive little booklet sets forth the advantages and infinite diversity of graphite, giving a short history of the Joseph Dixon Crucible Company and its connection with American graphite, graphite pencils, crucibles, in the foundry, for lubrication, graphite for bicycles and automobiles, for power launches, pot lead for yacht bottoms, for electricians' use, for domestic use, belt dressing, graphite paint, and as a pipe joint compound.

THE CROCKER-WHEELER COMPANY, Ampere, N. J., announces that a freight station has been established at Ampere, N. J., by the Delaware, Lackawanna & Western Railroad Company. All goods should therefore be addressed "per D., L. & W. R. R." A daily through car service has been established between Ampere and pier 41 North river, New York, foot of Le Roy street. All goods for the Crocker-Wheeler Company from New York and points east should be delivered at the Le Roy street terminal, pier 41 North river, New York. The receipt of freight closes at this point at 4.30 P. M., and the goods will arrive at Ampere the next morning. The receipt of freight at Ampere closes at 5 P. M. and the goods will arrive at pier 41 North river the next morning.

SMITH & HEMENWAY COMPANY AND UTICA DROP FORGE AND TOOL COMPANY, 296 Broadway, New York, publisher of the "Green Book of Hardware Specialties," has subdivided this book into four sections, uniquely and attractively printed on a green French folio paper. These sections, "Glaziers," "Electrical," "Razor" and "Caster," were printed in compliance with the request of many customers, to get up a catalogue small enough to be conveniently carried in the pocket. This progressive firm is ever on the alert for an attractive catchiness in its advertising, and in these subdivisions of its "Green Book of Hardware Specialties" has presented something that is not only attractive but useful, and the light weight of paper on which they are printed makes them fit so snugly in the pocket that they are always carried, and constantly used for reference.

THE REPUBLIC RUBBER COMPANY, Youngstown, Ohio, is distributing an elaborate advertising folder entitled "A Talk on Packing." This company is the manufacturer of "Searchlight" packing. The claim is made that a flanged joint made with this packing is not disturbed or displaced by any vibration of the main steam line. Its nature is yielding, and, at the same time, it is tough, strong and elastic. The composition is such that it will conform readily to the roughness of any irregular flanged surface, and requires no metal or wire insertion to make a tight joint. Another specialty manufactured by this company is the cross-arm tubular gasket. A brass wire mesh runs through the centre of the gasket, and when heat is applied, the wire is embedded into the rubber. Another feature is that the sleeve is a specially prepared composition of minerals and copper, so that when the heat is applied in connection with the rubber it vulcanizes solid, making a perfect gasket without a break or joint.

THE FORT WAYNE ELECTRIC WORKS, INCORPORATED, Fort Wayne, Ind., manufacturer of the "Wood" systems, is distributing several handsome catalogues dealing with "Wood" type apparatus. Bulletin No. 1049 describes and illustrates types MP and MPL direct-connected direct-current generators, and gives a list of operators of these machines. Bulletin No. 1050 describes and illustrates direct-connected type MPL direct-current generators for power and lighting. This bulletin contains a number of splendid half-tone reproductions of these direct-connected generators in typical installations. There is also an index to bulletins, including Nos. 1001 to 1050. This is a valuable addition to the Fort Wayne literature, as it brings within easy range all of the valuable bulletins which this company has published. Catalogue of parts, No. 2008, gives in detail the assembly of power circuit form C "Wood" arc lamps, while catalogue of parts No. 2009 gives the assembly of direct-current 110-volt form C "Wood" arc lamps.

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CHARLES W. PRICE . . . . . PRESIDENT AND EDITOR
STEPHEN H. GODDARD . . . . . SECRETARY AND MANAGER
WM. HAND BROWNE, JR. . . . . TECHNICAL EDITOR
AINSLIE A. GRAY . . . . . ASSISTANT EDITOR

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TO ADVERTISERS

CHANGES for advertisements should be in this office by *Friday noon* for the following week's issue.

NEW ADVERTISEMENTS should be in the office not later than *Monday noon* to assure publication in that week's issue.

CONTENTS.

EDITORIAL:
The Vindication of the Storage Battery 763
Raising the Voltage 764
Ill-Considered Reports 764
The Heating Effect of Radium 764
Electr lysis in Bridge Structures, by George T. Hanchett 765
Electrical Progress in the Nineteenth Century 766
Programme of the Annual Convention of the Interstate Independent Telephone Ass ciation 766
General Electric Company in an International Agreement 766
Latest Developments on Berlin-Zossen High-Speed Railway, by Frank C. Perkins 767
Transactions of the American Institute of Electrical Engineers 769
The Comparative Behavior of Floating and Booster-Controlled Batteries on Fluctuating Loads, by Lamar Lyndon 770
Two New Books 774
Notes on Steam Turbine Electric Generating Plants 775
How the United States Government Uses E ectricity, by J. E. Price 776
Annual Meeting of the American Society of Mechanical Engineers 777
Notes on X-Light, by Wiillam Rollins 778
Cape Town Industrial Exhibition 780
Weights of German Continuous-Current Machines 780
The Combined Use of Alternating and Direct Current for Central Station Work, by Professor F. C. Caldwell 781
The National Electric Light Association 783
The 181st Meeting of the American Institute of Electrical Engineers 784
Book Reviews 785
REVIEWS OF CURRENT ENGINEERING AND SCIENTIFIC LITERATURE 786
Transactions of the American Electrochemical Society 787
Electrical Patents 788
INDUSTRIAL SECTION:
Direct-Current Motor Grinders 790
Improvements in Automobile Design 790
Adjustable Round Split Dies and Hand Taps 790
Motor-Driven Fire Pumps 791
Electrically Driven Pumps for Mine Drainage 791
A Fine Display of Electric Heating and Cooking Apparatus 791
An Electro-Visual Thermo-Gage 792
World's Fair Bulletin 793
An Incandescent Lamp Meter 793
CURRENT ELECTRICAL NEWS 794

The London correspondent of the New York *Sun,* whose prediction we published last week, hopes to telephone from his London office to headquarters in New York within a year. It is too bad that our enterprising daily journalist is compelled to "wait the permission of the inventors before making more than this general announcement." We hardly believe that a Pupin cable could be manufactured and laid in twelve months, therefore we must eliminate that. And if it is the long distance wireless telephone, we hope the permission of the inventor will be granted without delay as we are all deeply interested. There is one disadvantage to progress in this direction; that is the difference in time will cause our English cousins to disturb our slumbers, and *vice versa.* We again urge you, Mr. *Sun* correspondent, to prevail upon the distinguished yet retiring inventors to hasten and let us know details.

THE VINDICATION OF THE STORAGE BATTERY.

It was only a few years ago that the storage battery was in disfavor. Storage battery cars had not been successful, and the apparatus itself was looked upon with much distrust. It was not, however, without its advocates for other uses, and in one notable instance a storage battery was installed on an important electric railway system by a prominent engineer, though this was done entirely at his own risk. In those days, unfortunately, engineers, as a rule, knew very little about the behavior and capabilities of the storage battery. It was thought of merely as a device for supplying electrical energy during the times when the generating station was shut down. How completely opinions have changed since then, was shown at the recent meeting of the American Institute of Electrical Engineers. Here an excellent paper by Mr. Lamar Lyndon discussed the capabilities of the storage battery as an auxiliary to the generating plant, and in the discussion which followed, all who took part expressed the opinion that this apparatus has become to-day an absolutely essential part of every large electrical system. The battery not only reduces load fluctuations on the station and assists in maintaining a constant voltage, but it ensures the system against breakdowns. There is a number of very large stations which to-day could carry the entire load from a battery, although every engine was thrown out of service.

Computing for a Battery Installation.

Mr. Lyndon's paper took up one application only of the storage battery, showing how it could be used to reduce load fluctuations on a railway system and, at the same time, effect a saving in copper and in the size of the generators. The effect of placing a storage battery at the station or out on the line is shown by a very simple method, which reduces the labor of calculating to a minimum.

Storage Battery Essential in All Systems.

Such papers are extremely important, as they give to those engineers who have not had an opportunity to make a special study of the storage battery valuable information. The storage battery will find a general application in the future, not only in such direct-current systems as may survive, and in those alternating-current transmitting systems which distribute direct currents, but, as well, in the pure alternating-current systems themselves. Here it is of vital importance to prevent absolutely any interruption of the exciting system, for which purpose the storage battery serves. It seems, therefore, that it will be necessary for all electrical engineers, in whatever line of work they may be engaged, to know something about the storage battery and its applications. It has become essential to prevent interruption of the service and it is now the duty of the engineer to see that the battery itself does not break down.

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RAISING THE VOLTAGE.

When the demand on a low-tension distributing system approaches its full capacity, to provide for the increase, the plan of raising the voltage is usually examined and often adopted. If a radical change, such as doubling the voltage, is decided upon, much of the old apparatus will have to be discarded or rewound; involving considerable expense. To avoid this a German engineer suggests raising the voltage gradually, say five volts a year until it has been increased from ten to twenty per cent. In this way all the old apparatus can be retained, the only change necessary being to add to the storage batteries a sufficient number of cells to bring them up to the proper voltage. Raising a 100-volt system to 120 volts increases its capacity about nineteen per cent, while if raised to 130 the increase is about forty per cent.

ILL-CONSIDERED REPORTS.

In describing the deplorable rear-end collision which happened November 19, on one of the Brooklyn elevated railroads and which resulted in the death of two train hands, the Metropolitan press, as a whole, treated the matter fairly. The details of the accident, so far as ascertainable, were given, the dangers involved in any transportation system where high power machinery is employed, were pointed out and such comments as were made were, in general, based upon reliable information and good sense.

Unfortunately, this sensible stand was not taken by all the New York papers, and one of them, which has not a reputation for sensational writing, took occasion to enlarge upon the dangers of electric traction. This paper referred to the "deadly third rail," as though that had been the cause of the accident, quoted an alleged "high authority," as saying that the third-rail system is dangerous, as "we still know very little about electricity," and finally expressed the opinion that the whole system would have to be changed on account of its dangers. The tone of the entire article was such as to add to the nervous feeling already existing in a large part of the riding public.

Now it is one thing to point out defects in a system and it is another to magnify its dangers and thus make the public unnecessarily nervous. It is this condition that the railway companies most dread, as it is likely, at any time, to cause a serious accident when there is no danger, and it makes matters far worse when there is real trouble. The conditions existing at our large cities make faster and larger trains necessary. Such trains are heavy and are equipped with motors of large power. Unfortunately, in spite of all precautions, accidents do happen to the trains, but the ratio of injuries to the total number of passengers carried is very small and the railroad companies are developing safeguards as rapidly as possible. The daily press is probably the most powerful educating agency in the world and there is here an excellent opportunity for it to do good by disabusing the public of the idea that electric traction is very dangerous. The sensible view taken by most of the New York papers of the recent accident is much to be commended.

THE HEATING EFFECT OF RADIUM.

When MM. Curie and Laborde announced their discovery of the fact that radium continuously emits heat at a rapid rate, two hypotheses were put forward to account for what at first appeared to be an exception to the law of the conservation of energy. According to this law, a body which gives off heat continuously must either receive energy from some external source, or its internal energy must decrease.

Effect Attributed to Unknown Form or Radiation.

The first condition is assumed in one of the theories offered, but as it has been shown that the action takes place when the radium does not receive energy in any of the forms in which we know it, it is necessary to assume, further, that the energy received by radium is some unknown form of radiation which is converted by it into heat and radiated as such. While there is no experimental basis to support this theory, it must be remembered that the phenomenon of a substance continually giving off energy, without apparent change, is new, and can only be explained by some heretofore unknown action. Far-fetched as this idea of an unknown radiation may seem, it is no more startling than the other explanation offered; but the latter has received more support, although if true it upsets a fundamental theory of chemistry.

Disintegration Theory.

This theory put forward by Rutherford and Soddy assumes that radium is an unstable element; that its atoms are slowly disintegrating, and that, during this disintegration, energy is set free in the form of heat. The reaction may be compared with the breaking up of an unstable chemical compound, though in the case of radium, the change is assumed to take place in the radium atom itself. This theory is supported by the fact that radium gives off a gaseous emanation, differing in properties from the original material.

An Important Experiment.

To throw some light on this important question, Professors E. Rutherford and H. T. Barnes have measured the heat radiation of radium emanation, and describe their work in a communication to *Nature,* for October 25. They measured, first, in a differential air calorimeter, the heat given off by thirty milligrammes of pure radium bromide. The bromide was then heated to drive off the emanation, and the latter was condensed in a glass tube which was sealed off. The heating effects of both the emanation and the deemanated radium were then measured separately. It was found that the heating effect of the deemanated radium diminished rapidly during the first few hours, and fell to a minimum, corresponding to about thirty per cent of the original value, and then slowly increased again; while, on the other hand, the heating effect of the emanation tube first increased for a few hours to a maximum, corresponding to about seventy per cent of the original heat emission of the radium, and then slowly decayed with time. At any time after removal of the emanation, the sum of the heating effect of the deemanated radium and of the emanation was found to be the same as the original radium.

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Heat Radiation Varies with Radioactivity.

It has been shown that if the emanation is removed from radium, the activity of the radium as measured by the α rays decreases in the course of a few hours to twenty-five per cent of its original value, while the activity of the emanation immediately after separation measured in the same manner rises; and that, at any time after separation, the sum total of the activity of the radium and the emanation has a value equal to that of the original radium. It is thus shown that there is a parallel between the variation in radiating power, measured by the α rays, and the heating effect of radium. This fact seems to Messrs. Rutherford and Barnes to be strong evidence in support of the disintegration theory. As radium disintegrates and sets free its emanation, there is a liberation of heat. If the emanation is separated from the radium, it carries the greater part of this heat with it, and gradually gives it up to the containing-vessel. To explain the increase which takes place immediately after separation, it is thought that the disintegration of the radium atom takes place in stages. About twenty-five per cent of the heat of disintegration is set free in the first stage of breakdown during which the emanation is formed, and the remainder in the other stages which take place afterward. The behavior of the deemanated radium is supposed to show that immediately after separation it is giving off heat which it received during the formation of the emanation. The heat radiated will then gradually decrease as it is given up until the heat developed by further disintegration causes the radiation to increase. In each case kinetic energy is liberated by the expulsion of the small charged particles of the α rays, and where the energy of these is absorbed heat appears.

The Explanation Questioned.

This explanation is questioned to Mr. Arthur Schuster also in a communication to *Nature* as it does not seem to him to explain the increase in heat liberated by the emanation immediately after separation, and the corresponding decrease shown by the deemanated radium. He thinks that, since the emanation itself begins to form again from the radium immediately after separation, the heating effect of the deemanated radium should start with a minimum, and then gradually increase; and that the opposite result should be observed in the emanation after separation. He suggests that the heating effect may be due to excited activity. After separation of the emanation, the deemanated radium retains its excited activity for some hours. During the course of the first few hours there is very little emanation, but there is excited activity, which falls to a minimum, and then slowly grows again as the formation of new emanation once more excites it. Mr. Schuster thinks the same explanation will account for the increase in the heating effect of the emanation after separation, as the effect seems proportional to the amount of excited activity present, and not to the amount of emanation. If due simply to disintegration of the radium atom, one would not expect an increase in the heating effect after separation. Mr. Schuster, however, does not offer any explanation of the manner in which the excited radioactivity causes heating. What is one of the most noteworthy facts observed in connection with radioactivity is the comparatively large amount of heat liberated by a quantity of matter, so small in this case that it could not be seen nor weighed, but could only be detected by its radioactivity and heating effect. We have been accustomed to considering the energy changes involved in chemical reactions as large, but they seem to be insignificant when compared with the energy transformations involved in atomic changes.

ELECTROLYSIS IN BRIDGE STRUCTURES.

BY GEORGE T. HANCHETT.

Large bridges, particularly those of the suspension type involving a long length of continuous metallic conductor connecting two distant points in the earth, exercise no little influence in disturbing the conductivity of the ground return for neighboring trolley systems. As such bridges *per se* exist only where electric trolley systems are very numerous, and often traverse the structure itself, it is important to seriously consider whether or not currents will flow in this structure, and granting that they do, whether they will do damage. In complete existing structures it is very easy to determine not only whether current exists in such cables, but the magnitude and direction. This may be done by measuring the potential around a known section of the cable by means of a suitable instrument, and if the structure of the cable is known and the conductivity of the material of which it is made, the actual magnitude of the current flowing is only a matter of a few figures. These currents will often be surprisingly large because the resistance of the cable is so low that a fraction of a volt is amply sufficient to force a very formidable current through it. The question then arises, where does this current leave the cable and under what conditions? If it leaves the cable from a solid metallic contact, there is little or no danger of corrosion at the point of leaving, but if it leaves from an anchorage in moist surroundings, as it is likely to do, it is certain, sooner or later, to corrode the anchorage so badly as to make it unsafe. If the anchorage is always in a place where it can not be readily inspected, the case becomes one of speculation, and it is very difficult to say how much current is flowing through the anchorage or what damage it is doing.

Bearing in mind the fact that the electric pressure to be insulated against is only a volt or two, it does not seem an at all impossible matter to insert in such a cable line an insulating joint of ample strength, both mechanically and electrically, to withstand the load and keep the current out of the cables. Many insulators are enormously strong under compression, however unsatisfactory their transverse and tensile strengths may be, and though they be inferior to steel and iron in their ability to resist stresses, the problem simply resolves itself into a computation of a proper area of section. It may, of course, be argued that the direct effect of electrolysis from railway return currents on such structures as these is very slight, but granting that that be true, it must be remembered that bridges of this character are built for all times, and given a sufficient time, a slight electrolysis may produce serious results.

It will soon become a part of suspension bridge engineering to measure the difference of potential between the points to which it is proposed to connect the anchorages, and to ascertain the source of such potential, and whether or not the power behind it is sufficient to cause it to produce currents of any volume through the proposed structure.

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Electrical Progress in the Nineteenth Century.

The Royal Philosophical Society of Glasgow, says the London *Electrical Engineer*, has arranged for the delivery of a special centenary series of lectures during the coming session in connection with the advancement of science during the existence of the society. The first of the series was delivered by Professor Andrew Gray at the opening meeting of the session on the fourth instant, and he chose for his subject "Electrical Progress in the Nineteenth Century." The lecturer traced the progress of electricity from the time of Galvani and Volta up to the present day, passing in review the work of leading scientists and physicists who had been chiefly responsible for this development. Thus, the achievements of Cavendish, Davy, Oersted, Nicolsin, Carlile, Ampere, and Faraday were individually described and commented on by the lecturer, who, in his reference to the electrochemical industry, deplored the fact that an electrical discovery made in this country had, through the apathy of our manufacturers, been allowed to become the foundation of what was mainly a German industry. In connection with Faraday's work, Professor Gray showed Lord Kelvin's reflecting galvanometer for the observation of induced currents, and made some experiments with it during the evening. Lord Kelvin's papers on the voltaic cell were mentioned, and a short account was given of his theory of the oscillatory discharge of a condenser, and the bearing of this result on the present-day experiments in electric wave telegraphy. Professor Gray next sketched the work of Gauss and Weber and the British Association Committee on Electrical Units and Standards, and gave a short history of the earlier researches on the determination of the ohm carried out by Thomson, Maxwell, and more lately by Lord Rayleigh. The lecturer also referred to Dr. John Hopkinson in connection with improvements in electric generators and motors, and went on to give a short exposition of Clerk Maxwell's great generalization—the electromagnetic theory of light—and of its direct verification by the experiments of Hertz. He concluded with references to the experiments in Hertzian wave telegraphy, and to the astonishing results that have followed the discovery of radioactivity. As to the progress made in the next century, he said it would be based on the knowledge gained in the past 100 years, and those who by spending laborious days and nights had built it up would be held in imperishable renown.

Programme of the Annual Convention of the Interstate Independent Telephone Association.

The annual convention of the Interstate Independent Telephone Association will be held at the Auditorium, Chicago, Ill., December 8, 9 and 10, 1903. An elaborate programme has been prepared, both from a technical and social point of view. Any corporation, copartnership or individual interested financially in or operating an independent telephone exchange or toll line, or any corporation, firm or person engaged in manufacturing any kind of independent telephone apparatus or equipment, or any supply house, is entitled to membership, and all are urged to attend the approaching convention, whether members or not. The association embraces over 8,000 independent exchanges and all of the factories and supply houses in the United States. A banquet will be given, and Cregier's orchestra of forty men has arranged a complete concert programme for the pleasure of the delegates. Reduced rates on all railroads have been arranged for.

A special programme has been announced which will be as follows:

Tuesday Morning, December 8—Reception of members and friends by the executive committee and officers, at the secretary's headquarters.

Tuesday Afternoon—Address of welcome, by the Hon. Carter H. Harrison, Mayor of Chicago; response and annual address by the president, Senator C. E. Hull, Salem, Ill.; report of the secretary and report of the treasurer will be read; selection of executive board; selection of nominating committee, and revision of constitution and by-laws.

Wednesday Morning, December 9—The officers and executive board will take charge of the delegates. Visiting exhibits.

Wednesday Afternoon—Wednesday afternoon will be devoted to addresses as follows: "Should the Territory of the Interstate Independent Telephone Association Be Enlarged, and if so, Why?" by the Hon. John Van Nortwick, Appleton, Wis.; "Are Our Telephone Periodicals Sufficiently Careful as to the Business Relations Sustained by Contributors?" by W. H. McDonough, New York, N. Y.; "Standardization of Apparatus," by Professor J. C. Kelsey, Purdue University; "Standardization of Construction," by W. C. Polk, Kansas City, Mo.; "Competition Between Independent Companies and Farmers' Mutuals," by O. Rex, North Manchester, Ind.

Thursday Morning, December 10—"Independent Toll Line Systems, and Is the Time Ripe for Merging," by J. S. Bailey, Jr., Toledo, Ohio; "Where Should the Line Be Drawn Between Independent Operating and Manufacturing Companies, and the Bell Company," by the Hon. Henry A. Barnhart, Rochester, Ind.; "What Should Be the Representation in Connection of the Interstate Independent Telephone Association in Voting?" by David Prewitt, Winchester, Ky.; "Who Is Who? What Are the True Ear Marks?" by the Hon. Theodore Gary, Macon, Mo.

Thursday Afternoon—Officers and executive board will take charge of and entertain the attending delegates. Visiting exhibits.

General Electric Company in International Agreement.

Announcement has been made that the General Electric Company has completed a working agreement with the Deutsche Allgemeine Electrische Gesellschaft, of Germany. The German company includes, or has agreements with, practically every large electrical concern in continental Europe. It is said that the Westinghouse company is also comprehended in the combination, and trade agreements will be made which will include all of the operations of these two American companies and the European combination.

The New York Central & Hudson River Railroad Company has placed an order with the General Electric Company for eight turbo-generators, of a capacity of 7,500 horse-power each. The turbines are of the four-stage vertical Curtis type. The generators are twenty-five-cycle, three-phase, generating current at a pressure of 11,000 volts. This is by far the largest order for steam turbines ever placed in this country or abroad.

The New York Central company has also placed with the General Electric Company an order for thirty electric locomotives. These locomotives are of an entirely new design, will weigh eighty-five tons each, with an adhesive weight on the drivers of sixty-seven tons. Each locomotive will have a capacity of 2,200 horse-power and will be capable of hauling a train of 500 tons at a speed of sixty miles an hour. This is by far the largest order for electric locomotives ever placed in any country.

The New York Central installation will ultimately include not only the equipment with electricity of the terminals, but probably also about fifty miles of railroad on each one of the New York Central branches, as well as the New York, New Haven & Hartford suburban lines.

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Latest Developments on Berlin-Zossen High-Speed Railway.

By Frank C. Perkins.

THE extremely high speeds attained recently on the Marienfelde-Zossen polyphase railway have renewed the interest in this experimental line, which has demonstrated in the past three years the feasibility of operating electric lines with high-tension alternating currents reaching at least 14,000 to 15,000 volts. The accompanying illustration, Fig. 1, shows the new track construction as well as the three overhead wires required for supplying the three-phase current to the high-speed locomotive and motor car. The latest report up to date from the Siemens-Schuckert Werke, of Berlin, Germany, states that on October 23 a speed of 207 kilometres per hour was attained with perfectly smooth running and under very satisfactory conditions, the voltage being that above mentioned.

The Marienfelde-Zossen section includes twenty-three kilometres, or about fourteen miles of track with grades up to three per cent and curves of 2,000 metres radius, the lines being straight nearly the whole distance. The rails of the original track weighed thirty-two kilogrammes per metre, and when the speed trials were under way it was found that at speeds exceeding 160 kilometres per hour the rails showed signs of bending and the sleepers, which were of iron, were cracked in places. This track construction was therefore considered unsafe for very high speeds and application was made to the Koeniglich Preussichen Eisenbahnministers for a heavier and new track and more solidly constructed roadbed. The trial track was therefore completely renewed and the gravel bed was replaced by a bed of finely pounded gravel. The broken basalt employed as a ballast has produced a very fine foundation and the new track construction is similar to the heavy permanent way used with the Preussichen high-speed trains in connection with special safety devices employed to guard against derailments.

On about seventeen kilometres length of track of the total twenty-three kilometres a guide rail was laid along each main rail about fifty millimetres distant from it, similar to that generally used on bridges, the old rails being used for this purpose, laid on sides. These guard rails, as noted in the illustration, Fig. 1, are bolted to cast-iron bed-plates or chairs, which are in turn bolted to the sleepers. The new track is constructed of rails weighing forty-two kilogrammes per metre of length and they are fastened to and supported by wooden sleepers and steel chairs. These heavier rails are twelve metres in length, and eighteen sleepers are employed for this length, the sleepers being thoroughly embedded in the broken basalt ballast, 15,000 cubic metres of the same being used.

This track construction has proved entirely adequate for the excessively high speeds attained, as in spite of the high speeds of 201 kilometres and 207 kilometres per hour no disturbing facts were noted during the various runs. The passengers were able to stand and take notes and write sitting, without difficulty.

Some trouble resulted some time ago from the vibration of the three-line conductors and poles noted at the side of the track in Fig. 1, but this was remedied by making the collecting bows lighter, fitting them with better springs. These changes, together with an improved arrangement of the conducting wires, eliminated the drawbacks and dangers from the oscillations of the poles and conductors which were the cause of the fractures and short-circuits.

The line is divided into sections one kilometre in length and a feeder connects the centre of each section. As will be seen in the photograph the three conductors are mounted one above the other vertically, the lowest being about twenty feet from the ground and the distance of the line from the track being about seven or eight feet. A pole is located every 100 feet, and on each is mounted a bow-shaped arm upon which the high-tension wires are suspended, not rigidly fastened, but supported by insulators of hard rub-

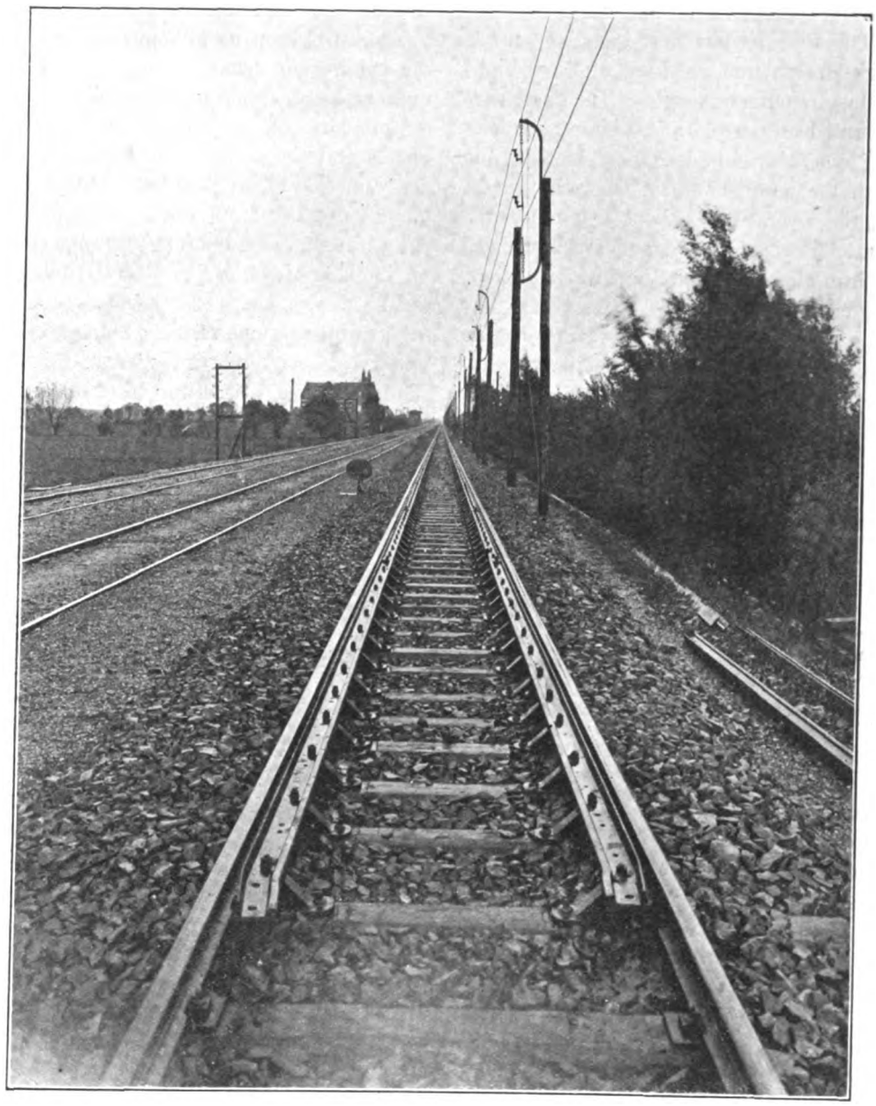

FIG. 1.—NEW ROADBED, BERLIN-ZOSSEN HIGH-SPEED ROAD.

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ber mounted upon a vertical chain and wire system. Each of the three hard drawn copper conductors has ninety-seven per cent conductivity and has a cross-section of 100 square millimetres.

A loop of wire about one-third of an inch in diameter, as will be seen in illustration Fig. 1, is fixed at each supporting insulator in such a manner that in case the trolley wire breaks, it will be grounded by being pulled into contact with a vertically suspended wire of the same cross-section, having a coil spring near its upper support, its lower end being directly connected to the track.

The four feeders first installed on the high-tension line consisted of three high-voltage conductors and a neutral wire mounted on porcelain insulators, connecting the Marienfelde-Zossen trolley line with the power-house at Oberschönweide, on the river Spree, about five miles distant. Part of the conductors consisted of insulated cables and part of bare wires, the cross-section of the latter being fifty square millimetres and the former having a cross-section of seventy square millimetres.

The voltage was increased for the last speed trials, the tension on the transmission line being raised to 14,000 or 15,000 volts.

The motor car which was used to make the very high speeds recently attained on the Berlin-Zossen has been reconstructed as to trucks, collectors and other apparatus. The trucks are somewhat longer than the old ones used on the first motor car trials, the wheel-base of the new equipment being five metres instead of 3.8 metres of the old construction, and the central pivot is allowed a lateral movement. The motors have been changed somewhat and connected one on each end axle, the centre axle running free. The wheels are a trifle over four feet in diameter and are equipped with pneumatic brakes, each cylinder serving two brake shoes, the pressure used being six atmospheres, giving a total brake-pressure of double the car weight. The car is practically the same as first constructed, being twenty-two metres in length, with platform at each end about two metres in length from which the operator controls the car. The Westinghouse air brakes are so arranged that they may be operated from either end of the car, and the compressed air was not only installed to operate the brakes but also for controlling the electrical apparatus as well. The car weighs about 100 tons, the body and running gear weighing somewhat more than the electrical equipment, consisting of switches, transformers, motors, and other controlling apparatus, and an electrically operated air pump with its transformer.

Each motor has a normal capacity of 250 horse-power, making a total of 1,000 horse-power for the four motors, but they are capable of handling a load of 500 horse-power each or 2,000 horse-power when called upon for a considerable period, and may be even worked to a capacity of 3,000 horse-power for a short time while starting. For excessively high speeds, the voltage and frequency are increased to a considerable extent.

There has been no difficulty in keeping the motors and transformers cool, as the high rates of speed produce tremendous air pressures on the car of many atmospheres and the cores of the transformers are connected by air pipe for cooling. The air is supplied from the outside of the car through the numerous openings seen on the side of the car in Fig. 2, and this air blast also keeps the resistances used at a proper temperature. Three resistances were originally installed in this car of large size, consisting of twenty-five coils and three smaller resistances of four coils each, one for each of the three phases. The six-pole motors were directly connected to the car wheel axles, the normal speed being 900 revolutions per minute and the diameter of the wheels 1,250 millimetres. These motors were provided with three collector rings upon each of which eight brushes pressed for giving the necessary contact. The rotors measured about thirty inches in diameter and the slots of the motor were well insulated with mica, wooden wedges being used to hold the bar winding in place together with the usual wire bands. The primary winding has ninety-six slots and the secondary seventy-two slots, the motor having a six-pole winding. The motor receives the current from the three-phase step-down transformers at from 1,150 volts to 1,850 volts, it being lowered to the former pressure from 10,000 volts.

Before the road-bed was reconstructed the Allgemeine Elektricitäts Gesellschaft, of Berlin, also supplied a motor car which attained very high speeds, and this company will now make additional trials, beginning with moderate speeds, before attempting the high speeds attained by the car of the Siemens-Schuckert Werke. The current for operating the railway is supplied from the power-house of the General Electric Company (the Allgemeine Elektricitäts Gesellschaft), the station being located at Oberschönweide. The motor cars were built by Van der Zypen & Charlier, of Cologne, Germany.

The Seimens & Halske electric locomotive was designed for four motors, two on each truck, but at first only two motors were installed, one on each bogie, with single-reduction gearing. In a test at 11,000 volts and drawing a trailer of thirty-one tons weight a speed of 100 kilometres and over was attained with an output of 280 horse-power. It has been reported that on another test a total weight of 130 tons was hauled, which included the heavy high-speed car above mentioned as attaining the recent high speeds, and the results were highly satisfactory.

The experiments on the Berlin-Zossen line were commenced in 1901, and the object was to demonstrate the possibility of attaining speeds of 200 kilometres per hour under practical conditions, and this was the highest speed expected to be obtained. This enormous speed was reached and passed on October 6, the trials on this date ranging from 180 kilometres to 201 kilometres per hour, the frequency used being forty-six cycles per second and the pressure 14,000 volts. The curve of 2,000 metres radius was taken at a speed of 165 to 170 kilometres per hour with perfectly smooth running and without the slightest trouble. The maximum authorized speed of 126 miles per hour was reached on the above date, thus giving the anticipated results. The total distance of twenty-three kilometres, or somewhat over fourteen miles, was traversed a number of times in about eight minutes, including the starting and braking. On about five kilometres of track on the Rangdorf-Dahlwitz-Mahlow section it is claimed only one and one-half minutes were required to make the entire distance.

On October 23 a speed of 207 kilometres per hour was made by this car, according to a letter received from the Siemens-Schuckert Werke. At this rate of speed the total distance from Cologne to Berlin, about 577 kilometres, would be covered in less than three hours, while the present quickest actual time is about three times as long, or about nine hours. It is stated that the power consumed was about 1,000 horse-power by the four motors of the car in these trials, and in this connection it is of interest to note some data given by G. B. Lochner, in April, 1902, before the Berlin Society of Railroad Engineering as to the results of the tests made on the Berlin-Zossen high-speed line at that time.

He stated that in starting with an acceleration of from 0.1 to 0.2 metre per

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second, from 500 horse-power to 1,000 horse-power was required, while at a uniform speed of 140 kilometres per hour the consumption of power in the car was only 245 horse-power.

It was stated that the power consumption increases very rapidly as the rate of speed is increased, particularly on account of the air resistance, and that if a speed of 200 kilometres per hour was attained, which is 124 miles per hour, somewhat more than 1,000 horse-power would be required. It was reported that in the experimental plant the efficiency of the whole installation was low as the power was located at a great distance and the drop in potential was heavy on the line from the plant to the road, being greater than that along the entire railway, while the power-factor of the motors was not over 0.6, as they were never fully loaded.

Within from 2,000 to 3,200 metres the speed of sixty-two miles an hour was attained in from two minutes and eighteen seconds to three minutes and thirty seconds, which is an acceleration of from 0.13 to 0.2 metre per second. It is stated that the motors of the motor car were capable of developing 3,000 horse-power for a short period and that only from 700 to 1,000 horse-power was ever tried. Higher accelerations were not attempted, as the power-house generators were not capable of taking care of rapid and heavy variations of load.

Mr. Lockner's conclusions were that from the tests the braking arrangements were not sufficient, as with speeds of over 120 kilometres per hour the signals could not be observed within a proper time to bring the train to a stop even in clear weather, while in rainy weather it was even worse. The tests showed conclusively that there was no practical difficulties in using polyphase motors for high-speed runs, ample cooling being possible with an air draft. It was also clearly demonstrated that at even the highest speeds there would be no difficulty in supplying the necessary high-tension polyphase currents from the trolley wires through the contact bows as indicated in the arrangement with the Siemens & Halske car.

From the recent trials it has been shown that Mr. Lockner's conclusions were correct, as no difficulty was found in collecting the current required for the motors at the highest speeds, reaching finally about 130 miles per hour. The experiments of the Allgemeine Elektricitäts Gesellschaft will be awaited with interest by all engineers engaged in electrical traction work.

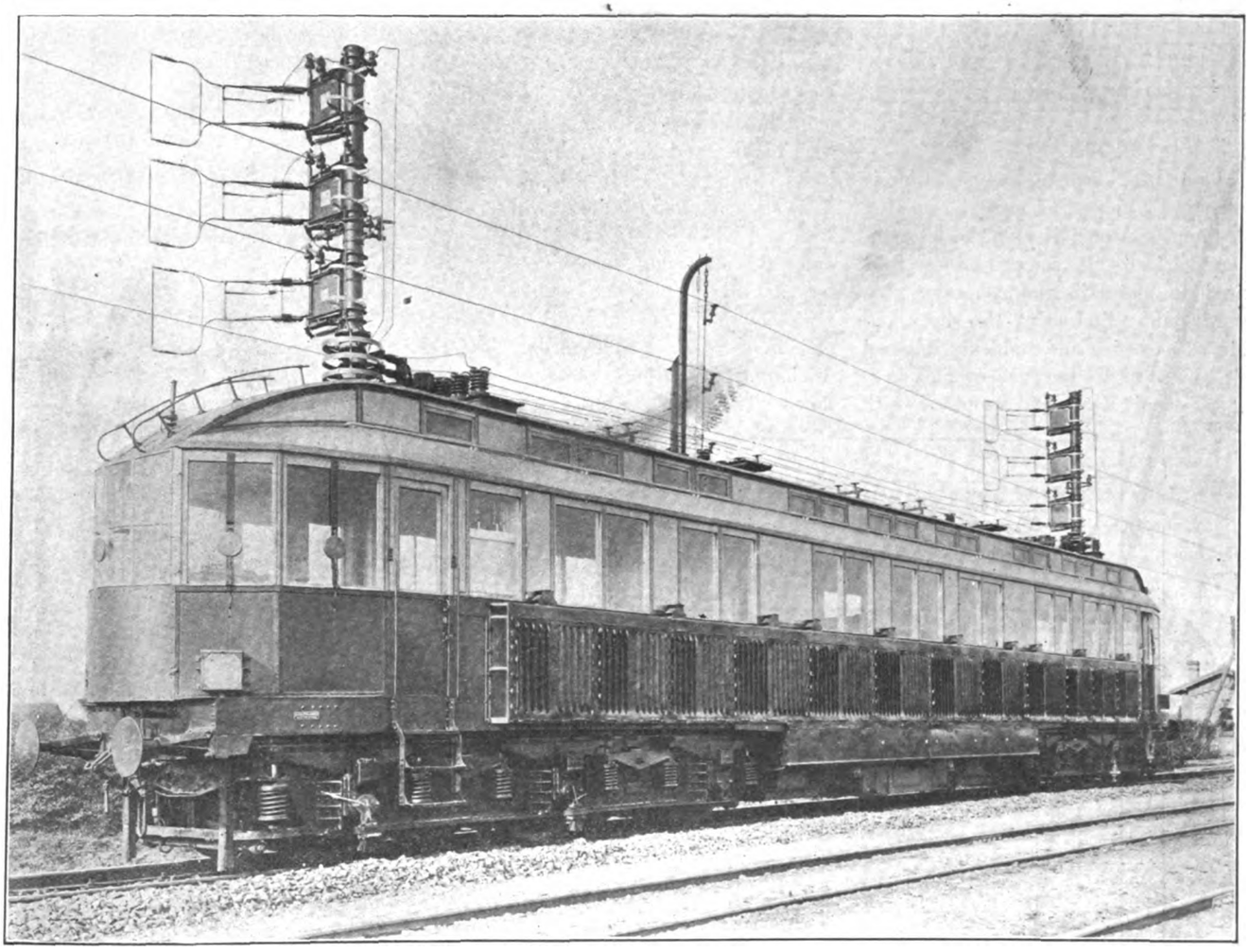

FIG. 2.—HIGH-SPEED CAR OF THE SIEMENS-SCHUCKERT COMPANY.

Transactions of the American Institute of Electrical Engineers.

The October number of the transactions of the American Institute of Electrical Engineers is being distributed. This number contains the paper and discussions presented at the Niagara Falls convention, on July 2 and 3, 1903. The papers include one by J. W. Esterline and C. J. Reed upon "The Factors Which Affect the Energy Losses in Armature Cores;" one on "Central Station Economies," by W. E. Goldsborough and P. E. Fansler; "A Legalized Standard of Electromotive Force," by Henry S. Carhart; and "The Cathode Ray Alternating-Current Wave Indicator," by Harris J. Ryan. On July 3 the papers related to technical education.

This number also gives the papers and discussions on hydroelectric installations read at the New York meeting, September 25, 1903.

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THE COMPARATIVE BEHAVIOR OF FLOATING AND BOOSTER-CONTROLLED BATTERIES ON FLUCTUATING LOADS.[1]

BY LAMAR LYNDON.

Methods of Application—The object of using the storage battery as a regulator on variable loads is to absorb, as far as possible, all fluctuations above or below the average current. When the external load is light, the generator sends current into the battery as well as to the external circuit. When the demand is heavy, the battery discharges in parallel with the generator, relieving the latter of the excess load. In some instances it is desired to maintain the generator current constant, eliminating the shock and strain of excessive and suddenly imposed loads, and to secure the fuel economy incident to steady loads as compared with fluctuating. In other cases, the object is to maintain a constant voltage on a circuit or rather to prevent it from varying more than a predetermined amount. Obviously, the maintenance of absolutely constant load, or voltage, is the ideal condition, and the more nearly this is approached the more nearly is the object attained.

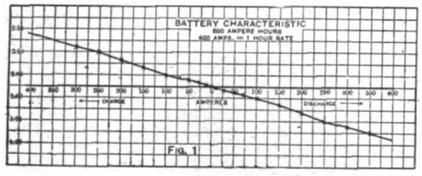

Fig. 1.—Battery Characteristic.

Where the load is applied some distance from the power station, there are five possible methods of installing a storage battery to maintain the load on the generator reasonably constant, which are:

(1) Floating battery in power station.

(2) Floating battery, out on line, at point of application of load.

(3) Battery with booster, in power station.

(4) Battery and booster, out on line, at point of application of the load.

(5) Battery out on line, at point of application of the load, and booster in the power station.

Cell Characteristic—Fig. 1 shows the characteristic of an 800-ampere-hour cell one quarter discharged, at seventy degrees Fahrenheit, in good condition. This will change with temperature, the characteristic more nearly approaching the horizontal with higher, and the perpendicular, with lower, temperature. It will also change with state of charge, density of electrolyte, and condition of plates. The ordinates above the horizontal line which intersects the characteristic curve at zero represent the voltage of a cell on charge, and those below this line the volts on discharge, at various rates of current flow. The abscissæ are amperes, the curve being extended on either side of the zero at that point where the current flow is equal to the one-hour rate of charge or discharge. Each reading was taken twenty seconds after beginning of the corresponding current flow. The zero point shows the voltage of a cell when current flows neither into nor out of it.

This is the general form of characteristic for nearly any type or size of cell, the conditions of charge, temperature, electrolyte, density, etc., being the same. The data then to construct the characteristic for any size of battery of same state of charge, temperature, and electrolyte density as given are:

Volts per cell at zero, 2.025; at the one-hour discharge rate 1.915, and at the one-hour charge rate 2.14. Connect these points by a straight line. As may be seen, the one shown is practically a straight line, and repeated tests on many sizes and types of cells indicate that if the conditions be maintained constant throughout a test and due allowance be made for the error in reading the small changes in the voltmeter deflections, that the characteristic is a straight line between the points of one-hour charge and one-hour discharge rates.

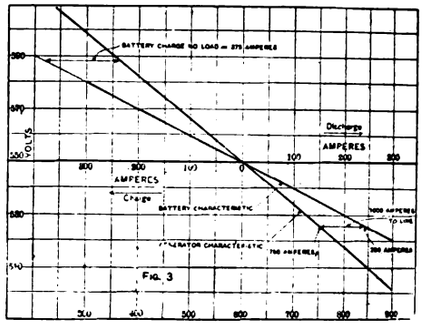

Fig. 3.—Generator Amperes.

Conditions Necessary for Floating—If a storage battery be "floated" on a system on which the load is fluctuating, the voltage of the circuit across which it is connected must obviously vary with the load; rising above that of the battery when the demand is light and sending in a charging current, falling when the demand is heavy and allowing the battery to discharge and assist the generator. In order that the system may work properly there should be a relationship between the battery characteristic and that of the generator. The greater the inclination of the generator characteristic to the horizontal, that is, the greater the change in voltage with change in load, the greater will be the battery discharge on loads in excess of the normal or average load. Referring to Figs. 2 and 3. In Fig. 2 the generator characteristic has a certain inclination to the horizontal.

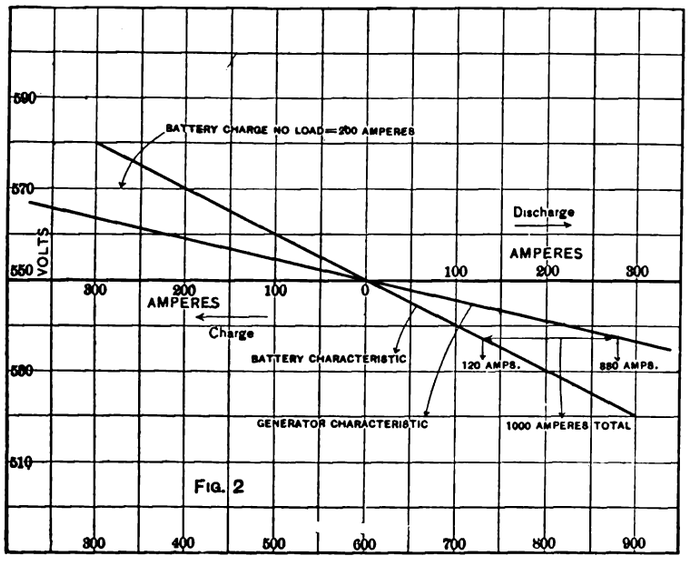

Fig. 2.—Generator Amperes.

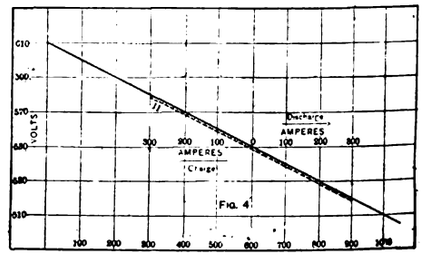

Fig. 4.—Generator Amperes.

[1] A paper presented at the 181st meeting of the American Institute of Electrical Engineers, New York, November 20, 1903.

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The battery characteristic is superimposed on it, the point of zero current flow intersecting the generator curve at the point of normal load—600 amperes. For simplicity both are here assumed to be straight lines. When 1,000 amperes are sent over the line, the generator furnishes 880 and the battery 120 amperes, the increase in load on the generator being 280 amperes, or forty-seven per cent.

In Fig. 3 the inclination of the generator characteristic is greater than in Fig. 2, and for 1,000 amperes station output, the generator furnishes 750 amperes, the battery 250, the increase of generator load above normal being 150 amperes, or twenty-five per cent. In the latter case, however, on light load, the voltage rises so greatly that an excessive current will pass into the battery, probably injuring it. As the one-hour rate of charge should never be exceeded—and even this should last but a very short time—the relative inclination of the two characteristics must come within certain limits. Furthermore, large shunt generators of high efficiency can not be made—or, at least, certainly are not made—so that the full-load voltage decreases more than fifteen per cent below the no-load voltage. This limits the inclination of the generator characteristic.

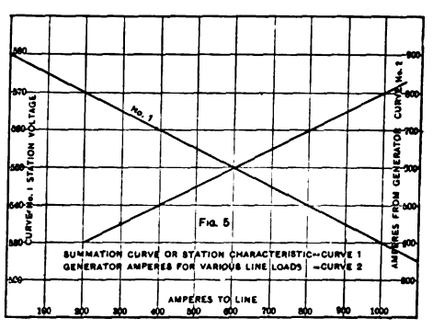
No. 1
SUMMATION CURVE OR STATION CHARACTERISTIC—CURVE 1
GENERATOR AMPERES FOR VARIOUS LINE LOADS —CURVE 2
AMPERES TO LINE

FIG. 5.—SUMMATION CURVES.

CASE I—FLOATING BATTERY IN STATION.

Data of System—Consider the case of a fluctuating load such as is shown in curve A, Fig. 7. The minimum current is 260, maximum 1,000, and average 600 amperes. Such a load coming directly on the generating equipment must result in low efficiency and high fuel consumption per horse-power-hour; and will require generators with large overload capacity and heavy engines to withstand the strains imposed. It may here be mentioned that the load curve shown is not an assumed one, but represents the actual readings made on an operating electric railway.

Assume that this load is carried over one feeder to a point two miles from the power station; that the minimum voltage at any time is to be 350 volts; that the track is of seventy-pound rail, well bonded. Still assuming both characteristics as straight lines, Fig. 4 is drawn. Line "I" is the generator characteristic. The dotted line running just underneath "I" is the characteristic of a 600-ampere-hour battery, the one-hour charge or discharge rate of which is 300 amperes. This line is in reality coincident with the generator curve. The voltage of the generator at normal load, 600 amperes, is 550 volts, which is also the open-circuit voltage of the battery. The ordinates are volts as indicated. The lower set of abscissæ are amperes of generator output; the set on the horizontal line at 550 volts are amperes of charge or discharge of the battery.

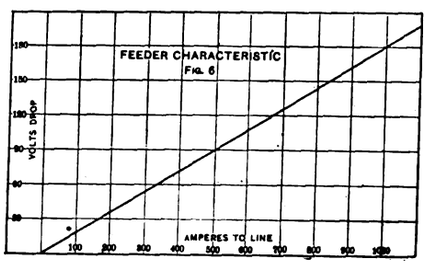

FIG. 6.—FEEDER CHARACTERISTIC.

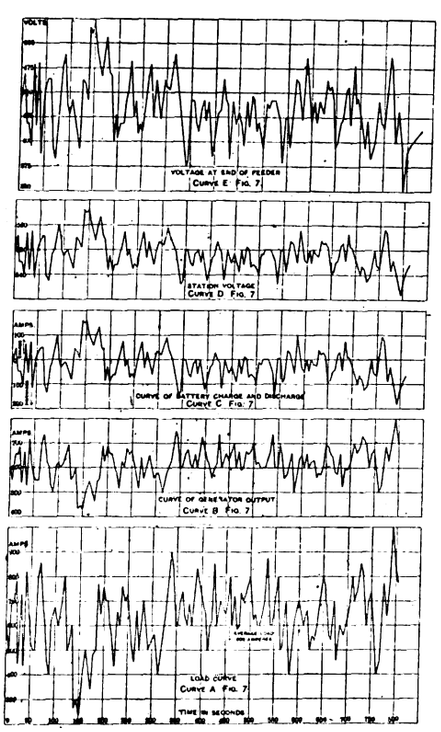

FIG. 7.—CURVES FROM FOREGOING DATA.

Summation Curve—Fig. 5 shows a summation curve which gives the station voltage at any output to the external circuit and is constructed as follows.

At voltage of 530 the generator output is 800 amperes, the battery discharge 200; total, 1,000 amperes to the line at this voltage. Similarly, at 540 volts the sum of the two outputs = 700 + 100 = 800; at 560 volts the generator output = 500 amperes and the current going into the battery = 100 amperes; hence the line current = 500 — 100 = 400. Likewise, at 570 volts, line current = 400 — 200 = 200 amperes. In this way the points on the summation curve are located which give line current as the abscissæ and station voltage as the ordinates. Since the characteristics are both straight lines, the summation curve is also a straight line. In this case only two points have to be located and joined together, but in many cases where the generator characteristic is a curve, the summation line becomes a curve and several points must be located to trace it. For this reason the method of tracing is here set forth.

Line Constants—From Fig. 5 it may be seen that the station voltage at 1,000 amperes is 530 volts. Since the minimum voltage at the delivery point two miles distant must not fall below 350 volts, the total line-drop must not exceed 180 volts, which fixes the resistance at 0.18 ohm. The resistance of two miles of well-bonded seventy-pound rails is 0.0582 ohm. This leaves 0.1218 ohm as the copper resistance, or 0.0609 ohm per mile, corresponding to 940,000 circular mils. Taking this resistance, the curve of line drop at various loads is plotted, which is shown in Fig. 6. This is, of course, a straight line.

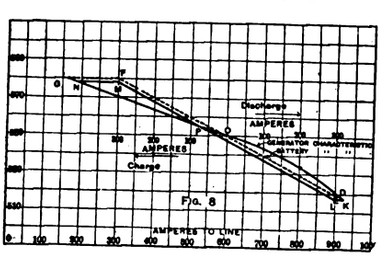

FIG. 8.—DROOPING GENERATOR CHARACTERISTIC.

Derived Diagrams—From the foregoing data and figures the curves in Fig. 7 are derived. Curve A is the load diagram before mentioned. The next curve B shows the generator load. Curve C shows the current to or from the battery. Curve D shows the variation in station voltage with the load, and curve E shows the voltage changes at the feeding point, being plotted by subtracting from the ordinates of D the feeder drop for the various currents. Since all the relations are of the first order, the various curves are of the same form as the load curve. Curves D and E are also of the same

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form, but reversed, being inverse functions of the load curve.

A study of these curves reveals the following:

(1) The voltage at the station falls off rapidly with increase of load (curve D, Fig. 7).

(2) Only two-thirds of the capacity of the battery to discharge are utilized. It can discharge at the rate of 300 amperes, and only 200 amperes are drawn from it at the instant of the maximum peak (Fig. 4).

(3) Because of the fall in station voltage with load, the copper required on the line is excessive, and the voltage at the feeding point unsatisfactory, as shown by curve E.

(4) The fluctuations on the generator are greatly reduced, and the capacity of the generating equipment may be decreased in the ratio of eight to ten, or twenty per cent.

Drooping Generator Characteristic—All the foregoing is based on straight generator characteristic. As a matter of fact, however, it would be of the form shown in Fig. 8. This change, from a theoretical straight characteristic to the actual drooping one, introduces complications. If the battery characteristic intersect that of the generator at the point of normal load—600 amperes—as indicated by the dotted line, the discharge on heavy loads will be greater than in the previous case, since the inclination of any element of the curved portion to the horizontal is greater than that of the straight-line characteristic, and a larger portion of the load will be taken by the battery. But it may also be seen that with the same light loads as before, the battery-charging current is less than in the previous case.

Relation between Input and Output—In any battery used for regulation, it is necessary that the input approximately equal the output, otherwise the state of battery charge is changed and the efficiency of the regulation decreased. If the input exceed the output, the excess energy will be lost, going off in the form of free gases from the cells, and the high voltage due to overcharging decreases the current which may be sent into the battery on light load, thus permitting more fluctuation of the generator load. Furthermore, continuous overcharge will ruin a battery, if persisted in.

If the output exceed the input, electrical bankruptcy follows and the battery is in no condition to help the generator when most needed.

From Fig. 8 it may be seen that the input and output are to each other inversely as the two areas on either side of the intersection of the generator and battery characteristics, which are formed by the spaces included between the two characteristics and closed by horizontal lines which are drawn through the points of voltage at maximum charge and discharge. That is,

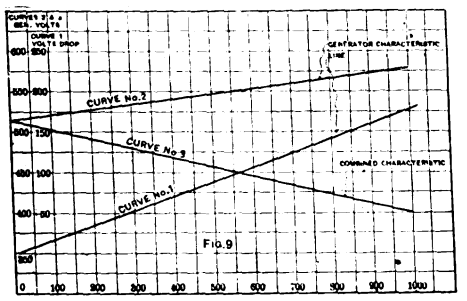

FIG. 9.— CHARACTERISTIC OF OVER-COMPOUNDED GENERATOR.

the areas O D E and O F G are to each other inversely as the battery input is to the output. The point O is not necessarily the intersection with the line of average external load, but is the point of intersection of the two characteristics. Obviously, therefore, the battery characteristic must be moved downward, increasing O F G and diminishing O D E until these two areas are equal, the resulting areas being P M N and P L K. This means that the normal battery voltage is lowered, its zero point being shifted downward. With the normal load of 600 amperes on the line, there will now be a charging current into the battery of twenty amperes, making the generator current 620 amperes and lowering the station voltage to 548 volts.

Conditions with Drooping Characteristic—The conditions are then manifestly less advantageous in the actual case than in the theoretical case first discussed and in either case are worse than they would be with an over-compounded generator in the power station working without a battery. A mere reduction of mechanical strains and fuel-consumption is of little

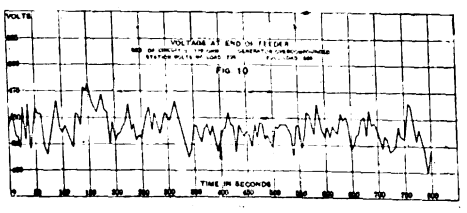

FIG. 10.—VOLTAGE CURVE AT FEEDING POINT.

avail if the cars on the system can not be accelerated, carried over grades and schedules maintained.

Compound Generator—For comparison with the previous cases, Figs. 9 and 10 are shown. In Fig. 9 are plotted the characteristic of an over-compound generator, the line characteristic with resistance 0.18 ohm as before and a combination of these showing the total characteristic for the feeding point. From this last, the curve in Fig. 10, which is the voltage curve at the feeding point, is plotted. This is drawn to the same scale as curve "E," Fig. 7, and a comparison of these two curves shows the superiority of the over-compounded generator working alone. The minimum voltage in the former case is 350, in the latter 401; and the maxima are 522 and 482 volts, respectively. If 350 volts are sufficient for satisfactory operation, the resistance of the circuit may be increased from 0.18 to 0.23 ohm. Deducting the track resistance, 0.0582 ohm, the copper resistance becomes 0.1718 ohm which corresponds to 665,000 circular mils, as against 946,000 circular mils in the first case—a reduction of twenty-nine per cent.

CASE II—FLOATING BATTERY OUT ON THE LINE.

Data of System—Consider now the case of a floating battery located at the feed point—two miles away from the station: assume an over-compounded generator giving 520 volts at no load, and 580 volts at full load of 800 amperes, and assume further that the battery will discharge 200 amperes at maximum load of 1,000 amperes, giving 800 amperes as the maximum transmitted over the line. If the minimum voltage allowable be 350 volts, the resistance = 0.287 ohm or 0.288 ohm for the copper resistance, corresponding to 495,000 circular mils or twenty-five per cent less copper than that required in the case of the compound-wound generator working alone.

Fig 11 shows the generator characteristic, the line characteristic, the combined characteristic, and the characteristic of a 600-ampere-hour, 392-volt battery. This shows that when the maximum load of 1,000 amperes comes on the system the generator supplies 700 amperes, the battery 300, and the voltage is 371.

Derived Diagrams—In Fig. 12 are shown the summation curve of Fig. 11, giving the voltage at the feeder point for any current to the line, and the line No. 2 which shows the relation between the amperes flowing over the line and the current from the generator. Fig 13 shows the three curves, B the load on the generator; C the current to or from the battery, and D the voltage at the feed point all for the same load curve shown in A, Fig. 7. All these are to the same scale as the corresponding curves in Fig. 7 and may be readily compared therewith.

Excessive Charge Rate—The only ob-

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jectionable feature in this system is that the charging current when there is no load on the line at no load would be far in excess of the permissible rate. This is shown both in Figs. 11 and 12. In Fig. 12 the voltage at zero line load is seen to be 425 volts, which on the combined characteristic in Fig. 11 corresponds to a current flow over the feeder of 450 amperes. If there is any possibility of the line ever being relieved of load, some provision must be made for avoiding this excessive charge. In the system under discussion, however, this never occurs.

Results—The location of the floating battery at the feeding point shows manifest and undoubted improvement in that it not only performs all the functions of equalization with the production of the accompanying benefits, but the copper and size of generator are so much decreased that the saving is greater than the cost of the battery, so that the first cost of the system is less than in the case of a generator without the battery auxiliary.

It is to be noted that the voltage at the feeding point, with average line load, is 392 volts, which is also the open-circuit voltage of the battery. In the case of the battery located in the power station, the floating voltage required is 550. The number of cells in series in the former instance is 194, and in the latter 271; so that the cost of the battery is diminished in this ratio, or twenty-eight per cent. Also this changes the slope of the battery characteristic. The 550-volt battery shows thirty volts increase above normal for the one-hour charge rate, and the same amount below normal for the one-hour discharge rate. In Fig 11 it may be seen that the variation above or below normal for the one-hour rate of charge or discharge is 21.5 volts due to the smaller number of cells in series. The change in the voltage of the individual cells is, of course, the same in either case.

Overcharge—In practice it is necessary to overcharge or "boil" the cells occasionally to maintain them in good condition. The voltage on overcharge rises to about 2.6 volts per cell or thirty per cent more than the normal voltage. Thus a battery which has a floating voltage of 550 volts would require a potential of 715 volts at the terminals to give a proper overcharge. Since it is seldom possible to increase the station voltage to such a figure, it becomes necessary when "boiling" to connect the battery so that it is divided into two portions, each having an equal number of cells in series. These two halves are then connected in parallel across the line. As the required voltage to overcharge is now halved, proper resistances must be inserted between each set of cells and the line. Generally, the ordinary water-barrel rheostat is used. Since overcharge need only be given ten or twelve times a year, this is not a continuous condition of operation.

Where the battery floats at the end of a long feeder of fairly high resistance, which is heavily loaded, the normal battery voltage is lower than that of the station, and during the early hours of the morning, when for half or three-quarters of an hour the load may be thrown off the feeder, the decrease in feeder-drop, together with full generator excitation, may bring the voltage at the battery terminals up sufficiently high to give it the required overcharge. In the case just cited, the voltage at the feed point with seventy-five amperes passing over the line (which current is ample for boiling a 600-ampere-hour battery) is 502 volts. The potential required at the battery is $194 \times 2.6 = 503$ volts. A very slight increase in the generator voltage will, therefore, meet the re-

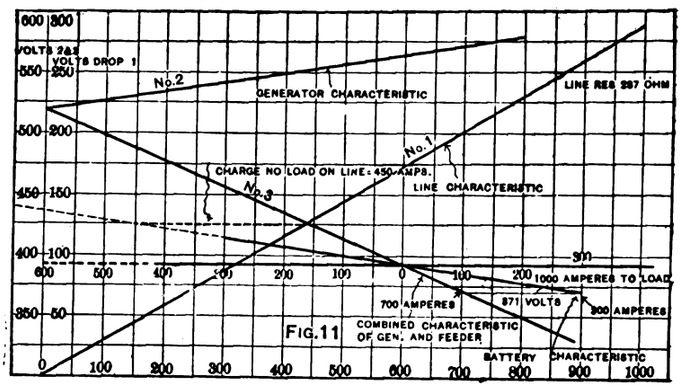

FIG. 11.—COMBINATION CHARACTERISTICS.

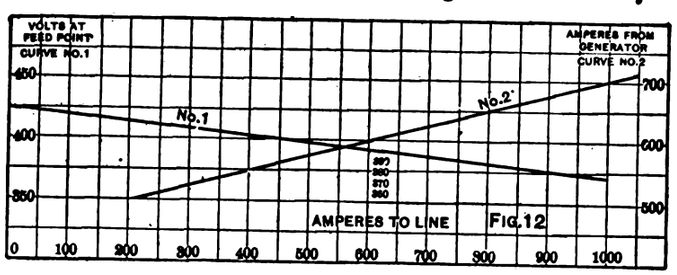

FIG. 12.—SUMMATION CURVE OF FIG. 11.

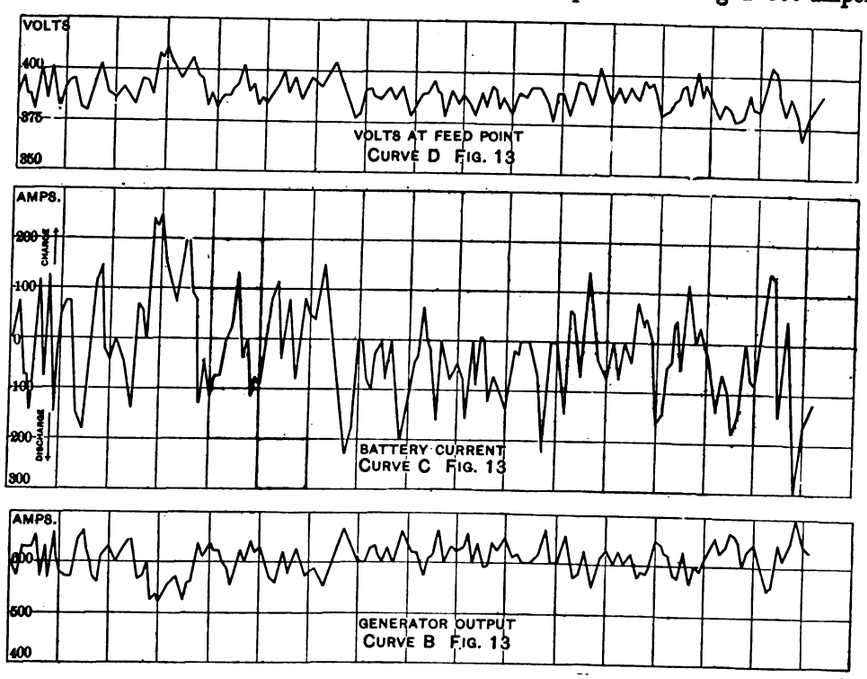

FIG. 13.—COMPARISON CURVES.

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quirement, if the feeder be entirely relieved of other load.

COMPARISON CASES I AND II.

The results, then, of locating a battery out on the line as compared with the use of the generator working alone are:

(1) Load on generator is maintained much more constant as indicated in curve B, Fig. 13.

(2) Copper cost is greatly reduced.

(3) Voltage varies much less and with less copper, the minimum voltage is increased.

Also the full capacity of the battery is utilized, which was not the case when floated in the station.

BOOSTER SYSTEMS.

In discussing the operation of the two batteries previously considered, with booster auxiliaries, it is proper here to indicate how, and under what conditions, automatic boosters operate. There are two generic types of regulating boosters: one in which slight changes of line voltage cause changes in field excitation to produce charge or discharge; in the other the field excitation is varied by the changes in external load.

Fig. 14 shows an example of the first-mentioned type: G is a shunt-wound generator, B the booster armature, E the battery, and MM the motors or variable load on the system. The driving motor is not shown. The operation of this booster is as follows: at normal load, the voltage of the battery is equal to that of the line, and as no current flows either into or out of it, the series field S is not excited and the booster voltage is zero. On increase of external load, the generator tends to send out additional current, causing a slight decrease in line voltage. The battery then begins to discharge and the field S being energized by the outgoing current, induces an electromotive force to assist the discharge, or in other words, adds an electromotive force to the battery electromotive force equal to the drop due to discharge. This added electromotive force compensates for the battery drop whatever the rate of discharge, since both vary directly as the outflowing current. Conversely, if the load decreases, the line voltage will rise slightly, causing the beginning of a charge. The direction of the current now being reversed in the coils, the electromotive force produced in the booster armature is also in the opposite direction and assists in forcing the charge into the battery. Since the rise in battery voltage on charge and the booster electromotive force both increase proportionally to the current, the rise in battery electromotive force is practically compensated for. Therefore, within small percentages the voltage is maintained constant, regardless of the rate of battery charge or discharge, and from this it follows that the load on the generator is also kept constant. Obviously, this booster is operative only on systems having a falling characteristic with load increase; that is, with a shunt generator, if the bat-

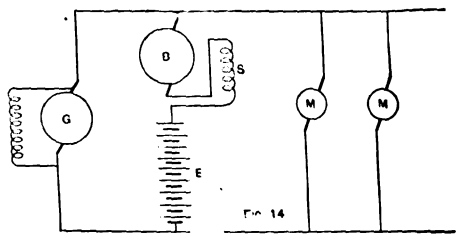

FIG. 14.—REGULATING BOOSTER.

tery is located in the power-house or on a feeder, the drop through which exceeds the increase in voltage at the generator terminals, if the system is fed by a compound-wound dynamo.

The second type of booster is shown in Fig. 15. In this the battery voltage is equal to that of the line, and at normal load the excitation of the series field S, which is in the external circuit, is exactly equal to that of the shunt field *f*. These being oppositely wound, neutralize, and the booster voltage is zero. If the external load be increased, the excitation of S overpowers that of *f* and there results a booster electromotive force proportional to the increase in external load and in a direction to cause the battery to discharge. Should the load decrease, the shunt field is the predominant one and produces an electromotive force in the booster armature to cause a charging current to flow into the battery. This booster can be used either with shunt or compound-wound machines.

These diagrams merely illustrate the salient principles of booster operation,

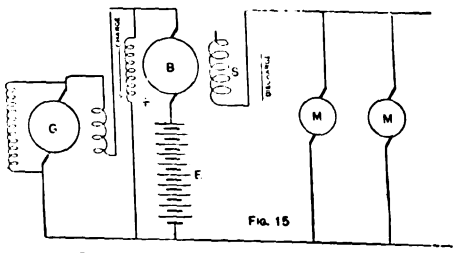

FIG. 15.—REGULATING BOOSTER.

and are not complete, practical devices, as additional windings are required to produce points of stable equilibrium and prevent excessive charge or discharge. There is a large number of different types having various windings and connected in ways peculiar to the ideas of the inventors, or the limiting factors of existing patents. These two, however, show the principles on which they all work.

(To be concluded.)

Two New Books.

The J. B. Lippincott Company, publishers, Washington square, Philadelphia, will shortly bring out "The Mechanical Engineer's Reference Book," by Henry Harrison Suplee. Mr. Suplee is editor of the *Engineering Magazine*, of New York and London, and a member of the American Society of Mechanical Engineers and several foreign societies. He is universally recognized as one of the foremost authorities in his field, and the new volume is intended to form a standard handbook for the mechanical engineer and designer of machinery, supplying, in convenient form, the general information which is constantly required. This is not to be an old book under the disguise of a new edition, but is the first edition ever printed, thoroughly up to date, set in new type, and with illustrations especially made for it. The work embraces mathematical tables, principles of statics and dynamics, machine design, materials of construction, hydraulics and hydrostatics, steam engineering, heat motors, the mechanical applications of electricity and modern machine shop methods, including works management and systems, cost keeping, intensified production, and the general relations of engineering to production.

The James T. Allen Patents Publishing Company, Washington, D. C., will shortly issue "A Digest of United States Patents on Wireless Telegraphy (Space)," under fifteen subdivisions, years 1789 to January, 1904. This digest is being compiled by permission of the Honorable Commissioner of Patents from the records of the United States Patent Office, and will include all of the American patents issued on wireless telegraphy between the dates above mentioned. The work will contain 500 pages of drawings and the specifications and claims in full. It will also contain all of the reissues, designs and trade-marks granted during the above period, accompanied by the full specifications and claims. Especial care is being bestowed upon the arrangement of patents, to simplify and facilitate expert, validity and preliminary examinations, and, to this end, the patents will be arranged chronologically under fifteen subdivisions. A general alphabetical index will be provided, in which will be given a complete list of the references cited, by number, name and date; interferences; parties thereto, and decisions while the applications—now patents—were being examined in the United States Patent Office. The digest will be in one volume, and the edition will be limited. The price has been fixed at $25; foreign subscriptions, $30. It will be ready for delivery in the early part of 1904.

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Notes on Steam Turbine Electric Generating Plants.

At a meeting of the Leeds local section of the British Institution of Electrical Engineers, Mr. George Wilkinson read a paper on steam turbine generating plants. Mr. Wilkinson first described briefly the historical development of the Parsons, De Laval and Curtis turbines, and the method of construction. He then discussed the value of this prime mover, as compared with the reciprocating engine.

The economy of space and buildings was set forth by comparing the 3,500-kilowatt Sulzer-Kolben two-phase generators at the Willesden works of the Metropolitan Electric Supply Company, with turbo-generators of equal output. The Sulzer-Kolben plant weighs, with condensers, approximately 585 tons. The space occupied by the foundations is sixty feet two inches in length by twenty-one feet six inches in width, with a vertical height above the engine room floor to the top of the piston tail rods of thirty-three feet four one-half inches. A Parsons turbo-generator of the same output weighs approximately 148 tons, and the space occupied does not exceed thirty-seven feet one inch in length by eight feet in width and fourteen feet six inches in height, plus about an equal depth for the condenser room beneath. A Curtis turbo-generator of 5,000-kilowatt output weighs approximately 175 tons, and the space occupied does not exceed twenty feet by fifteen feet, with a vertical height not exceeding thirty feet. In this size the condenser, turbine and generator are arranged vertically, the condenser forming the base of the plant.

According to the published data, the maximum steam consumption guaranteed by the builders of the Sulzer-Kolben plant works out with saturated steam at 150 pounds pressure and a vacuum of twenty-four inches at 22.2 pounds per kilowatt-hour at full load, twenty-three pounds per kilowatt-hour at half load. The makers of the Parsons turbo-generator guarantee the steam consumption, with steam at 150 pounds pressure, vacuum of twenty-eight inches, and superheat of 100 degrees Fahrenheit, at 17.5 pounds per kilowatt-hour at full load, and twenty pounds per kilowatt-hour at half load. A further interesting comparison in this respect is given between the most enconomical of the two 1,400-kilowatt two-phase plants with triple vertical engines recently installed in the Leeds electricity works and the 1,750-horse-power direct-current turbo plants installed last year in the works of the Newcastle and District Electric Lighting Company.

	Speed.	Superheat.	Kilowatts	Steam Pressure.	Vacuum.	Water per Kilowatt-Hour.
				lb.	in.	lb.
Leeds	200	76° F.	1,400	183	25.6	19.9
Newcastle	1,710	237° F.	897	145	26.5	17.73

Tests on a 500-kilowatt turbo-generator have shown an improvement in steam consumption resulting from a superheat of fifty degrees Fahrenheit of about eight per cent, and at 100 degrees Fahrenheit it averages about twelve per cent, and the author believes that by using very high superheat further economy in steam will be obtained in this direction provided the vanes at the high-pressure end of the turbo are made of a metal which does not become brittle at high temperatures. In the case of large engines of the usual types it is not advisable to superheat the steam by more than 200 degrees Fahrenheit, and in some cases there is much trouble with the valves if the superheat exceeds 150 degrees Fahrenheit, but in the steam turbine there are no such limitations.

So long as proper adjustments are maintained between the fixed and moving vanes, the efficiency as to steam consumption appears to be well maintained. This view is confirmed by the following tests taken on a 300-kilowatt Parsons turbo-generator under his own control, in which the tests made at the Harrogate electricity works in February, 1902, are compared with tests made in the same works and under precisely the same conditions after over nineteen months' heavy work. It will be noted that the results of the 1903 tests are better than those of 1902, which may be partially owing to the increased speed, but chiefly to the fact that the number of the vanes in the high-pressure end were found broken off on opening out after the test of 1902.

TESTS OF 300-KILOWATT TURBO-GENERATOR AT HARROGATE.

Date of Test.	Steam Pressure.	Superheat.	Vacuum.	Load in Kilowatts.	Speed.	Pounds Steam per Kilowatt-Hour.
	lb.	lb.	in.			
Feb. 19, 1902.						
Full load	130.5	41.9° F.	28	309.5	3,010	22.76
Half load	131	45° F.	28.8	157.4	3,010	25.1
Sept. 30, 1903.						
Full load	130	35° F.	28	307.5	3,080	21.12
Half load	130	38° F.	28	127.1	3,080	23.24

In the discussion of the paper, Mr. Holiday said that he had found there was a resistance of one megohm between the spindle of the turbine and the frame of the bearings, due to the film of oil in the bearings. In regard to oil economy, Mr. S. D. Schofield had found it necessary to use expensive lubricating oil, and had had some trouble due to the oil mixing with water, but this was overcome by filtering the oil. Mr. Stoney said that, with a 1,500-kilowatt machine, they were obtaining results two per cent better now than sixteen months ago, and that they saved $25 a week in oil for a load of 600 kilowatts, the equivalent of a saving of about two pounds of steam per kilowatt-hour.

Mr. W. J. A. London had no difficulty in synchronizing a 3,000-kilowatt Parsons-Brown-Boveri rotary turbine with a slow-speed engine, and he said that the overall length of the 5,500-kilowatt turbine for the London Underground Railway would be about forty feet, which compared favorably with any slow-speed, horizontal, reciprocating steam engine. The total weight of the combined plant was about 200 tons, about one-third of the 3,500-kilowatt Sulzer-Kloben plant. While with a Continental firm he found that the oil consumption for 1,000-kilowatt units was, for a reciprocating engine, four gallons of engine oil, four gallons of cylinder oil and four gallons of filtered oil for twenty-four hours. With the steam turbine 0.8 gallon of engine oil and 0.4 cylinder oil were used. With oil at ordinary prices, and a station having ten of these units, there would be a saving in the oil bill of $10,000 per year by the use of steam turbines.

Mr. Samuelson said that, by superheating 100 degrees, the steam consumption was reduced one pound. Assuming the consumption to be nineteen pounds, there would be a saving of ten per cent.

The last session of the University of Pennsylvania appropriated $25,000 to equip a laboratory for X-ray research and Finsen's light apparatus at the Hospital of the University of Pennsylvania. Dr. Henry K. Pancoast has charge of the work.

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HOW THE UNITED STATES GOVERNMENT USES ELECTRICITY.

BY J. E. PRICE.

What is the United States Government doing in the electrical field, in the use of electricity as motive power and otherwise? Well, the government knows a good thing, and is not slow to adopt anything of merit.

In nearly every department of the government at Washington electricity is used—for light, elevator or other service. The electric current now runs every press—by directly-connected motor—in the Bureau of Engraving and Printing, where two thousand men and women are engaged in turning out gold and silver certificates, bonds, revenue and postage stamps. Millions of the latter are turned out every year for this country, Porto Rico, Guam and the Philippines. This work is done entirely by electrical power, and the process is quite interesting. The plates—vignettes, numbers and lettering—are all engraved in the Bureau, and, after being printed on electrically driven presses, in sheets of one-hundred stamps to the sheet, they are sent to the gumming machines. Here they pass under gumming rollers, thence through a long heated box, from which they come out dry. Now they are put through an automatic electric perforating machine which makes the little holes that divides each stamp from the others on the sheet. After this the sheets are put in an hydraulic press and smoothed, and the process is completed.

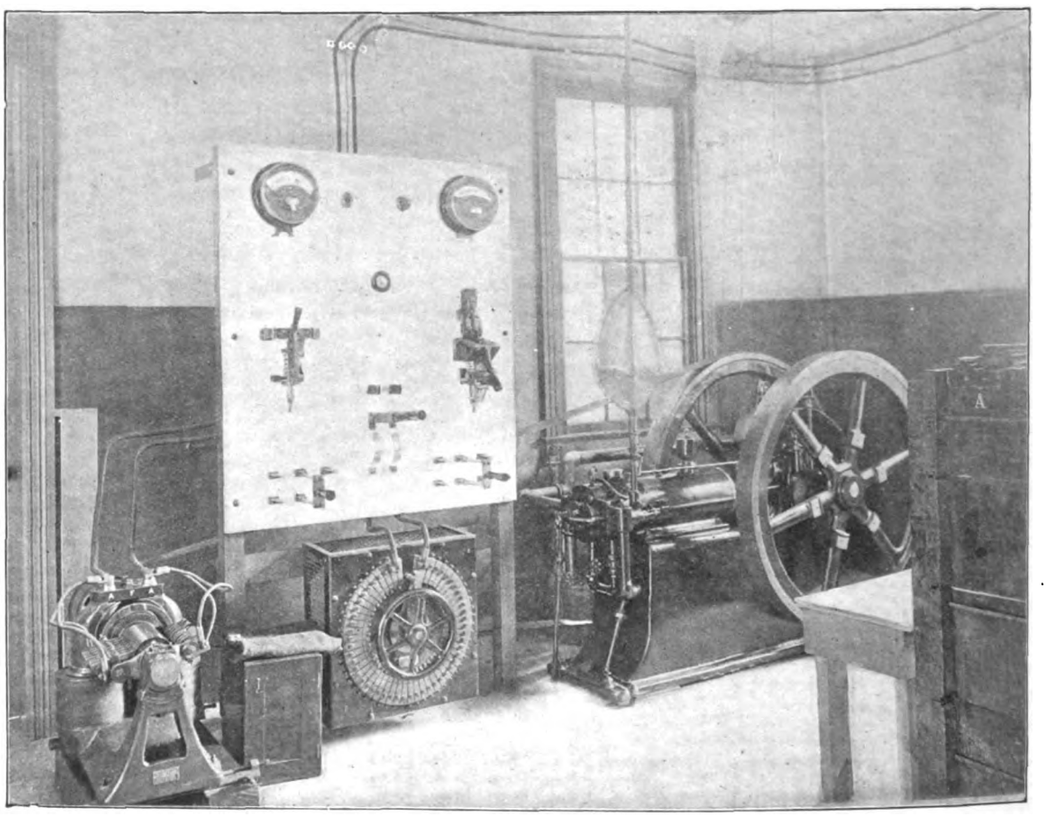
Next to the Washington Navy Yard, the Government Printing Office is the largest user of electricity of all of Uncle Sam's working-places. The new printing office, not long since finished, is the most complete of its kind in the world. It is a huge brick structure, seven stories high, fronting 175 feet on North Capitol street and 408 feet on G street. It has 400,000 feet of floor space and contains 12,000,000 bricks, 14,000,000 pounds of steel and 2,500,000 pounds of cast iron. There are fifteen elevators in the building, a refrigerating plant for cooling drinking water, and drinking fountains at convenient places.

All the Printing Office machinery is moved by electric power. There are over one hundred printing-presses, each with a direct-connected motor. In the power-house there are four engines, two of 800 horse-power, one of 400 horse-power and one of 250 horse-power. The battery consists of eight boilers of 300 horse-power each.

The working force of this great establishment consists of about 4,000 people, one-third being women. There are 900 book-binders, 1,200 compositors, 100 pressmen, 200 press-feeders, about 600 folders, 260 stitchers, 55 stereotypers and electrotypers; and besides these there are hydraulic pressmen, engineers, electricians, firemen, boxers, counters, watchmen, etc.

Until quite recently the Washington Navy Yard has been running the greater part of its machinery, for gun, gun-carriage making and numerous other purposes, by steam alone. Now the electric motor is seen in nearly all the navy yard shops. The electrical equipment there is excellent, and is being improved from time to time as Congress makes appropriation for such improvement.

The electrical outfit of this yard consists principally of one generating set of a 600-horse-power, McIntosh & Seymour engine, direct-connected to a 400-kilowatt, General Electric generator; one set consisting of one 125-horse-power Ball & Wood engine, direct-connected to a forty-kilowatt, 115-volt, General Electric generator; two generating sets consisting of a 300-horse-power, cross-compound, Ball & Wood engine, direct-connected to two 100-kilowatt, 115-volt, General Electric generators. All are connected with the Edison three-wire system. The 400-kilowatt generator is connected with the outside bus-bars. The every-day load is 3,600 amperes.



PART OF THE ELECTROPLATING OUTFIT, MAP MAKING DEPARTMENT, UNITED STATES COAST AND GEODETIC SURVEY.

In most cases in the navy yard shops the electric motors are located in the galleries high overhead, operating the machinery below by means of belts, but there are a number of small motors, from one to four horse-power, on lathes, shapers and milling machines, direct-connected.

The Washington Navy Yard gun plant is said to be the best equipped in the world. It is certainly a huge one. The great gun shop alone covers about two acres, and with its new extension is 1,000 feet long by eighty feet wide. The gun-

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carriage shop is almost as large; and there are others in the plant-building system which are of great dimensions, among them the foundry, occupying 22,000 square feet, and the forge shop, 13,500 square feet. The whole navy yard acreage now, by recent addition, is about ninety acres.

In this big war material manufactory there is a vast amount of machinery and all of this will soon be run by electricity. Nearly all of the fifteen lifting cranes—one of which carries 110 tons—are run by this power, and even the models, upon the lines of which government ships are constructed, are towed through the water by electric power.

These models—in hull-shape of warships—are constructed in a big shop in the navy yard, where twenty-three electric motors are altogether employed for power. When finished the models are taken for trial to the model testing tank in a brick building 500 feet long by fifty feet wide, and there put in the water and attached by a steel arm (rod) to a carriage. The latter spans the tank, on both sides of which is a rail track. The carriage has four trucks to each of which is attached an electric motor, the aggregate capacity of the latter being 300 horse-power. The speed of the tank carriage varies from one-tenth of the knot (ten feet per minute) to twenty knots per hour (2,000 feet per minute). The resistance of the model against the water is measured by a spring, the forward end of which, attached to a bracket, is screwed forward or back by means of an electric motor. A rigid arm extends from the bracket and marks its position with a pencil on a recording drum. The after end of the spring is connected with the towing rod which draws the model. These automatic appliances—all on the moving carriage—are so nicely adjusted that they record time, distance and resistance during each run of the model.

Two other places where Uncle Sam employs the electric current to do his work are the Coast and Geodetic Survey and the Bureau of Standards. The functions of the latter place consist in the custody of the standards; the comparison of the standards used in scientific investigation, engineering, manufacturing, commerce and educational institutions, with the standards adopted or recognized by the government; the construction when necessary of new standards, their multiples and subdivisions; the testing and calibration of standard measuring apparatus; the solution of problems which arise in connection with standards; the determination of physical constants and the properties of materials. At present the Bureau is giving its attention principally to length measures, weights, capacity measures, thermometers, polariscope apparatus, hydrometers, resistances (electric), standards of electromotive force and direct-current measuring apparatus.

Some of the rooms of the Bureau building (the office has not yet been moved to the new edifice just outside of Washington) are crowded with various kinds of testing instruments, largely electrical, many delicate and beautifully finished.

The power for running machinery for making and testing instruments at this place is supplied by a gas engine and an electric generator of nine kilowatts capacity. Besides this there is employed a storage battery of 132 cells for reserve and power, when the engine is not running.

The Bureau has comparatively recently received from England an electrostatic voltmeter which will be the standard for comparing such meters.

In the Coast and Geodetic Survey electricity is used principally as a working force in electroplating. Here maps and charts are made of land and water; thousands of miles of coasts must be looked after, and all the trackless paths of ocean and lake must be charted. And when maps and charts are made they are engraved upon large copper plates and put through the electroplating process. Some of the plates are about three by four feet in size. The electroplating plant is now run by a gas engine of six horse-power which drives an electric generator, furnishing a maximum current of 300 amperes at ten volts.

The Coast and Geodetic Survey also has a magnetic outfit for detecting measuring and telling the direction of magnetic currents. This is done by a photographic process. Three magnets, each balanced perpendicularly in an air-tight glass cylinder, are used. Running from each magnet is a boxed channel way, the three meeting in one channel, at the end of which is situated a recording drum revolved by clockwork and carrying a wide band of sensitized photographic paper. The drum revolves continually night and day, and the position of each magnet, by means of a spot of light centered upon it, is continually reflected upon the sensitized paper and photographically recorded. When there has been magnetic disturbance, causing the needles (magnets) to waver, the record appears in zigzag lines; when current is absent the lines are perfectly straight.

The knowledge thus gained is used principally in correcting the mariner's and surveyor's compass; but from data gathered in this connection it is said that it may also be used in forecasting coming earthquakes. It has been frequently noticed by scientists that great magnetic disturbance has preceded earthquakes.

The United States Weather Bureau, where maps are made and from which forecasts issue, is a user of electricity; the new War College, consisting of more than twenty buildings, now being erected on the Arsenal grounds in Washington, will be a large user of current in its work.

Programme of the Annual Meeting of the American Society of Mechanical Engineers.

The programme for the annual meeting of the American Society of Mechanical Engineers, to be held in New York, December 1 to 4, 1903, is as follows:

"The Money Value of Technical Training," presidential address by Mr. J. M. Dodge; "Is Anything the Matter with Piece Work," by Mr. Frank Richards; "Modifying Systems of Management," by Mr. H. L. Gantt; "Slide-Rules for the Machine Shop as Part of the Taylor System of Management," by Mr. C. G. Barth; "What Are the New Machine Tools to Be?" by Mr. J. E. Sweet; "Suggestions for Shop Construction," by Mr. F. A. Scheffler; "The Pitot Tube," by Mr. W. B. Gregory; "Methods of Determining Rates and Prices for Electric Power," by Mr. F. B. Perry; "Three and Four-Wire Multiple-Voltage Systems," by Mr. L. A. Gillet; "Test of a Compound Engine Using Superheated Steam," by Mr. D. S. Jacobus; "The Pressure Temperature Curve of Sulphurous Anhydride," by Mr. E. F. Miller; "Construction and Efficiency of a Fleming Four-Valve Engine," by Mr. B. T. Allen; "A Compact Gas Engine of the Beam Type," by Mr. C. H. Morgan; "Standard Unit of Refrigeration," by Mr. J. C. Bertsch; "Series Distilling Apparatus of High Efficiency," by Mr. W. F. M. Goss; "Air Motors and Air Hammers; Apparatus and Methods for Testing," by Mr. M. H. Wickhorst; "Valve Motion of Duplex Air Compressors," by Mr. S. H. Bunnell. The sessions will be held at the following places: the opening session of Tuesday evening, December 1, at the society's house, 12 West Thirty-first street; Wednesday morning, December 2, at Mendelssohn Hall, 113 West Fortieth street; Thursday morning, December 3, at Stevens Institute of Technology, Hoboken, N. J.; Friday morning, December 4, the concluding session at the society's house. The excursion and social numbers on the programme are: on Wednesday afternoon, visits to various large central power stations; Wednesday evening is left open; Thursday afternoon, inspection of Stevens Institute; Thursday evening, reception at Sherry's, Forty-fourth street and Fifth avenue; Friday afternoon, excursion to the works of the De Laval Steam Turbine Company, Trenton, N. J.

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NOTES ON X-LIGHT.

BY WILLIAM ROLLINS.

NOTE CLXXIII—FURTHER APPARATUS REQUIRED IN PUMPING X-LIGHT TUBES.

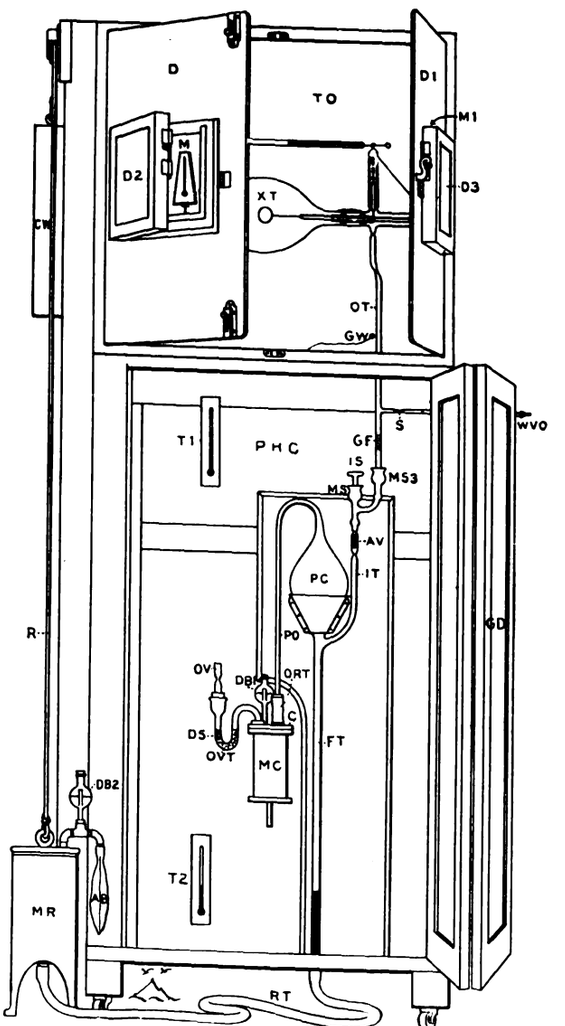
To any one who has studied the history of the mercury pump, the difficulty of saying anything new will be evident. About the only originality which can be shown is in a judicious selection and combination of valuable features, useless ones being discarded. The former are few, the latter so many it seems as if the object had been to complicate the pump.

If it is important to rapidly obtain the highest vacuum, the pump and vessel to be exhausted should be of one piece of glass without joints, drying tubes, gauges or stopcocks; the pump and vessel to be exhausted being hot.

When the calibre of the pump increases or diminishes, the change should be gradual, to allow the mercury to sweep off gases and vapors from the glass. A pump of this kind might be called the Swedenborg-Mile-Rood-Pump, for Swedenborg invented the first mercury pump in 1722, Mile added the barometric tubes on the inlet and outlet, and the rising and falling mercury reservoir in 1828. Rood, in 1880, showed that the pump should be hot. If all the other men who have worked on the hand mercury pump had never existed, it would to-day be as efficient. As the highest vacua are of no value in X-light tubes, though supposed to be necessary, a pump for exhausting them may well have its efficiency slightly diminished if it is made more convenient. A pump of this kind suited especially for experiments where it is desirable to collect the gases or measure the degree of exhaustion, is shown in Fig. 2. Mile's barometric tube on the inlet is replaced by a short, wide tube IT with a stopcock IS, only a little above the outlet tube. This construction was made possible by the invention of the automatic valve AV by Mitscherlich in 1873. In his valuable pamphlet "The Development of the Mercurial Air Pump," Thompson states, on page 23, that a stopcock between the vessel to be exhausted and the pump is worse than useless. As the experiments mentioned in these notes could only be made at night, on account of daily professional duties, it was necessary to economize time in pumping the X-light tubes. Preventing water vapor in the air from entering the pump (while standing unused) by means of a stopcock IS on the inlet tube was found to reduce the time required to exhaust the tubes. This is so important, it will be stated as another X-light axiom —water vapor should be kept out of the mercury exhaust pump.

Before the stopcock IS is opened, most of the water vapor should be removed from the X-light tube by heat and a small hand exhaust pump, attached by a flexible rubber tube at WVO, a partial vacuum being produced. The tube S is then sealed; IS being opened and the exhaustion finished with the mercury pump. Where the latter is not worked by hand, as in the figure, but by a mechanical pump, as recommended in note cxxxviii, the preliminary exhaustion should be directly into the mechanical pump.

One never sees a mercury pump without a drying tube between the pump and the vessel being exhausted. Usually it is sealed to the pump as shown in Fig. 1, note clxx. The temptation then is to allow the drying salt to remain too long, for the pump must be taken apart before new drying salt can be introduced. If a drying tube is used, it should be attached by a ground point, as imaginary leaks from such joints do less harm than damp drying salt. But to those who are not bound by tradition, the discarding of the drying tube is recommended. Therefore, it is not shown in the pump illustrated. Details of apparatus for preventing water vapor from entering the pump from the mercury reservoir having been given in note clxx only the method of applying the principle to the pump outlet will be here considered. In Fig. 2, Mile's barometric outlet tube PO ends in a vessel MC provided with a tight cover



NOTE 173, FIG. 2.—HAND MERCURY EXHAUST PUMP ARRANGED FOR EXHAUSTING X-LIGHT TUBES.

Front view of tube oven and pumping arrangements. TO, tube oven with non-radiable walls. D and DI, non-radiable doors. M and MI, mica windows. D2 and D3, non-radiable lead glass doors. XT, X-light tube. OT, tube connecting X-light tube with the pump. GW, grounding wire on outlet tube. S, tube connecting X-light tube with mechanical exhaust pump. GF, gold foil to prevent mercury from entering the X-light tube. MS3, mercury seal where the tube OT joins pump. AV, automatic valve. IS, stopcock with mercury seal MS on inlet of pump. PC, pump chamber. FT, fall tube connecting pump chamber with mercury reservoir MR through rubber tube RT. AB, air bag on mercury reservoir. DB2, drying bulb. R, rope connecting mercury reservoir with counterweight CW. P.O, pump outlet. ORT, soft rubber tube connecting pump outlet tube with mercury cistern MC. C, cover of mercury cistern. DB, drying bulb. OVT, outlet tube of mercury cistern. DS, drying salt. OV, outlet valve. T, TI, T2, thermometers, which can be read from the outside. PHC, pump hot closet.

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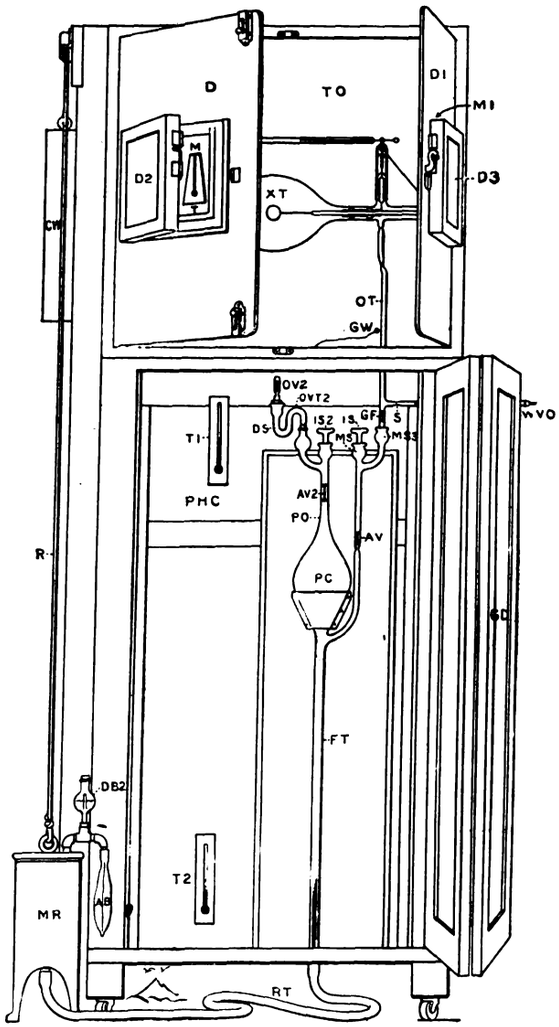
C containing three openings, two of which are closed by rubber stoppers, the third by a rubber tube ORT which makes an air-tight connection between the Mile's tube PO and the vessel MC. Through the first rubber stopper passes the tube OVT, closed at the outer end by a valve OV and filled with drying salt ES. The end of this tube, within the vessel MC, extends down over the upturned end of the Mile's outlet tube. As the mercury rises in the pump chamber, it flows over, appearing at the end of the Mile's outlet tube escaping into the vessel MC, the air from the pump arising through the tube OVT, passing out by the valve AV. As the mercury falls in the pump chamber the valve closes, excluding the outer air, retained air being freed from moisture by the drying salt. The soft rubber cylinder ORT connecting the Mile's tube PO with the vessel MC collapses, allowing the mercury to rise again by atmospheric pressure into the Mile's tube. When it is necessary to collect the gases from the vessel being exhausted, the tube OVT with its rubber stopper, is removed, a vial of mercury being inverted over the upturned end of the Mile's tube and held in place by a rubber hand, causing it to fit the hole in the top of the mercury cistern MC. For details of methods of introducing the collected gases into spectrum tubes, refer to Traver's valuable work, "The Study of Gases." In some of the experiments mentioned in earlier notes, while attemptng to find out the nature of the gases in the cathode stream, they were collected in this way, but a surer path was making the X-light tube the spectrum also, by a movable target. The third rubber stopper supports a drying tube DB which keeps the air in the mercury cistern MC dry. No gauge is shown on the pump, for the degree of the vacuum can be measured by having a mark near the upper part of the Mile's outlet tube, in making the necessary calculations. This form of pump, while well suited for investigations on X-light tubes in which it is desirable to collect the gases, is not to be recommended for routine work as the capillary is liable to fracture and care is required to prevent bubbles from rising through the capillary to the pump chamber. In Fig. 2A this capillary tube PO, Fig. 2, is replaced by an automatic valve AV2 which, like the similar one on the inlet AV, Fig. 2, is the invention of Mitscherlich, 1873. When this form of pump is used, the pump can not itself be a gauge, but this is no objection in a pump intended only for routine exhaustion of X-light tubes, therefore no gauge is shown in Fig. 2A. A drying tube like that in Fig. 2 at OVT should be attached to the pump outlet at OVT2, Fig. 2A, and a stopcock IS2 with a mercury seal, to prevent water vapor from entering the pump when standing unused. A pump of this kind should be called the Swedenborg-Mile-Mitscherlich-Rood. These are the only men whose work on the hand mercury pump has been essential for either efficiency or convenience, but to a pump with shortened fall tube to be mechanically operated, the name Robinson must be added. His form is more convenient than a hand pump, if power is available, and the mercury reservoir may be placed within the pump hot closet, rendering the heating of the mercury simpler. In the hand-operated pump, with the mercury reservior external to the hot closet, as shown in the figures, the mercury reservoir may be heated by an electric or gas heater.



NOTE 173, FIG. 2A.—APPARATUS FOR EXHAUSTING AND TUNING X-LIGHT TUBES.

Front view of tube oven and pumping arrangements for routine exhaustion of X-light tubes. TO, tube oven with non-radiable walls. D and DI, non-radiable doors. M and MI, mica windows. D2 and D3, non-radiable lead glass doors. XT, X-light tube. OT, tube connecting X-light tube with the mercury pump. GW, grounding wire on the outlet tube. S, tube connecting the X-light tube with the mechanical exhaust pump. GF, gold foil to prevent mercury from entering the X-light tube. MS3, mercury seal where the tube OT joins the pump. AV, automatic valve. IS, stopcock with mercury seal MS on inlet of the pump. PC, pump chamber. FT, fall tube connecting the pump chamber with the mercury reservoir MR through the rubber tube RT. AB, air bag on mercury reservoir. DB2, drying bulb. R, rope connecting mercury reservoir with counterweight CW. PO, pump outlet. AV2, automatic valve. IS2, stopcock with mercury seal. OVT2, drying tube. DS, drying salt. OV2, outlet valve. T, TI, T2, thermometers.

Heating Arrangements—In earlier notes the necessity of keeping the X-light tube and pump hot was repeatedly mentioned. An arrangement used in the experiments and already described is here illustrated.

Tube Oven—In Figs. 2, 2A and 3 is shown a tube oven TO with non-radiable walls. Its dimensions are sixty by seventy-five by seventy-five centimetres. It is lined with asbestos. There are two doors D and DI, each of which has a window of mica M and MI. The mica windows have doors D2 and D3 glazed with heavy lead glass, three centimetres thick or more. The X-light yielded by the tube can be seen through the mica windows.

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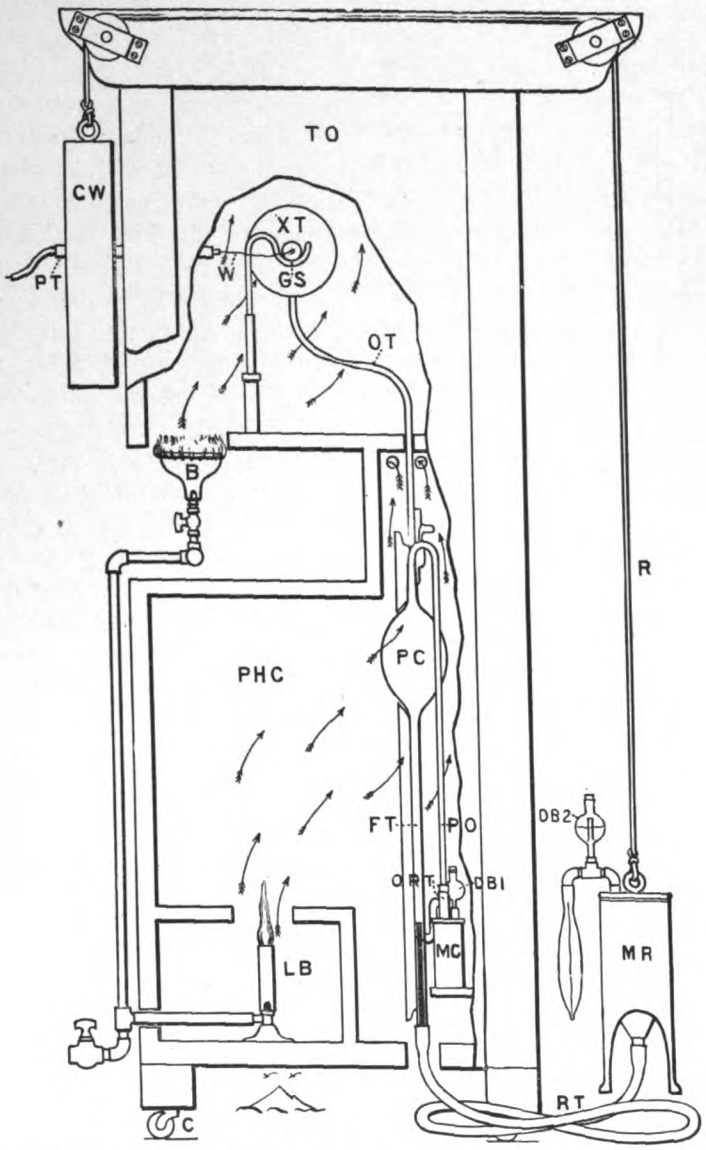
When this is not necessary, the mica windows are covered by the glass doors to prevent the operator from being injured by the X-light while pumping and tuning the tube. The importance of this precaution has already been sufficiently pointed out in former notes.

rangement is shown in Fig. 3 at LB. Both oven and pump closet are provided with thermometers which can be read from the outside. Sufficient details for pumping have been given in earlier notes, particularly in note cxxxviii.[1] Directions for operating pumps may be found in the



NOTE 173, FIG. 3.—APPARATUS FOR EXHAUSTING AND TUNING X-LIGHT TUBES.

Side view of tube oven TO and pump; hot closet PHC, with sides partly removed to show interiors. B and LB burners for heating. PC, pump chamber. PO, pump outlet. MC, mercury cistern on pump outlet to which it is connected air-tight by the soft rubber cylinder ORT. DB, drying bulb. MR, mercury reservoir. DB2, drying bulb. AB, air bag. RT, rubber tube connecting the mercury reservoir MR with the tall tube FT. R, rope connecting mercury reservoir with counterweight CW. OT, tube connecting X-light tube XT with the pump. GS, glass fork supporting one end of the X-light tube. W, one of two wires connecting the X-light tube with the electric generator. PT, one of two porcelain tubes insulating wires from the metal walls of the tube oven. C, one of four casters. The arrows indicate heated air.

One end of the X-light tube is attached to the pump by the tube OT, Fig. 2, the other end being supported by the glass stirrup GS, Fig 3, which can be adjusted. The means of heating the oven are shown in Fig. 3; B is one of three gas or kerosene burners. The heat ascends as shown by the arrows, PHC, Figs. 2 and 3, is the pump hot closet. The door D, Fig. 2, is glazed to allow the pump to be examined and folds in the middle to admit of partial opening, when necessary to reach the pump, and yet prevent too much cold air from entering. The heating arwork already mentioned. In former notes, it was said the emanations from the pump should be prevented from entering the X-light tubes during pumping, directions being given for accomplishing this. One means was to place a loose plug of gold foil in the tube going to the pump, to absorb mercury vapor. This is shown in Fig. 2 at GF.

[1] The discharge from the secondary of an induction coil at the time when the current begins to pass through the primary causes the anode to act as a cathode, blackening of the tube from the platinum torn off from the metal. Therefore in exhausting an X-light tube, when the terminals are being electrically treated, to remove the proper amount of amalgamated gas, there should be spark-gaps in series with the tube to prevent the inverse discharge through the tube.

Another was to insert a wire in this outlet tube, the wire being grounded. This is shown in Fig. 2 at GW. In many of the experiments, the coil was grounded for the same purpose. In former notes it was said an X-light tube should be exhausted and subjected to the same current, before it was sealed, that would afterward be used in exciting it, and as it was difficult to obtain satisfactory tubes for powerful apparatus, the suggestion was made in note lxviii to hospitals where X-light was much used, to have their own pumping arrangements. For these reasons, the pumping apparatus here shown is portable, the pump being worked by hand, the weight of the mercury reservoir being balanced by a lead weight illustrated in Fig. 3 at CW. With a hot pump this arrangement is less convenient, as the mercury reservoir is outside the hot closet.

The pump here shown is made of glass, the material always employed. It might be well to try to make a metal pump. Seamless, polished steel tubing can now be obtained and the beautiful electrical welding process of E. Thomson would enable a pump to be made of one piece. the inner sides of the welds being afterward ground smooth and polished. In order to attach the X-light tube, the glass tube connecting it to the pump could be sealed to a seamless platinum tube united with the pump. A pump of this kind instead of being a delicate instrument most suitable for the laboratory, might be a commercial machine.

Cape Town Industrial Exhibition.

The directors of the Cape Town Industrial Exhibition (international) are open to receive offers for lighting the grounds, etc. This exhibition opens in November, 1904, and closes at the end of January, 1905. The address of the managers is Palmerston House, Old Broad street, London, E. C.

Weights of German Continuous-Current Machines.

The following figures quoted by the *Electrician,* London, from a German paper, refer to continuous-current machines made by a leading German firm in 1896 and 1902, respectively. The figures given are based on a speed of 1,000 revolutions per minute.

Capacity of Machine in Kilowatts.	Weight per Kilowatt.	
	1896 (Kg.)	1902 (Kg.)
1	260	150
5	145	74
10	124	68
50	51	26
90	45	21

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THE COMBINED USE OF ALTERNATING AND DIRECT CURRENT FOR CENTRAL STATION WORK.

BY PROFESSOR F. C. CALDWELL.

Some twenty years ago the advocates of alternating and direct current were in violent antagonism and many were the heated discussions as to which of these two forms of current distribution was essentially the best; it seemed, at that time, to be a common belief that sooner or later either the alternating or the direct current would gain entire possession of the field. From the standpoint of dividends, and if the pudding is to be judged in the eating, it would seem that in the long run the direct-current men have had the best of the argument, at least under the conditions of the past. How much of this advantage has been due to an essential superiority of the direct current, and how much to the factor of superior organization and management, we will not undertake to discuss.

Conditions, however, have been greatly changed since the time of these debates, and with the enormous increase in the amount of electric energy distributed, and with ever-growing ambition to cover larger fields, the direct-current man has found himself obliged to call upon the alternating current to help him out, nor has the alternating-current man failed to do his share in burying the hatchet.

The question has now become, "In what proportion should the alternating and direct currents be used in any particular plant." There may still be found those who claim that the alternating current is competent to take care of all the business of the central station, but such a stand finds few supporters.

We may, in general, divide plants in which the use of alternating and direct current is combined, into those where the alternating is used for transmission only, the distribution being entirely by direct current, and those where the alternating current shares this function with the direct. There would seem to be little or no justification for the first class, since there must be in any case much work that can be performed by the alternating, at least as well as by the direct current. The second class of plants may be discussed, first for the case of new or entirely reorganized plants, and second for that of the extension and improvement of plants already installed. In the first case, a plant could be established which would be as near the ideal in all respects as engineering knowledge could make it. This case, while unquestionably the more interesting, is nevertheless seldom met with in practice, it may, however, be well to consider it first and then to notice what modifications will be introduced, because of the fact that the best must be made of parts, at least, of a plant already established.

For convenience, we may consider the problem first from the point of view of the consumer, second from that of the distribution of the current, and third from that of the station.

To the consumer, incandescent lighting is the only important use of electricity, where it is a matter of entire indifference whether the current be alternating or direct, providing only that the frequency of the alternating current is high enough to prevent flickering. When we come to the question of arc lights, there is liable to be a preference which would generally be on the side of the direct-current lamp, because of its greater quietness and steadiness, although occasionally the somewhat superior distribution of the light from the alternating arc might have weight. The Nernst lamp, in so far as it has been developed in this country, is much more satisfactory for alternating than direct current, while, on the other hand, the new Cooper Hewitt mercury vapor lamp can be used only with direct current. Summing up the conditions then for the lighting business, it would appear that the honors are about equal for the alternating and direct currents. What the future developments in the use of the two forms of lamp last mentioned may bring forth remains to be seen, but it is not likely that for some time to come they will constitute a very important factor in the problem.

Turning next to the matter of power, there are doubtless many customers who are quite indifferent as to whether their power be supplied from a direct-current shunt motor or from an induction motor, though at present owing to the greater cost the latter is likely to have weight among such customers. A considerable number, however, which will be larger or smaller according to the character of service, will have a more or less decided preference for the one or the other form of motor. Leaving out the factor of first cost of the motor, probably the larger part of these would want the alternating current on account of the great simplicity of the induction motor and of the small amount of care needed to obtain satisfactory service from it. On the other hand, those that wish for the direct-current motor would generally be more insistent in their demands. Among these by far the most important class for the average central station in the larger towns and cities would be the elevator motor; the importance of this work is shown by a statement that in Chicago it constitutes twelve and one-half per cent of the total output of the central stations. So far the induction motor has proved distinctly unsatisfactory for this work and seems, indeed, entirely incapable of handling the high-speed service of the tall buildings now becoming so common. Not only is the operation of the induction motor unsatisfactory for this purpose, but the heavy and lagging starting current proves a most inconvenient factor in the distribution problem. Another class of work where the induction motor has so far failed to give satisfaction, is that requiring a variable speed. While the speed of the shunt motor can be varied by resistance, either in the field or in the armature, the simple induction motor does not lend itself to such methods of speed reduction, having always a strong tendency to approach to a synchronous speed. Another class of work where it would seem that the induction motor could not give satisfaction is that where it is desired to open the circuit immediately upon the appearance of an overload, as, for instance, in the case of a motor running a large printing-press. On account of the heavy starting current necessary for induction motors, it is impracticable to use with them circuit-breakers or enclosed fuses which are rated at a reasonable per cent above the normal full load current. Traveling crane work and other similar cases where characteristics peculiar to the series motor are required would also in the present state of the art fail to find entire satisfaction in the alternating current, though it is possible that the recent development of the series alternating motor, due to Mr. B. G. Lamme, may alter this condition.

For electrochemical work, direct current alone is available, though the possibility of obtaining the exact voltage needed may make the use of alternating current converted to direct more satisfactory. There are also a number of minor uses of electricity where the one or the other form has a decided advantage; thus for charging batteries and also medical and other small batteries, the direct current alone is available; though, of course, the conversion of the alternating to the direct on the spot with the aid of a rotary converter is always possible; the expense, however, of this method is often prohibitive. On the other hand, the alternating is much

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the most available for producing the high-potential high-frequency currents used in the X-ray and other forms of medical manipulation; it is also much the most available for use with the ordinary form of dry electric welding.

In view of these facts it appears that the desirability of one form of current or the other, so far as the consumer is concerned, will depend much upon the class of work, apart from lighting, that is being done; thus in the centre of a large town the elevator problem proves a strong advocate for the direct current, and in manufacturing districts the preference for the direct or alternating would depend upon the class of manufactories that were being supplied. Thus, if the character of the work required an approximately constant speed and was such as to make the care of motors with commutators difficult, the alternating current might have a decided advantage, while if, on the other hand, the work required variable speed, the direct current would be preferred.

Looking at the matter now from the standpoint of the distribution of the current, a rather complicated problem or set of problems presents itself, and it will be well to consider several different cases separately. First, suppose that the generating station, as has been common in the past, is located in the centre of a considerable concentrated load. As between generating and distributing direct current or alternating current, the following advantages are to be noted: for direct current, great simplicity throughout the system and hence less liability to trouble, also an entire absence of danger to life, and an investment for copper in the conductors instead of for insulating materials. On the other hand, these advantages are balanced by the serious disadvantage of the limited area of distribution possible for the ordinary three-wire system. This may in some cases be increased by using 440 volts, but then the problem of a satisfactory lamp presents itself, and seems not yet to have been entirely solved. On the other hand, for alternating current we have the great advantage of an unlimited extension of our distribution, increased distances only requiring higher voltages on the primary circuits. The facility with which the constant-potential alternating current can be converted into constant current for series arc lighting is also a considerable advantage to be credited to the side of the alternating current; likewise is to be noted the facility with which the electromotive force upon the different feeders can be regulated by means of the various inductive voltage regulators. To set against these advantages, however, we find a series of troubles coming from the inductive character of the alternating current, especially when induction motors form a considerable part of the load and the power-factor is consequently low. This has the effect of decreasing the capacity of the lines, transformers and generators and also of seriously affecting their voltage-regulating qualities, though this latter effect has been overcome in the case of one generator now upon the market. With the use of large conductors, especially if the distance between them is considerable and if the load be a lagging one, considerable drop is produced by the inductance. The so-called skin effect also comes in to keep down the size of conductor that is available. Thus, a conductor one inch in diameter has its apparent resistance increased eleven per cent for a sixty-period current, while a conductor of 2,000,000 circular mils would be quite impracticable on account of a similar increase of thirty-five per cent. These facts are doubtless ample warrant for the condition of affairs which we find in general existing in such stations, that is, the generation and supply of direct current for the district immediately surrounding the station, with the use of alternating current for more distant areas.

If, however, as is coming to be more and more the case, all power is generated at one or more distant stations and transformed at substations suitably located to take care of the load, the problem becomes a somewhat more difficult one. As has been shown above, a large part of the demand for current probably ranging from eighty or ninety per cent can be as well met with the alternating as with the direct current, and it certainly seems at first sight rather a useless expenditure to convert the whole output of the substation because from ten to twenty per cent of the load needs a direct current for its proper operation. It would seem advisable to make sure that no other more satisfactory plan could be devised. Thus, might it not be possible to have a general system of distribution by alternating current, supplemented by a 500-volt direct-current power line for the operation of elevators and other motors requiring direct current. It has even been suggested that it might be more economical to install induction motors driving direct-current generators, which in turn should operate the elevator motors, rather than to convert the whole output of the substation for the benefit of this comparatively small part of the whole load. It must be remembered that we are, so far, considering only the case of the establishment of a new plant.

Taking up next the power station, we find some important considerations bearing upon the question. Probably the most vital of these is that of the storage battery, which has come to be regarded by most managers of the larger stations as quite indispensable to satisfactory operation. The battery, of course, makes the use of direct current, at least between its terminals, absolutely essential, and so far as the author knows no satisfactory application of it to the working of alternating-current system has so far been carried out, although it has been suggested that a rotary converter might be placed between the storage battery and the alternating-current system upon which it is floating. Even if this arrangement could be made to work, it would in practice involve so large a converter in order to get the full advantage of the capacity of the battery when used at a one-hour discharge rate, that the expense would probably be prohibitive. The importance of the battery in the larger stations is so great that this might often amount to a determining factor in the problem. On the other hand, we have the present wonderful development of the steam turbine directly connected to alternating-current generators, and it seems doubtful whether the same degree of satisfaction will be possible in applying the steam turbine in direct-current work.

To sum up then the conditions as they appear in the newly established plants of the present day, the evidence seems to favor for the smallest plants having no large concentrated load and little or no elevator work a distribution entirely by alternating currents. For larger stations located near their load centres, there seems to be no doubt about the use of direct current supplemented by the storage battery for the district surrounding the station and including the concentrated load, and the generation of alternating current for transmission to and distribution in the regions more distant from the station. For the generation of power in this case several different arrangements are possible; one of them is the use of double-current generators, but a difficulty presents itself here in that these are usually made for a frequency which is too low for satisfactory lighting. Another plan is the use of the direct-current generator and steam turbine alternator with a rotary converter to connect these, and

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make it possible to carry the whole load, when light, on either of the two machines alone. In some cases it may be possible to omit one or the other of the generators, at least temporarily, producing all the power as direct current and converting for the alternating-current distribution, or *vice versa*, according as the demand for one or the other form of current is the greatest. Lastly, comes the case of larger towns where it is desirable to generate the power at a greater or less distance. Here the almost universal practice is to have rotary converter substations at the centre of the concentrated loads, where the alternating current generated at the main power station or stations is converted to direct current; this is then distributed as such with the aid of the battery located in the substation, while the more distant and less concentrated districts are supplied with the alternating current. Here the question of frequency comes in again as a complicating factor. Rotary converters operate more satisfactorily on low frequency, but this is not suitable for lighting purposes; the question therefore must be decided as to whether to sacrifice the best interests of the converter stations and use a frequency of sixty or to use twenty-five periods for the transmission to the substations and to raise the frequency to sixty for use in the suburban districts; of course the relative importance of the two kinds of service would have considerable influence in deciding this question.

We must now consider the effect upon this problem of the adaptation of plants already installed, so as to fit them for modern conditions. Such plants if located near the centre of distribution will generally be direct-current plants and unless the development of business is such as to warrant the establishment of a new generating station at a distance from the centre of distribution, their development will naturally follow the lines that have been laid out above; that is, direct current will be retained for the transmission in the vicinity of the power-house, and alternating-current generators will be added for the more distant districts. If the development of business has been such as to warrant the establishment of a distant generating station, the old power-house will usually become a substation with rotary converters for supplying the old direct-current district; the alternating-current districts being supplied directly from the new generating station. The question then arises as to what shall be done with the generating outfit that has been heretofore used. If this is antiquated it may well be dispensed with entirely or if room will permit maintained simply for emergency work and for times of the peak load of the year during the Christmas holidays; if, however, the direct-current equipment is modern, it will be advisable to consider whether it should not be kept in constant commission to take care of the daily peak, the load being taken care of entirely by the main generating station through the converter during the remainder of the day and night.

Where the station to be remodeled is an alternating-current plant at a distance from the centre of the city, if it has been well located, it will probably be developed into the main generating station, and the question of the establishment of a direct-current rotary converter station in the growing centre of the town will have to be decided. In this case, the factors to be considered are practically the same as in those of establishing a new plant.

In the above discussion it has been assumed that only general power is under consideration. Of course if railway power is also to be furnished, a direct-current supply to that extent at least is, and probably for a long time will be, necessary. This railway current might be made to take care of elevators and other motors needing direct current were it not for the National Code rule prohibiting such usage, so that unless this rule is neglected the question of whether railway power is supplied from the same power-house or not will not materially affect the discussion as given above, except that if it should be considered best to have a special direct-current motor circuit, it would naturally be made of the same voltage as the railway circuit, in order that generators and rotary converters might be switched on to either the railway or the motor circuit at pleasure.

Assuming that the plant is to comprise both alternating and direct-current distribution, the question arises as to what part the direct and alternating currents should take, respectively, in the distribution. Three different arrangements are possible; the districts covered by the direct and alternating currents may be entirely separate, or the alternating and direct currents may both be available to the consumer throughout a considerable part of the system, or the alternating and direct-current districts, while in general separate, may overlap on their borders. The first of these conditions if practicable financially, would be the most satisfactory to the consumer, making it possible for him to have either form of current as best suited to his particular needs. It is doubtful, however, whether conditions would often permit of such a double distribution unless it were in a case where polyphase alternating currents were used for the general distribution of light and power supplemented by a 500-volt direct-current circuit, used only for such motors as required this current for their satisfactory operation. Otherwise it would seem that the entire separation of the districts covered by the two forms of current would be the only arrangement that could be worked without danger of a considerable amount of friction with customers desiring a different form of current from that most available in their district.

In conclusion, it is interesting to consider the probable effect of future developments upon this problem. There has already been presented to the electrical public a piece of apparatus which may go far toward making the alternating current satisfactory for universal distribution, at least so far as customers are concerned, this is the Cooper Hewitt mercury vapor converter which has been briefly described in the technical papers of the past year, and which was presented before a meeting of the American Institute of Electrical Engineers last July. If this simple instrument does what is hoped for it, and if it is sold at a reasonable price, it should make it possible for any customer upon an alternating-current system to obtain direct current of any amount with a very moderate expenditure. One development of which there is less promise but which we can not help hoping may yet not be a thing of the distant future, is the direct generation of current from fuel. Such current would doubtless be direct, and its generation in this form, if offering a considerable improvement in economy over present methods, would be a great factor in the problem which we have been considering.

National Electric Light Association.

The proceedings of the National Electric Light Association at the Chicago convention were of unusual scope and bulk, papers and discussions alike being of great importance. The work of preparing the annual volume of transactions has, therefore, been formidable, but the secretary hopes to have it ready for use very soon. The volume promises to be not far short of 1,000 pages, which, with its special appendices—one of them in colors—will constitute one of the best efforts of the association made in this direction up to date, and will be of great interest to all the members, particularly those who have been unable to attend the meeting.

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The 181st Meeting of the American Institute of Electrical Engineers.

Two Valuable Papers.

THE 181st meeting of the American Institute of Electrical Engineers was held at Carnegie Hall, New York city, November 20. The meeting was called to order by President B. J. Arnold.

The secretary announced the election of thirty-four associate members, and the transfer of the following associate members to full membership:

Walter Ambrose Pearson, New York city; Wynn Meredith, San Francisco, Cal.; Lorin Everett Imlay, Niagara Falls, N. Y.; Bernard Edward Sunny, Chicago, Ill.; John Joseph Carty, New York city; Eugene B. Clark, Chicago, Ill.

The first paper of the evening was by Mr. Lawrence Addicks, of Perth Amboy, N. J., and was entitled "The Electrical Conductivity of Commercial Copper." Mr. Addicks pointed out the importance of a careful study of the properties of copper, and said that the conductivity test was the most satisfactory method for detecting the presence of impurities. It is also interesting to note that commercial copper to-day has a conductivity one per cent better than the purest laboratory copper of forty years ago.

Conductivity is affected by the physical state of the metal, as well as by its chemical constitution. The influence of the chemical impurities most usually met was explained by means of diagrams. These impurities are suboxide of copper, arsenic, antimony, and in some coppers, bismuth. Small quantities of other elements may be met with, but the impurities mentioned are those looked for in low copper. The effect of arsenic or antimony is shown by one diagram, as the two elements have a very similar influence. The conductivity varies inversely as the per cent of these impurities present, and is reduced about five per cent by the presence of 0.01 per cent of arsenic or antimony.

The influence of the suboxide on the conductivity is greater, and the law governing the change of conductivity with per cent of suboxide present is more complex. The curve showing this relation has a crest where the conductivity is greatest, this occurring when there is 0.5 per cent of suboxide present. The decrease in conductivity with decrease in oxygen present may mean that the oxide is in combination with the impurities, rather than with the copper.

The conductivity of copper varies with its physical condition, but is less affected thereby than by the presence of arsenic or antimony. The tensile strength of copper varies almost directly as the reduction in area, and the conductivity drops about 0.1 per cent for every 1,300 pounds gain in tensile strength. The effect of annealing hard-drawn wire is to increase the conductivity, the increase varying with the annealing temperature until, approximately, it is 1,100 degrees. If the temperature is carried beyond this point, the conductivity again decreases. The question arises whether the lower conductivity due to overheating is caused by the absorption of oxygen, or by a change in the physical state. To investigate this it was first attempted to anneal copper in a neutral atmosphere, or to protect it by some non-oxidizable coating, but the results were not very satisfactory. When the overheated wire was immersed in dilute nitric acid until the diameter was considerably reduced, there was no appreciable change in the conductivity. This indicated that any chemical change taking place was uniform throughout the wire. In another test, samples of burned wire were drawn to a small size, reannealed, and then tested; and as the original conductivity was recovered, the tests indicated that the change was of a physical, and not of a chemical, nature.

Microphotographic studies of copper are useful, as they indicate the physical condition. Good cast copper shows a distinct crystalline formation. Where impurities are present, the crystals are smaller and the cleavage is in different directions in the grains. When the copper is rolled and drawn the granular construction is broken down and a fine fibre results; and when the copper is burned or overheated, crystallization begins again. In cast copper the conductivity results from the combined conductivities of the pure copper grains and the impure matrix of cement. When this is rolled, the structure is broken down, and the complex shunt and series circuits are rearranged to better advantage. In handling wire, the cement is softened and all internal strain is equalized. In burning, crystalline growth is started and reverts the metal to the original condition.

In opening the discussion, President Arnold called attention to the need of specifications for copper used in railway work. At present the engineer is usually satisfied to call for ninety-eight per cent conductivity, leaving the rest to the manufacturer. He thought that good service could be done by the manufacturers if they would tell the engineers how specifications for copper should be drawn, and what qualities should be called for.

Mr. F. J. Newbury, of Trenton, said that the conductivity test for the purity of copper was used because it is delicate and easily made. He called attention to the increase in resistance and the decrease in tensile strength of copper wires when stranded. Thus, a stranded wire of a given weight per foot will have a lower tensile strength and a resistance about three per cent greater than a solid wire of equal weight. The change in resistance and tensile strength due to stranding is uncertain, and he suggested that engineers, in calling for stranded wire, specify the qualities required of the individual strands, and not of the complete cable. Good values for commercial copper to-day are about 100 per cent conductivity, with a tensile strength varying from 50,000 to 65,000 pounds per square inch. Sixty-eight thousand pounds can be got, but only with difficulty.

President Arnold did not agree with the suggestion made for specifying the qualities of the individual strands of a cable. The engineer is looking for net results, and is willing to leave the quality of individual strands to the manufacturers.

The second paper of the evening was an excellent one by Mr. Lamar Lyndon, of New York city, entitled "The Comparative Behavior of Floating and Booster-Controlled Batteries on Fluctuating Loads." This paper will be found on another page of this issue. It considers various methods of using storage batteries for reducing the load variations on a station. Each case is considered fully, and a method is given for predetermining the result. The various cases are then compared to show which gives the best results.

President Arnold, in opening the discussion, spoke of the value of studies of this kind. Only a few years ago it was almost impossible to obtain any reliable information upon the performance of the storage battery, and its value for such purposes was questioned by a good number of engineers. To-day the opinion has changed, and is almost unanimously in

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favor of batteries for such purposes as here discussed.

Mr. J. R. Appleton, of Philadelphia, emphasized the value of a storage battery for relieving the stress on a station, and he gave as an illustration the experience of a station in California, operating a railroad in connection with a ferry, where, before the installation of the battery, two generators, with an aggregate output of 1,450 kilowatts, had been unable to handle the load satisfactorily, even with a man standing constantly at the throttle of each engine. After the installation of the battery the larger generator, rated at 850 kilowatts, carried the load without any difficulty whatever, although there were variations of 2,600 amperes.

Mr. A. S. Hubbard, of New York, said that in selecting a battery it was desirable to choose one with a large plate surface, so that the battery might be able to take care of the most violent load fluctuations.

Mr. J. L. Woodbridge, of Philadelphia, said that it was impossible to use one battery for both steadying the load on the generator and regulating the voltage out on the line. If both results were necessary, two batteries must be installed.

Professor W. E. Goldsborough, of Purdue University, La Fayette, Ind., described the result of installing a battery in St. Louis. This had been located at the centre of distribution and enabled the company to take down copper enough from the line to pay for the battery and the auxiliary machinery at the station. In his opinion engineers would never be able to get along safely without the storage battery, even if they adopt alternating systems.

Mr. J. W. Lieb, Jr., New York city, said that large generating stations have become so important as to make it imperative to use all possible safeguards against interruption. One of the most important features in station operation is constancy of field excitation, and here the storage battery becomes absolutely essential. The battery is floated on the exciting circuit, and it is desirable not only to prevent the interruption of current, but to prevent serious fluctuations in the voltage of the exciting circuit. At first it was thought that it might be necessary to use a booster of some sort, which would act instantaneously in case of accident to the exciting sets, to prevent a change in voltage on the exciting circuit. However, experimenting with a 10,000-kilowatt installation had shown that the battery alone was all that was required. In direct-current systems of distribution, developed with alternating-current transmission, the storage battery becomes most essential, even more so than in a pure direct-current system, because the disturbances occurring are more violent. In such systems the storage battery installation on the line should be fifteen per cent to thirty per cent of the total generator output at the station. It would be hazardous to undertake a large system without such an auxiliary.

Mr. W. W. Donaldson, of New York city, said that in investigating the behavior of a storage battery installation, it was desirable to study the diurnal activity of the batteries. The battery installed should be of such a capacity that it will work, and not merely smooth out the variations in load of the station. If the battery is put on a line and does zero work in regulating the fluctuations it is of no value. Taking the kilowatt capacity at the one-hour rate as a basis, with a wattmeter placed on the discharge side, with a polarized relay, so as to show discharge, at the end of the day one may find one only has a number of watts registered equal to the discharge capacity at the one-hour rate. This might be termed the diurnal activity of the battery. To his mind, the battery properly installed, with proper booster regulation, should do more than that. The more work that can be done with the battery above zero, the more one is getting for his money. If the battery discharges once a day, it does a certain amount of work; but if it discharges three or four times a day, it does proportionately that much greater work. This question of diurnal activity is not given the consideration it should receive.

Professor Goldsborough also emphasized the importance of selecting a battery of such size that it would have work to do, as this would keep it in better condition. The storage battery not only reduces the load variations to a minimum, and thus makes possible the operation of the station under the best conditions, but it ensures continuity of service. By way of illustration, he spoke of an instance happening in Chicago, where an interruption to the feed-water supply made it necessary to shut down the entire station during a heavy load. When the supply of water had been started again, the problem of throwing on the generators with every light in the city turned on arose, and there was some doubt whether the station would be able to stand the strain. It was done, however, by means of a long rod, which closed all the switches at the same time. Such a contingency could not arise to-day, as, should the power station shut down, the storage battery would carry the entire load.

Mr. Lyndon said that, in preparing his paper, he had endeavored only to cover one phase of the problem. The whole problem was an important one, but a careful study of each case would lead to a proper solution.

The secretary of the Institute, Mr. R. W. Pope, announced that the December meeting would be held in the same room, but after that the place of meeting would be the auditorium of the Chemists' Club, 108 West Fifty-fifth street, New York city.

BOOK REVIEWS.

"Friction and Lubrication." William M. Davis. Pittsburg. The Lubrication Publishing Company. Cloth. 236 pages. 5¼ by 8¼ inches. Numerous illustrations.

This book is written by a practical man who has had a large amount of experience in the handling of lubricating oil, and in making experiments and friction tests on various forms of mechanical devices. The first chapter is devoted to a review of the laws of friction, and simple examples are given to demonstrate these laws. Apparently every condition under which a lubricator can be used is taken up, and the book will, no doubt, be of great practical value to men using machinery of every character.

"Home Mechanics for Amateurs." George M. Hopkins. New York. Munn & Company. Cloth. 370 pages. 6 by 8½ inches. 320 illustrations. Supplied by the ELECTRICAL REVIEW at $1.50.

This book is one of the *Scientific American* series, and is by the author of "Experimental Science." A large number of valuable hints is given by the author for the manipulation of tools and familiar apparatus in the production of ornamental and useful devices. The chapter on the operation of the lathe, both for metal work and woodwork, and instructions about drills and drilling, is very complete, and the treatment is such as will be appreciated by the amateur. A chapter is devoted to the making of model engines and boilers, and this is taken up in a very simple manner, so that even the ordinary mechanic can understand the construction, though it may be entirely out of his line of work. A large part of the book is given up to electricity, the whole of part seven being devoted to this subject. Under this head are taken up the construction of a practical primary battery, an electric chime, a home-made electric night lamp, an electrical cabinet, a simple electric motor, how to make a sewing-machine motor without castings, a design for an electric launch motor, the Edison dynamo or motor, the utilization of 110-volt electric circuits for small furnace work, recording telegraph for amateurs, and how to make telephones and telephone calls.

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Reviews of Current Engineering and Scientific Literature.

Radium and Cancer.

The Vienna Academy of Sciences recently commissioned Dr. Exner to enquire into the method of curing disease by radium, and he has submitted a report in respect to the treatment of cancer. According to this report, in nine cases radium has effected very considerable abatement in the cancerous swelling, and in two of these cases the swelling has not reappeared, although five months has elapsed since the treatment. In one case, where it was impossible to operate for a cancer in the palate, radium has effected considerable improvement. Dr. Exner concludes, that in cases in which an operation is possible this course is preferable, but the radium treatment is advisable where an operation is impossible.—*Abstracted from Electrician (London), November 6.*

A New Electrolyte for the Wehnelt Interrupter.

When a sulphuric acid solution is used as the electrolyte for the Wehnelt interrupter, there are two drawbacks—first, a relatively high voltage is required for operation; second, a comparatively high current, varying according to the value of the voltage, must be used. The first difficulty has been partly overcome by Carpentier, by increasing the conductivity of the electrolyte. The second difficulty is partially avoided by increasing the resistance of the interrupter and by diminishing the surface of the platinum point, so as to have the latter reach an incandescent state at a lower current. To improve the interrupter, Mr. D. E. Hauser has sought for a new electrolyte, and he has found that that best meeting the conditions is a half-saturated solution of magnesium sulphate, slightly acidulated with sulphuric acid. This electrolyte, though exhibiting a considerable conductivity, is not corrosive, and permits the operation to be started at a lower voltage. It also gives rise to an increased number of interruptions of the current. Mr. D. E Hauser found that this solution worked well with voltages as high as 118; but, by adding to a solution of sulphuric acid of the specific gravity of 1.05, twenty per cent of magnesium sulphate, the interrupter started at twenty volts, with a consumption of only five amperes. With sulphuric acid alone the best results at a voltage of twenty were obtained with a specific gravity of 1.305, fifteen amperes flowing.—*Abstracted from the Electrical Engineer (London), November 6.*

Relative Cost of Public Lighting by Gas and Electricity.

In a report prepared by Mr. J. W. Bradley, for the council of the city of Westminster, comparative costs are given for street lighting by gas and electricity. This city is lighted by electric arcs, and by gas burned in ordinary flat-flame burners, in single burners with incandescent mantles, in lamps having four burners grouped together with incandescent mantles, and in Sugg high-pressure lamps with incandescent mantles. All the lamps burn about 3,900 hours per annum. The candle-power of the electric arcs is about 570. For flat-flame gas burners, and for those with single incandescent mantles, the candle-power is about fifty. For the lamps with four-grouped burners, the candle-power is 113, and for the Sugg high-pressure lamps it is 481. The total cost per electric arc per year varies from $110 to $170, according to the location of the lamps. The average total cost per candle-power per year for these lamps varies from seventeen to thirty cents. For the ordinary flat-flame gas burners of from forty-eight to fifty-eight candle-power, the total cost per lamp per annum varies from $30 to $47.70. The average cost per candle-power per year varies from fifty cents for the fifty-eight-candle-power to ninety-five cents for the forty-eight-candle-power burners. For the single-burner incandescent mantle the cost varies from $14.45 to $17.50. The average total cost per candle-power per year is about thirty-seven cents. For the lamps with four incandescent mantles the total cost per annum is $66.60. The average cost per candle-power per year is about sixty-two cents. For the Sugg high-pressure lamps, the total cost per year is $91.25, and the average cost per candle-power per year is twenty-one cents.—*Abstracted from Engineering (London), November 6.*

Electrolytic Preparation of Metallic Powders.

If an electrolyte composed of a metallic compound be electrolyzed with a mercury cathode, a corresponding amalgam is obtained, and this may be done in the case of metals which ordinarily do not form amalgams. This furnishes a convenient method of preparing metallic powders, and has been used for this purpose by M. A. Zamboni. The amalgam is prepared as indicated above, the excess mercury is pressed out and is then heated to distill off the mercury. The metal remaining behind can then easily be reduced to a fine powder, and in consequence of the treatment is in a pure condition. The method is suitable for preparing powders for the Edison storage battery.—*Translated and abstracted from L'Electricien (Paris), November 7.*

Radium and Plants.

With a view of obtaining information regarding the sensibility of protoplasm toward the radiations of radium, Mr. Henry H. Dixon distributed 100 cress seeds uniformly over the surface of some sand contained in a saucer. Then a tube containing five milligrammes of pure radium bromide was supported at a height of one centimetre over the centre of the sand. During the experiment the saucer was covered with a glass shade and was kept in the dark. After two days, germination took place nearly simultaneously all over the sand, the growth of all the seedlings being nearly uniform; but a close comparison showed that the seedlings immediately under the radium tube were retarded in their development to some extent. This retardation was apparent in the seedlings situated within a radius of about two centimetres of the radium bromide. Besides being smaller, they developed fewer and shorter hair roots than those nearer the margin of the sand. The subsequent growth of the plants seemed to be in no way affected by the radium, nor did it appear to exercise any noxious effects, other than the retardation just described. The experiment was repeated twice with the same results. To determine if motile organisms are sensitive to the radiations, Mr. Dixon enclosed the radium in a tube of water containing large quantities of volvox globator. Extraneous light was cut off during the experiment. After twenty hours many of the volvox colonies had sunk to the bottom of the vessel, but they were evenly distributed over the bottom, while those that were still swimming in the water were also uniformly distributed through it, some being in contact with the radium tube. None showed signs of being attracted to or repelled from it. These experiments indicate that the radiations emitted by radium bromide are not able to produce marked effects in a short time on these vegetable cells and tissues. —*Abstracted from Nature (London), November 5.*

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Photometric Tests of the Chemical Brightness of Burning Magnesium and Phosphorus.

Bunsen and Roscoe have said that the burning of magnesium gives a simple and safe method of making photometric measurements. Herr J. M. Eder has found that magnesium light may also be put to other uses. The optical brightness of magnesium, burning in air, of which 7.4 milligrammes burn in one second, is 135 candles. The chemical brightness with free action upon silver bromide plates for one milligramme of magnesium is 435 second-metre-candle; for one milligramme of magnesium, acting on silver chloride, it is 872 second-metre-candles. Aluminum in sheet form, burned in air, gives, for one milligramme, a chemical effect on silver bromide of fourteen second-metre-candles; while the same material, burned in oxygen, gives from 715 to 824. Phosphorus, in comparison with magnesium and aluminum, as a source of light for chemical action, is of little value.—*Translated and abstracted from the Journal für Gasbeleuchtung und Wasserversorgung (Munich), November 7.*

Acceleration of Steam Locomotives.

In a technical study of train acceleration made recently by Messrs. D. W. D'Alton and John Manheim, London, the opinion is expressed that the eighty or 100-ton locomotive will not give the acceleration required for handling suburban traffic. Even leaving the great questions of economy, life of permanent way, and impracticability as a consequence of huge dimensions and weight out of the question, they reach the conclusion that the locomotive engineer, although he may overcome all his difficulties and construct a boiler—perhaps a water-tube one—which will keep steady steam, and increase its weight almost to the point at which the engineer responsible for permanent way will protest, he will find that his engine will require more than double the energy which the electric train asks for. This comparison is made only at a speed limit of twenty-two miles per hour, and stations one mile apart. These are the conditions which must be met, if the competition of the electric tramways in the vicinity of large cities is to be broken down.—*Abstracted from the Railway News (London), November 7.*

The Capacity of a Geissler Tube in a Magnetic Field.

The variations in the capacity of a Geissler tube, caused by a magnetic field, have been studied by Herren E. Lapuchin and A. Afanasieff. Three series of experiments were carried out: first, without the magnetic field; one in which the tube lay parallel to, and the other in which the tube lay at right angles to the lines of force. They find that when the tube is not in a magnetic field the capacity is constant so long as there is no illumination of the tube. The capacity in this case appears to be that of the electrodes alone. This condition holds for air pressures from one atmosphere to fifty millimetres. At lower pressures illumination appears, and the capacity increases rapidly. It reaches its maximum at a pressure of one millimetre. By further exhaustion, to pressure of 0.07 millimetre the capacity diminishes. From 0.07 millimetre to 0.03 millimetre pressure there is a sudden decrease in the capacity. When the magnetic field is parallel to the tube it has no marked effect upon the capacity, so long as the pressure in the tube is greater than one millimetre and there is no illumination. As the pressure is decreased from one millimetre, the effect of the field becomes marked, the capacity of the tube diminishes. At the same time the illumination is distorted, and is split into two rays. When the pressure on the tube has been reduced to 0.07 millimetre, the effect of the magnetic field decreases, and at a pressure of 0.03 millimetre the capacity is not much greater than that of the electrode. When the tube is perpendicular to the magnetic field, the effect of the magnetic field appears much sooner, the illumination is distorted, and the capacity increases, the maximum increase appearing with a pressure of five millimetres. With further exhaustion, the effect of the field decreases until, after a pressure of 0.05 millimetre, the capacity is not increased by the field. With still further exhaustion, the field decreases the capacity of the tube, the action being analogous to that of tube parallel to the field.—*Translated and abstracted from the Physikalische Zeitschrift (Leipsic), November 1.*

Seeing at a Distance by Electricity.

The various methods which have been proposed from time to time for transmitting sight electrically have been studied by M. A. Nisco, but they seem to him to lack certain necessary features. He has therefore devised the following system, which he believes to be practical. A sensitive screen is prepared by coating a metallic net with some insulating gum. Into the meshes of this net copper wires are inserted before the insulation hardens. After drying, the surface is dressed off with a file, and is then coated with selenium, thus forming a sensitive connection between the wires and the net. The screen prepared in this way is treated to crystallize the selenium, so as to bring it into the proper sensitive condition. The copper wires which terminate in the screen are then led into an ebonite cylinder, and pass out through holes corresponding in position to their termination in the sensitive screen. These holes are arranged in spirals in such a way that a metallic blade which revolves around the cylinder successively makes contact with every terminal. The blade is revolved about the cylinder at a speed of 600 revolutions per minute, so that every contact is repeated ten times a second. From the blade and from the wire net of the sensitive screen, wires are led through a battery and to a telephone receiver. If a picture be thrown upon the sensitive screen, and the blade be revolved about the cylinder, a varying current will be sent through the telephone, the intensity of which will vary with each contact, according to the intensity of the light falling upon the corresponding section of the screen. This telephone by means of a sensitive carbon microphone, repeats through the transmission line the current variations produced by the apparatus just described. At the receiving station a second telephone repeats the variations in current through a second microphone in a local circuit arranged to produce a spark. The intensity of the spark at any instant corresponds to the intensity of illumination of a particular part of the selenium screen. This spark-gap is placed within a cylinder having spiral slots, and the slotted cylinder revolves in synchronism with the contact blade at the transmitting station. This arrangement throws the light of each spark on such a part of a receiving screen so as to produce an illuminated image similar to that thrown on the sensitive receiving screen. The method can only produce variations in illumination. It requires two wires, one for synchronizing the moving parts, and one for transmitting the varying current.—*Translated and abstracted from Electro (Brussels), October.*

Transactions of the American Electrochemical Society.

Volume iv of the transactions of the American Electrochemical Society contains the papers and discussions of the fourth general meeting, held at Niagara Falls, N. Y., September 17 to 19, inclusive. This volume is now being distributed.

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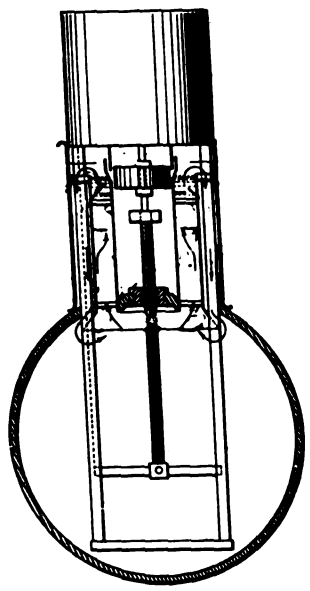
Electrical Patents.

Mr. Andre Blondel, a Frenchman, residing in Paris, France, has patented in this country a new type of arc lamp. The feature of this lamp he describes as follows: The invention has relation to an electric arc lamp of the type or class where in one or both of the carbons is or are combined with light-producing salts; and in such connection it relates to the construction and arrangement of the parts of the lamp whereby the composite carbons can be economically and advantageously employed. Heretofore it was known that the luminosity of highly incandescent carbons could be increased if the carbon is mixed with salts of lime, magnesia or similar minerals. However, in the use of such carbons it has been found that certain disadvantages due to the nature of the carbon were present—namely, the production of melted scoria, the diffusion of vapors and smoke, and the unsteadiness of the light. The principal objects of the invention are, first, to provide in an electric arc lamp two vertically arranged carbons, one, the lower and positive carbon, being mixed with the light-producing salts, and the upper electrode, either of carbon combined with a small percentage of these salts or of pure carbon provided with a refractory shield or plate encircling the carbon above the arc formed between the carbons; second, to provide an electric arc lamp with a smoke-consumer or draft passage, in addition to the two carbons and the refractory shield or plate upon one of said carbons; third, to provide an electric arc lamp, wherein a composite carbon is opposed to a substantially pure carbon, a combined means for preventing the accumulation of scoria upon the carbon and the diffusion of smoke and vapors about the luminous centre of the lamp, as well as for securing an increase in the luminosity of the arc by refraction. The lower carbon is preferably the positive electrode when in a continuous-current lamp, and as such it consists of carbon mixed with the light-producing salts either in block or having a core of such composite carbon surrounded by pure carbon. This lower carbon in an alternating current is the alternative electrode. The upper carbon is preferably the negative electrode of a continuous-current lamp, and as such it is essentially of pure carbon with a slight percentage of the light-producing salts either in block or in its core. It may, if desired, be formed of pure carbon with a composite covering. In alternating-current lamps this carbon is an alternative electrode. Upon this upper or negative carbon is arranged a shield or plate of refractory material or metal. This shield or plate may be of any preferred form, so long as it accomplishes the twofold purpose or function of protecting the upper carbon from vapors arising from the arc by condensing said vapors of its under surface, as well as reflecting the light from above the arc downward from that surface upon which the vapors are condensed. A number of advantages are claimed with the above described arrangement, some of which follow: "By placing the composite positive carbon below the upper or negative carbon a curious phenomenon arises. As is well known the luminous mineral vapors have a tendency to rise and separate themselves from the carbon or smoke vapors when the current flows from the upper to the lower carbon. The arc in this instance is luminous only in its upper part, near the upper carbon. When, however, the composite carbon is



Showing New Design, Electric Arc Lamp.

placed below the upper negative carbon, the ascending current heats the luminous vapors during the whole of their course, and when assisted by the shield or plate this results in an increase of the total luminous flux of from twenty-five to forty per cent in similar lamps and from one hundred to three hundred per cent in other arc lamps. Again, when the composite carbon is placed below, it is no longer licked by the flame, and hence produces less scoria. The scoria produced runs off the carbon without falling into the arc. The upper carbon being substantially pure produces no troublesome globules of scoria. To increase the steadiness of the light, it is preferable in alternating-current lamps to place in both carbons a core containing alkaline salts, such as tartrates, carbonates, etc., of sodium or potassium, etc. The combining of a small percentage of light-producing salts with the carbon of the upper electrode is of little value in continuous-current lamps except perhaps in reducing the consumption of the upper carbon. In alternating-current lamps, however, the combining of each carbon with the light-producing salts assists in increasing the luminosity of the arc. In such instances the lower carbon should contain from thirty to sixty per cent of mineral substance, whereas the upper carbon should contain from but five to twenty per cent of the salts of lime, etc., or a core of large diameter containing a considerable quantity of this substance. In any case the special feature is a composite lower carbon. In addition to this the shield or plate around the upper carbon protects it from the action of the flame, the ordinary function of a shield, and it condenses on its under surface adjacent to the arc a large proportion of the mineral vapors, which form upon the shield or plate a white reflecting coating or layer. Its reflecting surface renders the light uniform by diffusing nearly the same quantity at all times, in all directions."

A novel electric furnace has been patented by Mr. William S. Franklin, of South Bethlehem, Pa., who has made an assignment of one-half interest to Mr. Frederick Conlin, of the same place. The furnace is particularly intended for the reduction of iron ore, though useful for operating upon other substances. A suitable brick structure is provided within the lower portion, in which is formed a pear-shaped chamber, communicating at its upper end with a short cylindrical passage that terminates in a flaring or funnel mouth, by which materials are introduced into the furnace. At a level above the bottom of the lower chamber is located a layer of carbon, metal, or other suitable material constituting a conductor of electricity and preferably in the form of plates built into the structure. This also extends entirely around the chamber and constitutes a part of the wall thereof. The portions of the chamber which are not covered with the carbon and also the passage and the mouth are preferably lined with suitable refractory material. The layer of carbon is connected with a pole of a suitable source of electricity and constitutes one electrode of the furnace. The second electrode is in the form of an ordinary rod or bar of carbon, metal, or other suitable material, which is supported in any suitable manner so that it will hang down in the funnel mouth of the passageway with its lower end located in

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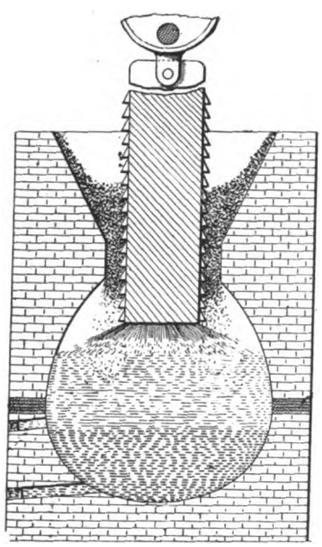
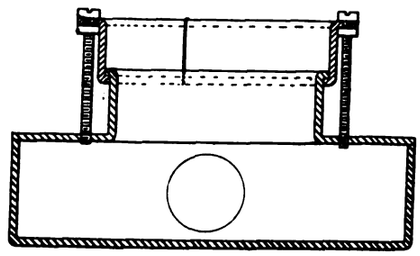
the chamber. This bar is provided on its sides with downwardly inclined teeth. It is adjustably supported by any suitable means, preferably a shaft having a cam about which passes a strap having a lug that is pivoted to the upper end of the bar. Near the bottom of the chamber is located a vent that passes through the walls of the structure and communicates with said chamber, and at a higher level a second vent of a similar form is located. These are normally closed by suitable plugs. In the operation of the furnace, a portion of the chamber is filled with a molten electrical conductor which has a high resistance, such material as slag or glass being suitable for this purpose. The current of electricity is made to pass from the suspended electrode through the molten conductor to the layer of carbon in the walls, consequently the conductor is raised to and maintained at a very high temperature. If the upper electrode is partially immersed in the



NEW TYPE OF ELECTRIC FURNACE.

molten conductor the heat developed will be almost entirely due to the resistance of the same. If, however, the upper electrode is above the upper surface of the molten conductor an arc will be formed between such electrode and the said surface, and the heat of such arc will be added to the heat developed by the resistance of the molten conductor. The material to be acted on by the furnace is introduced into the mouth or funnel and is fed slowly downward by any suitable means, as for instance, by the reciprocation of the electrode, the teeth of which operate upon the material surrounding the same. In its downward passage such material is first subjected to the action of the heat ascending from the molten conductor and afterward comes into contact with the highly heated molten conductor itself. If the upper electrode is raised above the molten conductor the descending material is also directly acted upon by the arc formed between said electrode and such conductor. If the product resulting from the action of the heat or electricity, or both, on the descending material is of greater specific gravity than the molten conductor, such product will pass through said conductor and collect in the bottom of the receptacle. During the passage of the conductor, the product will be separated from impurities of lighter specific gravity than itself, as such impurities will either float on the surface of the molten conductor or will remain in the body thereof. The product then can be drawn from the lower vent, while the molten conductor can be kept at the proper level by means of the upper vent. If such product is of less specific gravity than the molten conductor, the conductor will occupy the bottom portion of the receptacle, while the product will accumulate at the level of the upper vent and can be withdrawn therethrough. In such case, if the product be of greater conductivity than the molten conductor, it is desirable not to have the lower electrode extend above the level of the molten conductor.

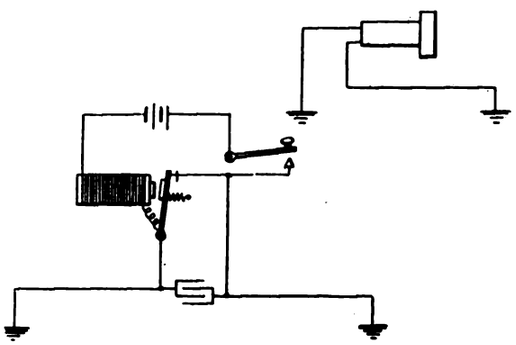
An electrical outlet box, having an adjustable mouth, has been patented by Mr. Hubert Krantz, of New York. The box which is made of any suitable form is provided with a cover having a projecting mouth, sleeve or base, the rim of which is outturned to form an annular flange. An adjustable sleeve embraces the mouth sleeve and has at its inner end an inturned flange that interlocks with the outturned flange of the rim. This limits the outward movement of the adjustable sleeve. This adjustable sleeve is split so that it



SECTIONAL VIEW OF NEW ELECTRIC OUTLET BOX.

may be sprung over the flange rim of the box sleeve and it furthermore has an outturned flange at its free end provided with openings. Adjusting screws pass through these openings, and either bear against or are threaded into the box. By rotating these screws the adjustable sleeve can be moved toward or from the cover and thus the length of the mouth changed as desired.

An invention in systems of electrical communication has been patented in this country by two Englishmen, Messrs. James T. Armstrong and Axel Orling, both residents of London, England. The invention relates to means and apparatus for operating or controlling distant apparatus or mechanisms without the employment of wire or other like connection between the controlling station and the apparatus to be operated or controlled. In carrying out this idea the inventors provide transmitting apparatus with two or more earth connections, through which are conducted a combination of high-potential discharges and low-tension currents whose circuit or circuits are completed through numerous lines of current flow which traverses the earth. The transmitted impulses enter the earth by one of the earth connections and after traversing the same return to complete the circuit through the other. The receiving apparatus is also provided with two or more earth connections which are adapted to cut the lines of current flow at points of



TRANSMITTING AND RECEIVING APPARATUS—WIRELESS TELEGRAPH SYSTEM.

different potential, causing some of the transmitted energy to flow through them and actuate the receiver. Preferably the transmitted discharges take place with great rapidity, while the earth connections are also preferably some distant apart.

Meeting of the Directors of the Hudson River Telephone Company.

On November 19 the directors of the Hudson Telephone Company held a meeting at Albany, N. Y. Mr. James H. Manning tendered his resignation as president of the company, to make way for the election of a practical operating telephone man, Mr. Charles F. Cutler, president of the New York and of the New York & New Jersey Telephone companies. During President Manning's term the company's subscribers increased from 7,000 to nearly 23,000.

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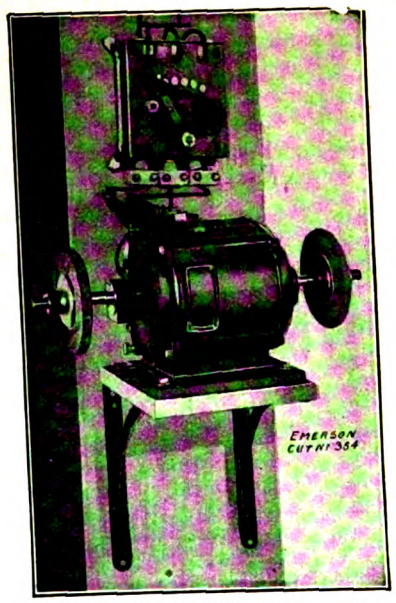
INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Direct-Current Motor Grinders.

The accompanying engraving shows a simple inexpensive motor grinder with ample power for lathes and planer tools, drills, etc. Two emery wheels, six inches diameter, one-half-inch face, five-eighths-inch bore, are mounted on a grinding spindle which is substituted for the ordinary shaft on a regular type of Emerson direct-circuit motor, made by the Emerson Electric Manufacturing Company, St. Louis, Mo. No tool rests are furnished, as experience indicates that they are unnecessary for a large proportion of the light grinding for which this outfit is designed.

This grinder forms a valuable adjunct to any machine tool where frequent grinding of the cutters is necessary, as the motor may be placed close at hand, on a near-by post, as shown, or on any bench where current is available. Very often it is possible to locate this outfit in a busy part of the shop, where it will conveniently serve a number of tools, and where line shafting is inaccessible, and when mounted on a shelf, the post forms a convenient back for switch, starting box, and fuse-block.



DIRECT-CURRENT MOTOR GRINDER.

The motor is of the Emerson type, designed for one-third horse-power normal load, but with a heavy overload capacity running as high as 100 per cent for a few moments. It is entirely enclosed to prevent injury from dust, dirt, etc., and has removable covers, giving access to the brushes. The bearings of the motor are protected from injury by emery dust by brass caps surrounding the shaft, and are extra heavy and well proportioned for the work. The armature and commutator are of the engine type. The field is built up of mild steel laminations and has six poles with form-wound coils.

This spindle is removable without difficulty, as the armature and commutator are arranged on an interior sleeve in place of being assembled directly on the shaft as is usual in motors of this size. The shaft or spindle may be withdrawn from this sleeve by knocking out one pin, and without disturbing the relation of the armature and commutator.

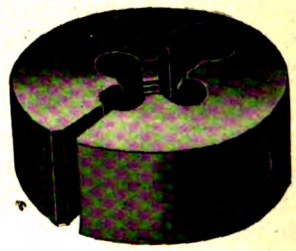
This outfit meets almost all the requirements of light grinding. The outfits are covered by the Emerson Electric Manufacturing Company's guarantee.

Improvement in Automobile Design.

In a report of a committee to the British Association, on the resistance of road vehicles to traction, the progress in automobile design is given as follows: In 1895 Levassor made the run from Paris to Bordeaux in a five-horse-power car weighing about one ton, or one horse-power for 550 pounds dead weight. In 1896 this weight was reduced to 365 pounds per horse-power. In 1900 it fell to ninety pounds per horse-power. In the recent Paris-Madrid race, M. Gobron Brillie used a 100-horse-power car, the weight of which rated only twenty-two pounds per horse-power. This weight has been still further reduced in the case of motor bicycles, reaching as low a figure as 17.5 pounds per horse-power, but there is not a corresponding increase in speed. In 1901 M. Fournier made 53 miles per hour with a twenty-eight-horse-power Mors, and last year M. de Knyff only slightly exceeded 58.5 miles per hour with a seventy-horse-power machine—that is, an additional forty horse-power. The small increase in speed can be attributed partly to low resistance, but not all. An extremely powerful motor must be accompanied by a comparatively heavy load; otherwise, the wheels do not bite well and energy is wasted. The modern racing car skims along the surface of the course, without sufficiently close contact between the wheels and the ground. To overcome this defect, the driving wheels should be more heavily weighted and springs made less elastic.

Adjustable Round Split Dies and Hand Taps.

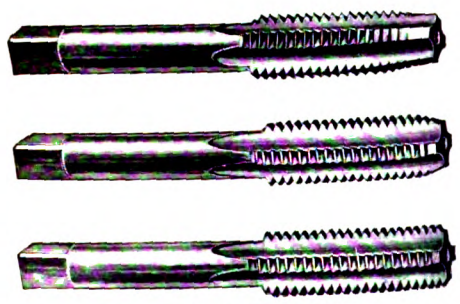
The Smith & Hemenway Company, 296 Broadway, New York city, has added to its line of hardware specialties Bay State taps and dies, manufactured by the Bay State Tap and Die Company, the entire market of which the Smith & Hemenway Company controls. These tools are made of highest grade steel, are well finished, and the manufacturer states have excellent wearing qualities. The workmanship executed by these tools is of a superior nature, and special attention has been paid by the maker to the pitch of the thread, which it is claimed is absolutely correct.



ADJUSTABLE ROUND SPLIT DIE.

United States standard "V" or Whitworth form of thread will be made on any style tap or die. Each tap or die is sold under rigid guarantee, and should any defective tool be found, it will be exchanged for a perfect one.

The Smith & Hemenway Company has the entire marketing of the products of the following companies: Utica Drop Forge and Tool Company, manufacturer of pliers and nippers; Acme Ball Bearing Caster Company, manufacturer of casters and jacks; Bay State Tap and Die Company, manufacturer of taps and dies; Vandegrift Manufacturing Company, manufacturer of wrenches; Page-Storm Company, manufacturer of drop forges; Champion Manufacturing Company, manufacturer of hammers, hatchets and ice picks.



HAND TAPS.

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Motor-Driven Fire Pumps.

The Chicago Edison Company recently installed in the basement of Marshall Field & Company's wholesale house, Chicago, a water-proof motor for fire protection, which has attracted considerable attention. The equipment consists of a 100-horse-power General Electric CE motor geared through a single reduction to a Laidlaw-Dunn-Gordon eight and one-half by twelve duplex pump. The motor is shunt wound for 230 volts and is totally enclosed. It has a fan mounted on the armature shaft, inside of the frame, between the armature and pinion end bearing. The purpose of this fan is to ventilate the windings by drawing air through a large wrought-iron pipe, screwed into a flange fastened on the front end of the motor frame. The air passes through the motor and is discharged from a similar opening at the opposite end, thus keeping the field coils and armature at a safe temperature when operating at full load. The electrical conductors to the motor are led in through a pipe screwed into the frame, and the construction is such that a fire stream of water can be played upon the motor or it can be completely submerged in water without injury. The pump operates at sixty revolutions per minute and is connected to a sprinkler system extending to all parts of the buildings. The pressure of the system is maintained at 100 pounds per square inch, by means of a pressure gauge so constructed that when the pressure goes below 100 pounds the needle or hand of the gauge closes an electrical circuit through an automatic controller, thus starting the motor. When the pressure increases to the desired amount the gauge hand closes another circuit through the controller and stops the motor. The motor controller being also water-proof, the basement in which the apparatus is located may become filled with water without shutting down the pump, an advantage which is obvious.

The General Electric Company has also furnished an outfit to the Underwriters' Bureau of Fire Protection Engineers, consisting of a CE, fifty-horse-power, 220-volt, totally enclosed and ventilated motor, direct-connected to a No. 7 Quimby screw pump which has a capacity of 500 gallons per minute at 100 pounds pressure. The motor receives current from an Edison three-wire system and is controlled with an R-15-D rheostatic controller constructed so that the motor can be started on 110 volts and when up to about half speed is thrown on 220 volts by the reverse cylinder, the shunt field being connected permanently on 220 volts. This gives twelve different speeds as follows, which is a great advantage for testing purposes:

	110 Volts.	220 Volts.
Step 1, just turning over		470 R. P. M.
Step 2,	119 R. P. M.	585 R. P. M.
Step 3,	230 R. P. M.	695 R. P. M.
Step 4,	330 R. P. M.	795 R. P. M.
Step 5,	400 R. P. M.	865 R. P. M.
Step 6,	435 R. P. M.	900 R. P. M.

The motor is compound wound with accumulative series winding. The resistance (dimensions twenty inches by twenty inches by twenty-six inches) used for starting is immersed in running water and takes up very little space in comparison to air-cooled resistance. This outfit is installed at the Underwriters' laboratory at 67 East Twenty-first street, Chicago, and is used for testing hose, hose nozzles, sprinkler heads, valves and all apparatus used for fire protection. The Underwriters' Engineers state that the motor has given universal satisfaction and they will be pleased to exhibit it in operation to visitors at any time.

Electrically Driven Pumps for Mine Drainage.

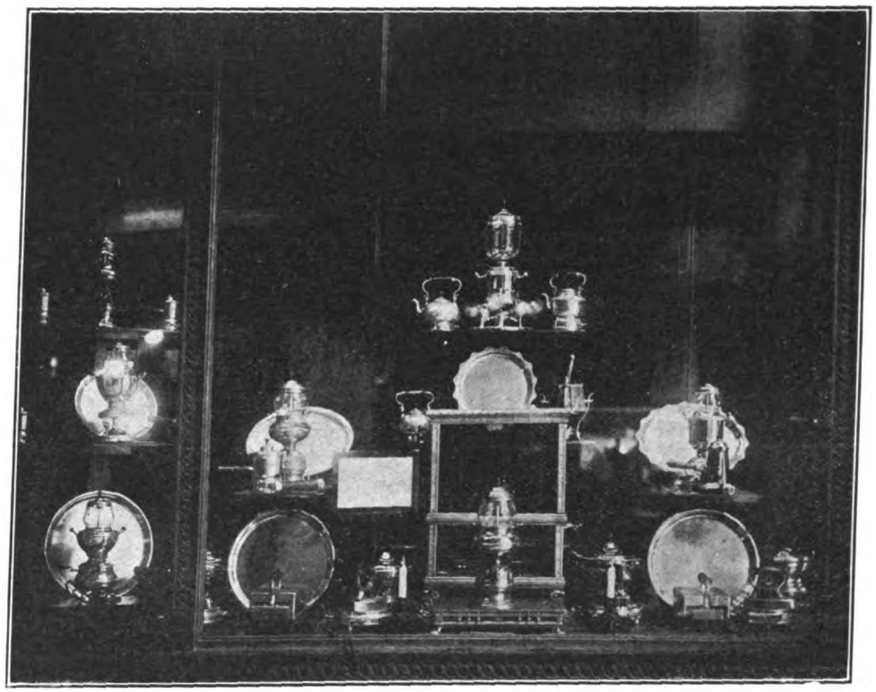
The electrically driven pumps installed for drainage purposes in south Staffordshire are said to be giving excellent results, and it is thought that this method of draining will make possible the recovery of many coal fields in that section of England, which are now lying drowned. It is stated that the substitution of electricity for steam will make a difference of fivepence per ton of coal worked.

A Fine Display of Electric Heating and Cooking Apparatus.

The accompanying illustration shows an interesting display of electric heating and cooking apparatus exhibited in one of the large show-windows of R. H. Macy & Company, of New York city. This apparatus is manufactured by the Prometheus Electric Company, 39 Cortlandt street, New York city.

The apparatus manufactured by this company has been described at length in the ELECTRICAL REVIEW and contains, as is well known, a resistance element which can be readily removed in case this should become necessary.

In addition to the exhibition in the window, the Macy company has an attractive display and demonstration of electric cooking apparatus in the basement of the building. The sales since this crusade has begun have been considerable and entirely up to the expectations of the manufacturer.



A WINDOW DISPLAY OF ELECTRIC HEATING AND COOKING APPARATUS.

A large number of agencies have been established by the Prometheus company throughout the country, all of which are meeting with success. Orders have recently been received for the entire heating equipment contract for the factory of F. Berg & Company, hat manufacturers, of Orange Valley, N. Y., as well as the heating equipment of two large ships now building in New London, Ct., for the Great Northern Company.

A number of new industrial appliances have been perfected recently, such as cigar box branders, paste heaters and heaters for all machinery. All of these have been highly successful on account of the ease with which the elements can be applied to the machinery and the high efficiency of this method of application.

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An Electro-Visual Thermo-Gage.

In various industries accurate means are provided for measuring the different properties of the various materials which enter into the construction of the vast outputs. · Lengths are measured with the greatest accuracy by the aid of a delicate micrometer, weights by scales of various degrees of delicacy, densities by hydrometers, and the composition of various materials by mechanical analysis, etc.; but while the lower temperatures are read by the aid of mercurial thermometers, the higher temperatures seem to have been left to guess at, or measured by the observation of skilled operators. These operators determine the temperature by the color or degree of incandescence of the materials being heated. The Morse Thermo-Gage Company, Trumansburg, N. Y., has placed on the market a pyrometer, by means of which high temperatures can be accurately determined. This thermo-gage is based on a comparison of color and degrees of incandescence and is covered by seven United States patents which are as follows: April 1, 1902, No. 696,878; April 1, 1902, No. 696,916; March 17, 1903, No. 722,770; August 4, 1903, No. 735,361; August 4, 1903, No. 735,423; August 4, No. 735,424; August 4, 1903, No. 735,525.

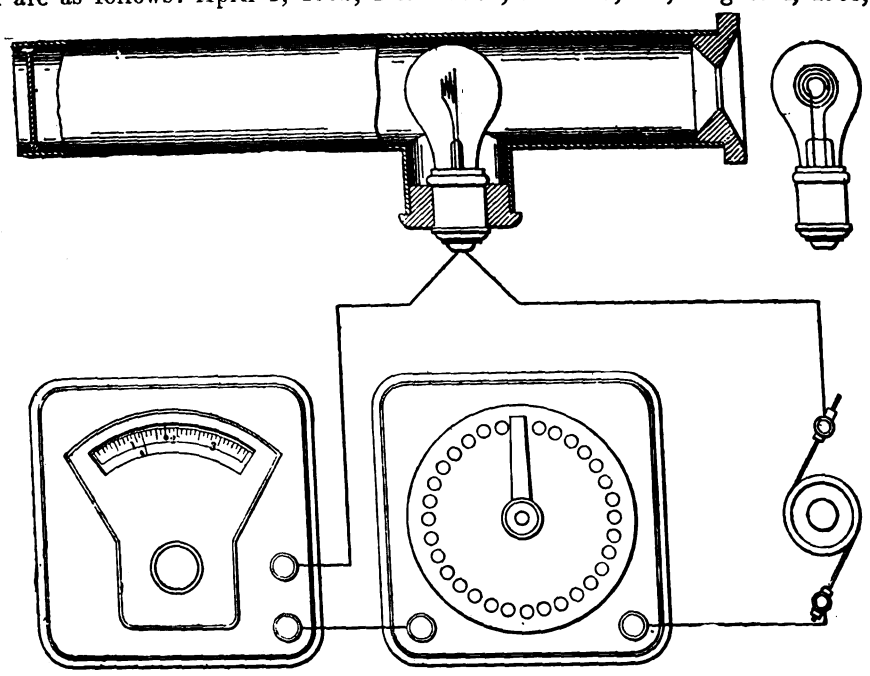

FIG. 1.—DIAGRAMMATIC ILLUSTRATION, SHOWING MORSE THERMO-GAGE.

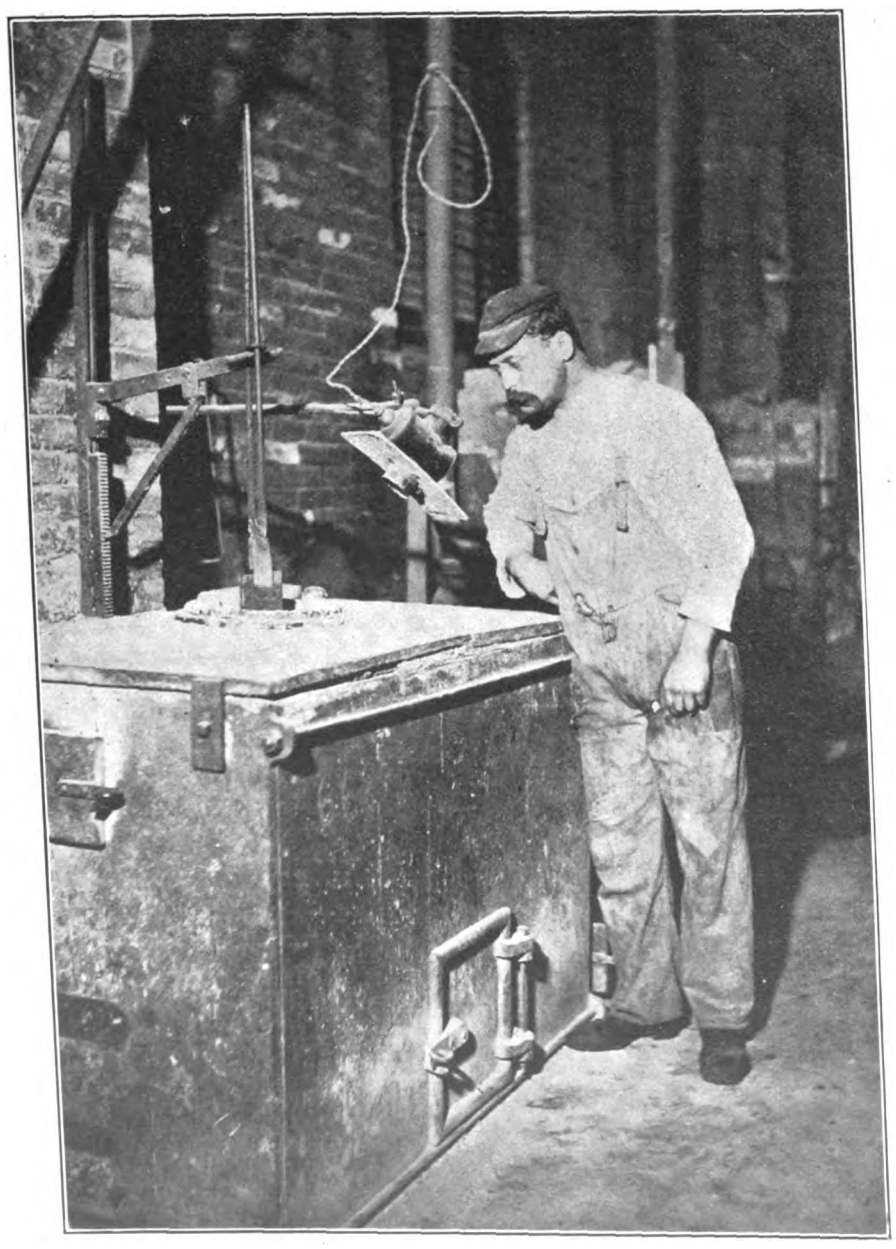

FIG. 2.—HEAT GAGE AS USED WITH A LEAD BATH.

The instrument is diagrammatically illustrated in Fig. 1, and consists of a lantern tube, incandescent lamp, rheostat and an ammeter. The incandescent lamp contains a specially designed filament and is placed in the lantern tube as shown in the illustration. If it is desired to measure the temperature of any substance being heated, the substance is viewed through the lantern tube and the coiled filament. Then the temperature, and consequently the color of the filament are raised, by adjusting the rheostat, until it merges into the color of the substance. When the heating has reached this point, the filament and the heated substance will be at the same temperature. This temperature can then be determined by means of the ammeter and a table of constants which accompanies each instrument. If, on the other hand, it is desired to heat the substance to a certain temperature, the rheostat is regulated until the ammeter indicates the desired temperature; the substance is then heated and viewed through the lantern tube until it has reached the same degree of heating as the filament. When this point is reached, the substance is at the required temperature.

Fig. 2 shows the instrument arranged for regulating the temperature of a lead bath, and Fig. 3 shows it in use in connection with a heating furnace.

Fig. 4 shows the instrument as arranged for the direct inspection of tools when heated in a blacksmith's forge. The end of the tube is covered by a hood to ex-

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clude all outside source of light, the hood having an opening on one side into which the tool is inserted.

The manufacturer claims that a variation in temperature to five degrees Fahrenheit either side of that of the filament may be detected, while by using a magnifying glass this is reduced to one degree. Every steelworker is aware of the fact that high carbon steel is far more sensitive to heat than is low carbon steel, and there is no doubt that this fact has greatly restricted its use. The zone of hardening temperature for high carbon steel is, in fact, so narrow that it can not. The same hardener does not always confine himself to it and there is no doubt that with different hardeners the variation in hardening temperature has often nullified the superior qualities of the steel.

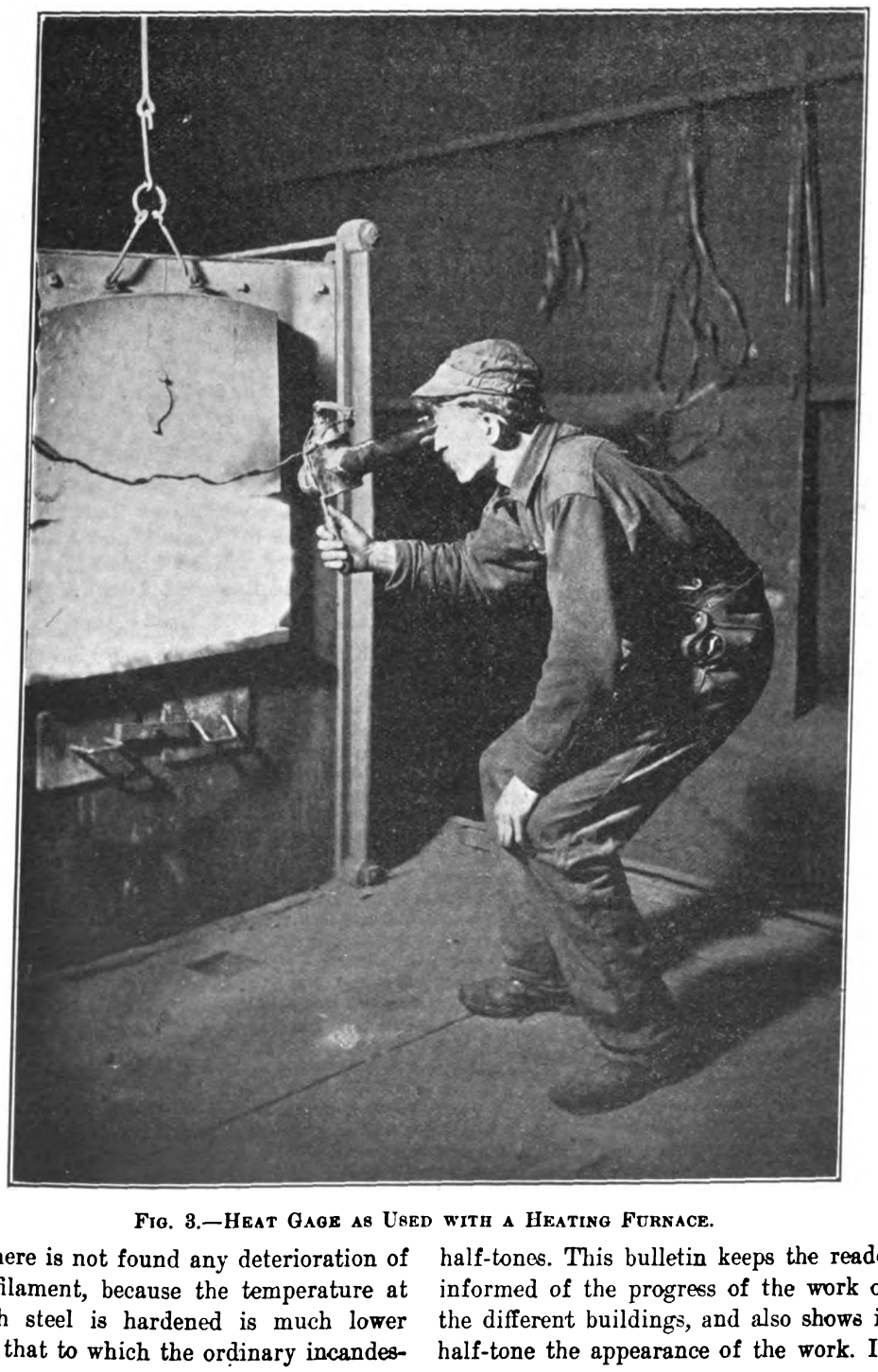

FIG. 3.—HEAT GAGE AS USED WITH A HEATING FURNACE.

There is not found any deterioration of the filament, because the temperature at which steel is hardened is much lower than that to which the ordinary incandescent lamp filament is subjected. The latter is a glowing white heat, while the former is a "cherry red" or lower. At these temperatures the filaments are not found to deteriorate appreciably, one of them having been in constant use for the past three years. The readings of the ammeter are in all cases standardized in order that different instruments may give the same results. The graduations may be made to indicate the degrees of temperatures directly or they may be arbitrary marks for different brands of steel and different classes of work.

World's Fair Bulletin.

The *World's Fair Bulletin* for November, published by the World's Fair Publishing Company, contains a great deal of interesting information and many fine half-tones. This bulletin keeps the reader informed of the progress of the work on the different buildings, and also shows in half-tone the appearance of the work. Illustrations of the north side of the Machinery Building and the west front of the Manufacturers Building make it appear that there is little more to do to make these complete. A full list of the departments and subjects to be undertaken by the Congress of Arts and Sciences, together with the appointments

FIG. 4.—HEAT GAGE AS USED WITH A BLACKSMITH'S FORGE.

to the different departments, is given. This list includes the foremost scientists of Germany, Switzerland, Austria, Russia, Great Britain and others.

An Incandescent Lamp Meter.

The Talmont Electric Engineering Company, 150 Nassau street, New York city, has placed on the market an incandescent lamp meter. This consists of an amperemeter built in between the plug and the lamp socket. The dial is marked off to read from zero to 1.5 amperes. The instrument can be used for either direct current or alternating current. The range of the meter is from eight to thirty-two candle-power at 64 to 220 volts alternating current, forty to fifty cycles, and it is fitted with either Edison or Swan sockets.

To operate, the meter is screwed into the lamp socket, and the lamp is attached to the meter, as shown in the illustration. Current is then turned on, and the needle on the dial will indicate the consumption of current.

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CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

CANADIAN TELEPHONE PROPOSITION—The organization of the Canadian Telephone and Telegraph Company, with headquarters at Ottawa, has been completed. The company has been chartered at a recent session of the Dominion Parliament, and has made a deposit of $25,000 with the government, as required by the act of incorporation. Another requirement, that $100,000 of stock be subscribed, has also been met. The total capital is $1,000,000. If the company can get the franchise from Ottawa council, it will begin the construction and installation of its system at once. The company is empowered to build trunk lines, and the ultimate expectation is to stretch the system across the continent.

EXTENSIVE NEW ZEALAND TRACTION SYSTEM—An extensive electric traction system is to be constructed at Christchurch, New Zealand. There will be thirty-six miles of single track, including two and one-half miles of double track. Contracts will be let after March 17 for the power-house equipment, steam plant equipment, steel stack, traveling crane, cooling tower, car bodies, car trucks, car motors, compressed-air brakes, equipment of cars and sundry supplies, together with road-bed and auxiliary apparatus, including the overhead construction. Copies of the drawings, specifications and schedules may be had by the middle of December, on application at the office of the general agent for New Zealand, Victoria street, London. The engineer in charge of the proposition is F. H. Chamberlain.

PROPOSITION FOR MUNICIPALLY OPERATED TRACTION IN NEW YORK CITY—It is stated that municipal officials are considering a project to establish an electric car line service over the Williamsburgh bridge, to run from terminal to terminal, and to have no connection or relation with any transit system running to either the Brooklyn or the Manhattan side of the bridge. By this means the officials believe the bridge transit problem may be solved, in view of the alleged refusal so far of the Brooklyn Rapid Transit, the Interborough and the Interurban companies to make any proposition looking to a transit system over the bridge or connecting with it. The plan has not taken any absolute form, but the general scheme includes the building of a power-house, the laying of trolley tracks, and the running of bridge cars by either the overhead trolley or the third-rail system.

NEW WESTERN POWER PLANT—It is announced that the McCloud River Electrical Power Company, of Shasta County, California, has completed arrangements for securing the necessary funds for installing its plant for developing the power of the Shasta river. The company plans to supply Oakland and San Francisco with electric power, and will transmit 20,000 horse-power a distance of 275 miles. Light and power will also be supplied to the near-by towns along the way and to several of the largest mining companies in California. It is said that the company will expend $2,000,000 on the plant. The dam and power-house will cost some $850,000; the hydraulic and electrical equipment, $420,000, and the poles and lines, $275,000. James D. Schuyler, of San Francisco and Los Angeles, is the engineer in charge. The power plant will be located sixteen miles from Baird Spur, on the Oregon division of the Southern Pacific.

WATER POWER LITIGATION IN WASHINGTON ENDED—After a long fight for control of the White river water power, a decision has been made by the Superior Court, in favor of the White River Power Company, owned by the estate of William T. Baker, of Chicago. The company has spent $250,000 in developing the work, and will push to completion a plant to generate 50,000 horse-power. The same interests own the Snoqualmie Falls power plant, now supplying Tacoma and Seattle, Wash. Another company, which owns the street railways of Tacoma and Seattle and the connecting interurban line, is constructing a $2,000,000 plant on Puyallup river, near Tacoma. This company also sought to obtain control of the White river power rights. The companies together will supply Tacoma with electric power. The possibility of diverting the waters of White river and dropping them over 800 feet was discovered about eight years ago by Mr. Edwin McHenry, now chief engineer of the Canadian Pacific Railway.

ELECTRIC LIGHTING.

COLUMBUS, OHIO—The Mt. Victory Electric Light Company, of Mt. Victory, has been incorporated with a capital of $10,000.

ESSEX, IOWA—Farris and Eastman, of Clarinda, propose an electric light plant for Essex.

GLENWOOD, IOWA—The electric light power-house was damaged by fire, the machinery being severely damaged.

LOUISVILLE, KY.—The new electric light plant at Jackson has been completed, and the city is now lighted throughout by electric lamps.

TRIBES HILL, N. Y.—The Edison Light and Power Company of Amsterdam is preparing to furnish electric lights for this place and Fort Hunter.

HARRISBURG, PA.—The council has awarded the contract for eighty-five street lights to the Steelton Light, Heat and Power Company, at its bid of $53 per light per annum for five years.

SIOUX FALLS, S. D.—The electric light company has installed a large new dynamo at the Cascade plant. It is an alternating-current machine with a capacity of 2,300 volts, or enough for 3,000 incandescent lights.

NEWTON, N. J.—Ground has been broken for the new electric light plant. Assurance having been received that the equipment will be shipped at the date heretofore set and the company hopes to rush the work for its reception.

ST. PAUL, MINN.—The Columbia Power Company, of Minneapolis, has been incorporated with a capital of $1,000,000. William S. Herber, S. Edward Woodbury and Fred W. Bates, all of Minneapolis, are the incorporators.

NEW YORK, N. Y.—Plans have been filed with the Bureau of Buildings in Manhattan for a four-story and basement brick power-house to be erected by the New York Edison Company, to cost $85,000.

JERSEY CITY, N. J.—The North Jersey Street Railway Company has bought another tract of land in this city and will erect a power-house to cost $350,000. Power will be furnished for the whole trolley system on this side of the Hackensack river.

NEW BRUNSWICK, N. J.—At a meeting held in Newark the Central Electric Company, which supplies light and power to a dozen towns near its main plant in Metuchen, was purchased by the Public Service Corporation of New Jersey.

EAST GREENWICH, R. I.—A five-year contract has been made by the city with the East Greenwich Electric Company. The company is to provide thirty-seven arc lamps for $2,000 per year, and also a number of incandescent lights at $13.20 per light per year.

BILOXI, MISS.—A deal has been closed whereby the Biloxi Electric Light Company has passed into the control of the Biloxi Electric Street Railway and Power Company. The consideration was $29,500 in cash and $18,000 in stock.

ALBANY, N. Y.—F. Y. Lyon, H. A. Bradley and Benjamin Patterson, all of the city of New York, have capitalized the Bradley Universal Heat, Light and Power Company with a capital of $100,000.

VISALA, CAL.—The permit for the construction of a new power plant on the Tule river has been granted by the secretary of the interior, and work on construction will begin at once. It is said that there is now nothing in the way and that the enterprise will be pushed to completion with all possible speed.

BOSTON, MASS.—The Lynn Gas and Electric Company has decided to place all its electrical wires underground in Lynn and the adjacent towns where lighting is supplied and has asked permission to construct underground conduits in the city. The com-

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pany plans to first remove all its overhead wires in the centre and closely settled portions of the city.

ST. CHARLES, MINN.—At the first annual meeting of the stockholders of the St. Charles Electric Light Company, the following directors were chosen for the ensuing year: A. B. Dyar, Acil Hendee, Charles Knapp, George Miller and Charles Rabbin. The directors chose the following officers: Acil Hendee, president; Charles Rabbin, vice-president; Charles Knapp, secretary and treasurer.

FAIRFIELD, ME.—The power-house of the Waterville & Fairfield Electric Railway and Light Company, used for the incandescent system of lighting, has been destroyed by fire. The loss to the machinery was about $6,000, covered by insurance. Loss to the building was slight.

BATAVIA, N. Y.—The Consolidated Gas and Electric Company at a meeting of the stockholders voted to increase its capital stock from $200,000 to $300,000. Among the stockholders present were G. D. Miller, of Rochester; C. D. Lawton, of Boston, and Richard C. Garhart, of New York. The increased capital is to be used in the extension of the large plant which is at present under course of construction.

ROSLYN, L. I.—The Nassau Electric Light and Power Company, of Roslyn, has been granted permission by the Hempstead town highway commissioners to erect poles and string wires on all town roads in the town of Hempstead, the privilege being subject in all cases to the consent of abutting property owners. The company is to give a bond of $5,000 for the protection of the town against damages arising by reason of the franchise being granted.

NEWBURGH, N. Y.—The Hillburn Electric Light Company is negotiating for right of way through the Ramapo valley to set poles and string wires for the purpose of supplying the villages of Monroe, Central Valley and the intermediate places with electric lights. Measurements have been taken over the proposed route from Hillburn to Monroe. The company may extend the line on to Highland Mills, also to Hillcrest Hall, the Summit Lake and Mountain Top hotels.

LITTLE ROCK, ARK.—The Fordyce Light and Water Company, of Fordyce, has been chartered by the secretary of state. The capital stock is $20,000, and the officers are B. H. Wood, president and treasurer, and J. G. Pattillo, vice-president. The other incorporators are C. B. Hickey, W. R Ramsey, John M. Covey, G. M. Hampton, A. B. Banks, J. E. Hampton, Jr., T. M. Rowland, L Amis, E. R. Thomas, R. Finley, G. G. Gatling, E. A. Acruman, G. W. Smith, E. H. Stover, W. J. Proctor, G. N. Richardson and others.

COLUMBUS, OHIO—The board of public service has submitted to City Solicitor Butler the detailed estimate for the construction of the lines of the new municipal electric light plant. The estimate covers the erection of the trunk lines and provides for several minor features of the plant. The estimate is for $60,000, and the money is in the hands of the city treasurer ready for certification by the auditor. The members of the board give it as their opinion that the plant will be ready for operation, furnishing 1,900 city lights, by the first of March.

COLUMBUS, IND.—The city council has decided to install a new electric light plant, the one now in service having become practically worn out and obsolete. The new plant will be of sufficient capacity to furnish light for a much larger city than Columbus, with the purpose of furnishing lights for an extended period of years, and meeting the requirements of a growing municipality. Besides furnishing lights for street lighting purposes, the City Hall, fire department headquarters and waterworks will be lighted, and there is some talk of the city going into commercial lighting, but the latter proposition is not meeting with general favor.

ROSLYN, L. I.—The Nassau Light and Power Company, formerly the Roslyn Light and Power Company, will move its plant, at present located on the line of the Oyster Bay branch of the Long Island Railroad a mile south of this village, to Glenwood. While the transfer will not be made until spring, work upon the new buildings will begin at once, and it is said they will have a capacity not exceeded by any electrical plant on Long Island and not excepting those in the Borough of Brooklyn. The tract purchased by the company comprises nine acres, upon which a power-house will be erected, with a capacity for machinery which will be capable of generating electricity for supplying all of Nassau County. It is expected to have the plant completed and the removal of the present plant to Glenwood before next spring. The Nassau company expects to realize several benefits from the change of location of its principal plant, one of the most important of which will be the reduction in freight rates, the one item of coal alone will amount to considerable within a year's time. The new plant will also be more central, the company now having considerable business in the town of Oyster Bay, including several street lighting contracts.

TELEPHONE AND TELEGRAPH.

WEST FRANKLIN, PA.—The LeFrank Telephone Company will build a line from LeRoy to Franklin.

NASHVILLE, TENN.—A charter has been granted to the Huntland Telephone Company with a capital of $1,000.

WEBSTER CITY, IOWA—The Martin Telephone Company has purchased and consolidated the Chamberlain toll lines, which operate in Hamilton, Boone and Webster counties.

AUGUSTA, ME.—The Bethel Local Telephone and Telegraph Company has been incorporated with a capital of $5,000. F. L. Edwards and D. R. Smith are the incorporators.

LOUISVILLE, KY.—The Oldham Telephone Company, of Oldham County, has been organized with a capital of $10,000. Joseph Sauer, R. B. Blakemore and R. B. Cassady are the chief incorporators.

NASHVILLE, ILL.—At a meeting of the city council a franchise was granted to the Rixman Telephone Company, of Irvington, to operate a telephone system in this city and to establish a toll station. The line of the company has been completed to the city limits.

CONNELLSVILLE, PA.—The Tri-State Telephone Company has opened its new lines to Waynesburg, Greene County, and now has connections with Fairmont and Wheeling and all intervening towns. The company has started the building of its new line to Pittsburg.

GREENSBURG, IND.—The Decatur County Independent Telephone Company has absorbed the Westport & Sardinia Telephone Company, and will operate that line through the local exchange. The new arrangement will give access to the southern part of the county.

DEADWOOD, S. D.—A new franchise has been granted the Nebraska Telephone Company by the council of Deadwood. It gives the company the right to erect its poles and wires and lay subways throughout the principal streets of Deadwood. It is announced by the company that it is prepared to expend upwards of $30,000 on its plant and system in Deadwood.

CROOKESVILLE, OHIO—The Crookesville Telephone Company has been organized with a capital of $10,000, by J. B. Rhodes, J. C. Moore and Thomas F. Wilson, Will Harris and S. M. Winn, for the purpose of establishing an exchange as an adjunct to the Zanesville Telephone and Telegraph Company, with United States and Independent connections with all points that these lines reach.

LITTLE ROCK, ARK.—The Ozark & Cecil Telephone Company has been chartered by the secretary of state. The capital stock is $5,000, and the officers are: William Jones, president; W. G. Stockton, vice-president, and J. C. Wiggins, secretary and treasurer. The other incorporators are J. F. Andrews, J. Bumpers, R. C. Bumpers, S. T. Bumpers, John E. Bryan, W. Carnaham, W. P. Evans, G. W. Ford and others.

AUTOMOBILE NOTE.

GORDON-BENNETT CUP RACE—The Gordon-Bennett cup race will be held in Germany, in the summer of 1904. The Automobile Club of America announces that as the driver of an American automobile in this race must be a member of the club, this opportunity is given of sending in applications. The American team will consist of not more than three. It is further announced that the committee will receive entries until the fifteenth of December, 1903. All entries must be accompanied by a description of the automobile, also a check for $600, which will be refunded as soon as the team has been definitely selected, in case the sender is not chosen.

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ELECTRIC RAILWAYS.

TRENTON, TENN.—A company under the name of the Gibson County Construction Company has been organized for the purpose of constructing an electric railway from Trenton to Eaton, Brazil and Gibson Wells.

ANDERSON, IND.—The council has granted a fifty-year franchise to Wallace B. Campbel for an interurban electric railway into or through this city, the road to be in operation by July, 1905. The proposed road will connect Anderson, Noblesville and Lebanon.

WILMINGTON, DEL.—The Delaware Suburban Railway Company, which will construct a line from this city to Newark, a distance of twelve miles, and there connect with other lines which are to be constructed, expects to have the line to Newark completed by May next.

DETROIT, MICH.—The Michigan Central Traction Company has been organized here with a capital of $1,500,000, of which $250,000 is paid up. The company will run limited trains between Detroit, Pontiac, Durand, Lansing, Grand Ledge, Grand Rapids, Battle Creek, Kalamazoo and Niles.

SHARON, PA.—Farmers in this section of the state have formed a mutual company to obtain right of way, and will build a trolley line from Sharon to New Castle by way of New Wilmington. Pittsburg capitalists have promised to aid in the enterprise. The line will enable the farmers to market their grain without making long hauls as heretofore.

MERIDAN, CT.—A syndicate of New York capitalists, represented by Francis Atwater, has purchased the franchise of the Watertown & Litchfield Tramway Company. The company owns a charter to construct a trolley line from Watertown, through Morris, Litchfield, Goshen and Norfolk. It is stated that the new owners will construct the road next spring. The preliminary surveys have already been made.

SPRINGFIELD, MASS.—It is announced by the officials of the Boston & Albany division that the Newton Lower Falls branch will soon be operated by electricity, the power to be furnished by the Watertown & Newton Electric Lighting Company. This branch is about eleven miles long, and runs from Riverside to Newton Lower Falls. It is understood that about forty trips a day will be made under the new arrangement.

ST. PAUL, MINN.—Proceedings to condemn land for a right of way for a new electric line through southern Minnesota have been brought and about 100 miles of trackage land has been secured. A rural line will be constructed, running through Shakopee, Faribault, Mankato and Albert Lea to the Iowa line. The road will carry passengers, but it is expected that its chief revenue will be from freight or express service.

LAKE PROVIDENCE, LA.—The Lake Providence & Gouldsboro Railway Company, Limited, with a capital of $100,000, has been chartered. The following are the officers and directors: Joseph L. Fischer, president; E. J. Hamley, secretary and treasurer; G. M. Purdy and W. C. Borcherding, directors. The purpose of the company is to build and operate a line of street cars from Lake Providence to Gouldsboro, a suburb of the town.

LEWISTON, ME.—The Lewiston & Kennebec Street Railway has been formed to build twenty-one miles of electric railroad connecting Lewiston, Webster, Wales, Monmouth, Litchfield, West Gardiner and Gardiner, and running into Sabatis. The incorporators are Sidney M. Bird and Maynard S. Bird, of Rockland; George W. Heselton, of Gardiner; John D. Clifford and Charles C. Benson, of Lewiston, and Edward W. Gross, of Auburn. The road will do an express, as well as a passenger, business.

TOLEDO, OHIO—Incorporation papers for the Toledo, Bay Shore & Michigan Railway Company have been sent to Columbus, the incorporators being Frank D. Cope and Frank B. Gunnin, of Pittsburg, and Frank M. Ohl, Willis F. Brown and Joseph R. W. Cooper, of Toledo. The company will construct a road from the terminus of the Toledo Railways and Light Company, at the Casino, to Point Place. The construction of the road will be commenced at once, and completed as soon as possible.

UPPER SANDUSKY, OHIO—The survey for an electric railway between Marion and Tiffin has been completed, and work has been begun on the route from here to Tiffin. The total distance will be about forty miles. It is stated by the projectors that the road has been financed by New York and Philadelphia capitalists, and that the preliminary work will be done this winter, so that construction work can be begun early next spring. When this gap is completed Cincinnati will be connected with Toledo, Sandusky and Cleveland, making a direct line from the lake to the Ohio river.

DETROIT, MICH.—The Grand Rapids & Ionia Railway Company, capitalized at $1,000,000, has been organized here and will build an electric line along private rights of way connecting Grand Rapids and Ionia, Mich., entering Grand Rapids over the tracks of the Grand Rapids Railway. The officers are: president, E. M. Hopkins, of New York and Detroit, president of the Dayton & Kenton Electric Railway; vice-president, John T. Rich, Detroit; treasurer, C. H. Pomeroy, Saginaw; secretary, Frank Westcott, Vernon. The same men propose later to build lines connecting Ionia, Owosso, Lansing and Jackson.

UNIONTOWN, PA.—Surveys are being made to connect Uniontown with Pittsburg, by way of the Monongahela valley, by trolley. The line will run by Vance Mills, Smock, Brownsville, Fayette City and Bellevernon. Several bridges will be required over Redstone creek. The road will run through a populous rural section, and pass several coal and coke works with not less than 50,000 population. Frank M. Fuller, secretary of the Commonwealth; S. M. Graham, of the Fayette Title and Trust Company; Charles H. Seaton and other prominent local capitalists are owners of the franchise rights, and already have the line built from Monessen to Fayette City.

MONTGOMERY, ALA.—A certificate of incorporation has been issued by the secretary of state to several prominent Birmingham people to build a new railroad to be known as the Birmingham & Lineville Railroad. The incorporators are S. E. Thompson, John S. Jemison, W. R. Prowell, R. H. Pearson, Robert Jemison, Vassar L. Allen, of Birmingham, and R. L. Ivey, of Lineville. It is set forth that the present terminal points of the road shall be Lineville and Pyriton, in Clay County. The right is given at some future time to build the road into Birmingham, through the counties of Talladega, Shelby, St. Clair and Jefferson; also to extend the road into Randolph and Tallapoosa counties. The capital stock is $100,000, divided into shares of $1,000 each.

WATERBURY, CT.—It has been announced that the Connecticut Railway and Lighting Company will immediately proceed to construct a trolley line between Waterbury and Cheshire, Ct. A franchise has been secured, the surveys have been completed, and needed rights of way are now being obtained. Construction of the road will put Waterbury in trolley communication with New Haven. Waterbury now has no trolley connection with any other municipality. This property, controlled by the United Gas Improvement Company, of Philadelphia, is a combination of some fourteen street railways, gas and electric light companies. The railways embraced comprise about 160 miles of track. Recent income statements show gross earnings to be $1,615,384, net $679,082, interest charges and taxes $533,735, extraordinary expenses $57,533, and balance, surplus of $87,814.

EAST HARTFORD, CT.—At a special meeting of the stockholders of the East Hartford & Glastonbury Street Railway Company, held recently, it was voted to accept the amendments to the company's charter which were granted at the last session of the General Assembly. The amendments authorize the company to build various extensions in the towns of East Hartford and Glastonbury. The company is a subsidiary corporation of the Hartford Street Railway Company, and the extensions will be constructed by the latter corporation. The Hartford Street Railway Company owns about ninety miles of main track and has enjoyed a prosperous existence for many years, having paid six per cent dividends regularly. Stock and bonds outstanding last July amounted to $1,000,000 and $2,700,000 respectively. Gross earnings have steadily increased from $618,913 in 1899 to $780,558 in 1902, and the surplus from $443 in the former year to $37,213 last year.

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PERSONAL MENTION.

MR. THOMAS ELLIOTT, of Pittsburg, Pa., has been appointed chief engineer of the Cincinnati Traction Company, Cincinnati, Ohio.

MR. FRANK M. DUNLAP, M. E., of Detroit, Mich., has been appointed acting assistant professor of mechanical engineering in the University of Michigan.

MR. DAVID MORRISON, of Cleveland, Ohio, has been elected president of the Mansfield & Eastern Electric Railway, to be built between Mansfield and Ashland.

PROFESSOR C. F. CHANDLER, of Columbia University, gave a lecture before the American Philosophical Society recently, his subject being "The Electrochemical Industries of Niagara Falls."

MR. HENRY B. BATES, formerly professor of electrical engineering in the Thomas S. Clarkson School of Technology, at Potsdam, N. Y., has been appointed professor of electrical engineering in the University of Colorado.

MR. CHARLES F. CUTLER, president of the New York and the New York & New Jersey Telephone companies, was elected president of the Hudson River Telephone Company, at a meeting of the directors held on November 19.

MR. R. R. SUTHERLAND, general superintendent of the Chicago, Cincinnati & Louisville Railway, has tendered his resignation to accept the position of superintendent of the Chicago, Rock Island & Pacific Railway, at Topeka, Kan.

MR. J. M. BRYANT, a graduate of Worcester (Mass.) Polytechnic Institute, has been appointed instructor in electrical engineering in the University of Illinois. Mr. Bryant has had two years' experience with the General Electric Company, Schenectady, N. Y.

MR. J. E. POWELL, chief mechanical and electrical engineer, supervising architect's office, Treasury Department, Washington, D. C., recently left New York for Porto Rico, to be absent until January 1, on a tour of inspection of the government buildings of the Antilles.

MR. H. H. VREELAND, president of the Interurban Street Railway Company, New York, and Mr. J. C. Hutchins, president of the Detroit United Railway Company, Detroit, Mich., have been elected honorary members of the Tramways and Light Railway Association, of Great Britain.

DR. CLAYTON H. SHARP has been sent by the Lamp Testing Bureau, New York city, to inspect all of the principal electrical laboratories of Europe. During Dr. Sharp's absence, Dr. C. P. Matthews, of Purdue University, La Fayette, Ind., will advise with the company concerning the photometric equipment of its new laboratory.

MR. JOHN I. BEGGS, president of the Milwaukee Electric Railway and Light Company, has been appointed nominal manager during the World's Fair period of the Union Electric Company, St. Louis, Mo., which has been awarded a contract to supply the World's Fair 10,000 horse-power of electric current, beginning May 1, 1904.

MR. GEORGE H. MOSEMAN, Boston, Mass., has been appointed the first selling representative of the Weston Electrical Instrument Company, of Newark, N. J., for the New England territory. Mr. Moseman was connected with the General Electric Company for ten years, and the old United Edison Company, as well as with the Edison General Electric Company, four years previous to the formation of the General Electric Company.

MR. A. A. THRESHER, of the Thresher Electric Company, Dayton, Ohio, was a New York visitor last week attending to important business connected with his company, as well as taking in the banquet of the Naval Architects and the Horse Show. This company has greatly increased its output since taking over its large factory, and is one of the busiest and most successful electrical manufacturing houses in the Middle States.

DR. BERGEN DAVIS exhibited at the meeting of the Physical Society, recently held at Columbia University, New York city, his apparatus in which mechanical rotation is produced by the electrodeless discharge. The apparatus consists of a little anemometer mounted at the centre of a vacuum tube. The discharge in the tube is produced by an oscillating current in a surrounding coil. The motion of the ions constituting this current then produces rotation in the anemometer.

ELECTRICAL SECURITIES.

Despite the general depression of values which still holds in financial circles, there is a cheerfulness evidenced which is remarkable in its extent and strength. Except in the steel and iron trade, there seems little to encourage the belief that there will be any strong tendency toward a reaction in industrial conditions. There has been so much recently in the speculative field to raise a doubt in the public mind as to the safety of speculation, that it is not remarkable that the public is staying away from the market, even when contingencies which would ordinarily provoke a good rally occur. The daily reports of railroad earnings are satisfactory, and the October report of foreign trade was encouraging. This report gave the second largest total of exports for a month in the country's history.

ELECTRICAL SECURITIES FOR THE WEEK ENDING NOVEMBER 21.

New York:	*Closing.*
Brooklyn Rapid Transit	38¼
Consolidated Gas	177½
General Electric	153
Kings County Electric	160
Manhattan Elevated	138¼
Metropolitan Street Railway	114⅛
New York & New Jersey Telephone	140
Westinghouse Manufacturing Company	165

The annual stockholders' meeting of the Metropolitan Securities Company, the holding company of the Metropolitan Street Railway Company, will be held at 32 Liberty street, New York city, December 9 at 12 M.

Boston:	*Closing.*
American Telephone and Telegraph	125¼
Edison Electric Illuminating	240
Massachusetts Electric	76½
New England Telephone	120
Western Telephone and Telegraph preferred	79

The American Telephone and Telegraph instrument statement for the month ended October 30 is as follows: gross output, 111,749; returned, 49,885, leaving a net output of 61,864, as compared with a net output of 55,446 for October, 1902. Since December 20 last the gross output has been 923,978 and the returned 408,716, leaving a net output of 515,262, as compared with 517,091 for the same period last year. The total number of instruments outstanding October 30 was 3,665,582, against 3,042,697 at the same time last year.

Philadelphia:	*Closing.*
Electric Company of America	7⅜
Electric Storage Battery common	47
Electric Storage Battery preferred	46
Philadelphia Electric	5⅞
Union Traction	43⅞
United Gas Improvement	78½
Chicago:	*Closing.*
Chicago Telephone	122½
Chicago Edison Light	140
Metropolitan Elevated preferred	55
National Carbon common	17½
National Carbon preferred	86⅞
Union Traction common	5½
Union Traction preferred	29

NEW INCORPORATIONS.

IRONTON, OHIO—The Eureka Trolley Company. $30,000.

COLUMBUS, OHIO—The Mantua Light, Heat and Power Company; $10,000; incorporators, Edgar P. Williams, Fred Price, C. M. Williams, William J. Kelly and William O. Comer. The Pataskala & Hebran Telephone Company; $65,000; incorporators, Dwight E. Sapp, Frank L. Beam, Clayton H. Bishop, Robert M. Greer, C. Wesley Coe and Bonner M. Allen.

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INDUSTRIAL ITEMS.

THE CROCKER-WHEELER COMPANY, Ampere, N. J., has established headquarters for the southern representative of its Washington office, Mr. S. M. Conant, at 425 Empire Building, Atlanta, Ga.

THE H. E. LINDSEY ELECTRICAL SUPPLY COMPANY, 1007-1011 Locust street, St. Louis, Mo., announces that it has changed the name of the company from the above to the Century Electric Company.

THE ELECTRIC APPLIANCE COMPANY, Chicago, Ill., general sales agent for the Zenith lamp, reports that the large increase in factory output which has recently been effected will obviate any further delay in filling orders for these lamps.

THE NORTHERN ELECTRICAL MANUFACTURING COMPANY, Madison, Wis., is distributing its new motor booklet No. 33. This is devoted to its "B" frames, a new size built to meet the demand for a small sized Northern machine. This booklet will be sent on request.

THE AUTOMATIC ELECTRIC COMPANY, Chicago, Ill., has received an order from Bills Brothers for a complete equipment for an automatic exchange of 2,000 stations (initial installation) for Sioux City, Iowa. The exchange will have an ultimate capacity of 10,000 stations.

THE SAWYER-MAN ELECTRIC COMPANY, New York city, N. Y., has recently issued an attractive booklet descriptive of the incandescent lamps which it manufactures, and also containing interesting suggestions for those who use incandescent lamps. This little book will be sent on request.

THE ELECTRICAL APPLIANCE COMPANY, Cincinnati, Ohio, announces that it is meeting with a very large demand for the Churcher alternating-current rectifier, which it manufactures. This company will be pleased to send illustrated literature describing the design and capacities of this apparatus on request.

THE ELECTRIC CONTRACT COMPANY, 202-204 Centre street, New York city, has issued its new catalogue No. 4. This describes a fine line of electrical novelties, dry batteries and automobile specialties. The company is the general selling agent for Williams spark coils and Jaeger bulbs. This catalogue will be sent to any one upon request.

THE TRUMBULL ELECTRIC MANUFACTURING COMPANY, Plainville, Ct., is the manufacturer of the "Ideal" cord adjuster. This adjuster is easy to install, simple in construction, takes the strain entirely off the lamp, and stays adjusted. The device is entirely separate from the lamp cord. The New York office of the company is at 136 Liberty street.

THE WARNER ELECTRIC COMPANY, Muncie, Ind., manufacturer of electrical specialties, dry batteries, and the sole manufacturer of the Warner pole-changer, announces that on November 2 suit was brought in the United States Court against the Illinois Electric Specialty Company for the alleged infringement of patent No. 685,887, issued November 5, 1901; reissued October 13, 1903; and No. 739,128, issued September 15, 1903, on the Warner pole-changer.

THE CENTRAL ELECTRIC COMPANY, Chicago, Ill., has issued a circular calling attention to its line of electric fixtures. An entire room of its establishment has been fitted up for the purpose of displaying fixtures, and while the display itself is not large, the decorations are pleasing and of an exceedingly attractive nature. The fixtures shown are varied, including almost everything of an electrical or combination nature, as well as glassware and trimmings. This display is a convincing argument that the company is an important factor in the fixture business, and is prepared to take care of a large and growing business.

MR. GEORGE H. MOSEMAN announces that he has been appointed selling agent for the Weston Electrical Instrument Company, of Newark, N. J. He will be established at 176 Federal street, Boston, Mass. In establishing a selling agent in Boston, the company has responded to a demand for more direct connection with the large number of electrical engineers, electric light and power stations, educational institutions and others located throughout New England who are interested in electrical measuring instruments, and appreciate the high grade of instruments for station, laboratory and testing work which this company has developed.

THE LAMP TESTING BUREAU is equipping its electrical testing laboratory, Eightieth street and East End avenue, New York, with the most complete and up-to-date apparatus a wise and liberal management can procure. Nothing better indicates the broad policy of the company than the fact that it has recently sent its test officer, Dr. Clayton H. Sharp, to inspect all of the principal elecrical laboratories of Europe, so that, on his return, he may be better able to equip the new laboratory to meet the needs of those who require its services. During Dr. Sharp's absence, the company has secured the services of Lr. C. P. Matthews, of Purdue University, La Fayette, Ind., to advise concerning the photometric equipment of the new laboratory.

MR. G. M. GEST, the well-known subway conduit contractor, New York and Cincinnati, has been awarded the contract for the installation of a complete conduit system by the Manchester Electric Company, Manchester, Mass. Manchester is an ideal resident place for many of the prominent people of New England, and boasts of many fine private residences, and is modern in every way. This conduit system being installed requires in all a quarter of a million feet of conduit, and covers fifteen miles of streets. A system of this extent for a country residential place is rather unique. The increasing use of high-tension alternating currents, and the facility and modest expense with which conduit can now be laid, are making this form of underground engineering very popular.

THE BULLOCK ELECTRIC MANUFACTURING COMPANY, Cincinnati, Ohio, is distributing a bulletin describing the Bullock type "B" motors and generators. This type has been designed to meet the increasing demand for small machines which will successfully withstand rough usage. The machines are thoroughly well built mechanically and electrically, and each machine is carefully tested before leaving the factory. They are guaranteed against mechanical and electrical defects for a period of one year. The generator rating for moderate-speed, open-type, compound-wound machines is 120 volts from six to twenty-five kilowatts. The motor rating for slow-speed machines is 120, 240 and 500 volts from one and one-quarter to twenty-five horse-power for open machines, and one to twenty horse-power for enclosed ones. The moderate-speed machines are from two and one-half to thirty-five horse-power for the open machines, and from two horse-power to twenty-five horse-power for the enclosed.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, Pa., has recently closed a contract with the Indiana Interurban Construction Company for the installation of a battery of chloride accumulators for the Kokomo, Marion & Western Traction Company, at Kokomo, Ind. This battery consists of 288 cells, having a capacity of 384 kilowatts, and is to be used in regulating the load on sixty-cycle rotaries, so that the lighting and railroad service can be obtained from the same generators. A contract has also been closed with the Department of Commerce and Labor, Washington, D. C., for two batteries, to be operated by the National Bureau of Standards, Wasnington; with the Clark University, Worcester, Mass., and the Bacon Air Lift Company, for the residence of Herman B. Duryea, Westbury, L. I.—This latter installation consists of a battery of sixty-eight cells, having a capacity of forty-six kilowatts, to be used for lighting and power after the generator plant has shut down for the night.

THE KINSMAN ELECTRIC AND RAILWAY SUPPLY COMPANY, 91 Liberty street, New York city, is booming the new Kinsman "Daylight" desk lamp. This electric desk lamp is constructed on scientific principles, and is of great value to those who are compelled to do desk work. The parabola effect creates a light which is soft and abundant and well distributed, leaving no shadows or dark corners on the desk. At the same time, the lamp is entirely shaded from the eyes. In appeartnce it is ornamental and attractive, is adjustable in six directions, and in no way interferes with the opening and closing of a roll-top desk. Another specialty which this company is calling attention to is the Kinsman automobile cable. This cable is extremely flexible. It is made up with a core of high-tension conductor, surrounded by a sheathing of pure rubber. This, in turn, is surrounded by a covering of white core rubber, which is wrapped in a high-resistance vulcanized rubber, the whole being taped with an insulating braid. The braid and tape are protection from oil, and, with a lead covering, this cable is absolutely oil-proof. Circulars describing these and other specialties manufactured by the Kinsman company will be sent upon request.

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STEPHEN H. GODDARD . . . . . SECRETARY AND MANAGER
WM. HAND BROWNE, JR. . . . . TECHNICAL EDITOR
AINSLIE A. GRAY . . . . . ASSISTANT EDITOR

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CONTENTS.

EDITORIALS 799-801
Industrial Electrochemistry and Electrometallurgy 799
Conservatism Desirable in Electrical Applications 799
The Convention of the Interstate Independent Telephone Association 800
Electrolytic Drilling 800
The Magnetic Effect of Electric Convection 801
Power for Lighting Cars 801
Helium and Radium 801
The Misuse of Physics by Biologists and Engineers, by W. S. Franklin 802
Electrical Notes from Europe, by Our Special Correspondent 805
The Fourth Progress Report of the Committee on Photometric Value of Arc Lamps of the National Electric Light Association 807
Drainage by Electricity 807
130 Miles an Hour 808
Coal Storage Under Water 808
Brooklyn Rapid Transit Company Makes Changes in Its Transit System 808
Industrial Electrochemistry and Electrometallurgy II, by John B. C. Kershaw 809
Electrical Mining Notes, by Sydney F. Walker 810
The Electric Railway at La Mure, France 811
The Interstate Independent Telephone Association 812
The Comparative Behavior of Floating and Booster-Controlled Batteries on Fluctuating Loads—II. by Lamar Lyndon 815
The Telephone 817
Electrical Patents 818
Reviews of Current Engineering and Scientific Literature 820
INDUSTRIAL SECTION:
A Heavy Service Overhead Electric Traveling Crane 822
Wireless Telegraph Experiments 822
Latest Type Automatic Telephone Switchboard 823
Machine vs. Hand Numbering in Metals 823
Telpherage in Coal Handling 824
Wireless Cluster Incandescent Lamp Fixtures 826
Allis-Chalmers Company's New Standard Reynolds-Corliss Engine 827
Conduit Systems 827
A Heavy Turret Lathe 828
The New Worthington Plant 828
An Improved Solid Expanding Sleeve 828
A Novel Use for a Refrigerating Machine 828
Rapidity in Telephone Line Construction 829
CURRENT ELECTRICAL NEWS 830

INDUSTRIAL ELECTROCHEMISTRY AND ELECTROMETALLURGY.

On another page of this issue will be found the first section of a second series of notes prepared by Mr. John B. C. Kershaw and dealing with recent progress in the industrial application of electrochemical and electrometallurgical processes. The author has exceptional facilities for keeping in touch with the conditions prevailing in the older processes and for getting early and reliable information relating to newer methods and installations. The notes will doubtless be appreciated by all interested in these lines of work. The first series of these notes appeared in the ELECTRICAL REVIEW, January to April, 1903.

CONSERVATISM DESIRABLE IN ELECTRICAL APPLICATIONS.

In applying electrical methods to old processes or to new, the inventor too often attempts too much. Instead of being satisfied to make a change in one stage of the process and perfect that before passing to the next, he seeks to revise the whole process—too often without complete success. If, on the other hand, he would make use of electrical energy for that stage of the process where it can be used to the best advantage, the success attained at this point would indicate whether it were worth while to carry the development further, and the experience gained would be most helpful in new work. Moreover, the inventor's whole attention could be devoted to that one stage, and he should make better progress in this way than if he were attempting to change the entire process at once.

Limitations of Electrical Methods Overlooked.

The limitations of electrical methods are too often overlooked in electrometallurgical processes. Since electrical energy can be transmitted easily, handled conveniently, and may be used to produce extremely high temperatures, it seems very suitable for furnace operations; but in this application highly developed metallurgical processes must be contended with, and it becomes a question whether the additional cost of the heat produced electrically, as compared with that produced directly from fuel, can be compensated for by the reduction in the cost at other points. Where only moderately high temperatures are desired, and the use of coal or gas is, in itself, not objectionable, there seems to be little reason for attempting to supply this heat electrically, as to do so would simply add to the cost and perhaps bring about failure. Thus, in reducing metals in the electric furnace, where a high temperature is desirable to bring about the reduction, it would seem advisable at first to limit the application of electricity to this one point only, such other heating as is required being brought about by other means. Or, as another illustration, in making glass in an electric furnace, after fusing the raw material it must be kept in a molten condition for about twenty-four hours, so as to allow all entrapped air to escape and the molten mass to become transparent; but to maintain a large mass of glass in a molten condition for twenty-four hours with electrical energy, would most certainly make the process too expensive to be commercial.

The Ruling Factor.

There are, of course, cases where questions of safety and convenience are all important, and considerations of cost are secondary; but such cases are not very frequently met in commercial processes. In these, cost is generally the ruling factor, and this should never be overlooked. Let electrical means be applied first wherever they can reduce cost, or where other means

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will not suffice, and other applications will follow later. It is no disgrace to retain, in certain stages of an electrical process, older methods which have proved to be economical.

THE CONVENTION OF THE INTERSTATE INDEPENDENT TELEPHONE ASSOCIATION.

The annual convention of the Interstate Independent Telephone Association will be held in Chicago, Ill., December 8, 9 and 10. Of course, every one knows of the attractiveness and convenience of that city, as a convention headquarters, particularly as concerning telephone men. A large part of the manufacturing element has permanent establishments in Chicago and this element has always been a prominent factor in conventions of independent telephone associations, and particularly so with regard to the Interstate Independent Telephone Association. The convention in 1904 is pledged to St. Louis, Mo., and no doubt the manufacturers will be strongly in evidence this year at Chicago.

Another Successful Session.

The association is one of the youngest of the independent telephone organizations, having been inaugurated in April, 1902. Notwithstanding, it is a strong body, and thoroughly representative of the independent movement, embracing a large portion of the entire investment in this industry. Its two former sessions have been marked by an enthusiasm and completeness that have almost paralleled the affairs of the national body and the present indications are that the third general gathering will not fall short, in point of attendance and interest, of those that have gone before.

The Programme.

The published programme anticipates an address of welcome by the mayor of the municipality. Inasmuch as Chicago is about to make an elaborate experiment in independent operations and under a system involving radical differences from existing installations, there is an excellent opportunity here for something different from the stereotyped form of generalities and offering of the city privileges, etc. Mayor Harrison is presumed to be an antagonist of monopolies and has recently gone on record as declaring vigorously in favor of a municipal lighting plant. It would therefore be refreshing to hear some matter-of-fact opinion on this subject from this source. The present executive of the association, Senator C. E. Hull, is well equipped and will no doubt have a message of importance to convey to his listeners. At the last meeting the secretary, Mr. E. M. Coleman, offered some valuable suggestions as to unifying the work and establishing a firmer foundation of organization. His ideas on clearing-house methods and census-taking are particularly debatable and should receive a great deal of attention. There is a lamentable lack of accessible information with regard to independent statistics, and this should be remedied at once.

Statistics Hard to Gather.

Of course, any one who has watched the development can appreciate the apparent difficulty which the compilation of such data would entail. But a start should be made. The members of such associations are in possession of the facts and should encourage all legitimate efforts to construct accurate tables of information.

Growth More Stable than Hitherto.

Apropos of the compilation of comparative data, this should be easier as time goes on, as each year is seeing a decrease in the mushroom growth of independent exchanges. This does not mean that the movement is suffering any retardation, but rather that it is attracting slow-moving, careful investors and is losing all semblance of wildcat venturing. This is as it should be, for it matters little to the subscriber, after all, who gives him service, as long as it is given conscientiously. Members of the Interstate Independent Telephone Association can be of great help one to the other only when they make their every effort toward a betterment of conditions where they can be improved, and then impart freely and fully the methods employed in doing so.

ELECTROLYTIC DRILLING.

In a brief article contributed to the October issue of the *Electrochemist and Metallurgist,* Mr. Sherrard Cowper-Coles describes an electrolytic method of drilling and slotting metals, which is an interesting application of electrolytic action as an aid to the machinist. In this method, the metal to be drilled is made the anode of an electrolytic cell, any other suitable material serving for the cathode. A heavy current is then passed from the plate to the cathode through any convenient electrolyte, the effect, of course, being to dissolve metal from the cathode. In order to limit the action of the current to the section to be removed, the anode is covered with a soft rubber washer having an opening of the size and shape of the hole to be cut. In the apparatus, as devised, the electrolyte is confined in a vulcanite tube and, being rapidly circulated, prevents treeing of the deposited metal on the cathode, as this might cause a short-circuit. If a slot is desired, it is only necessary to move the apparatus over the metal where the cut is to be made.

The Method Has Advantages.

While this method will not give results as exact as drilling and slotting with a tool, it would seem suitable for a number of operations, and, although the electrolytic drilling proceeds slowly as compared with machine drilling, the method may be used without previous treatment of the metal. A hardened steel armor plate would be no more trouble to drill than a similar plate of soft steel. The work can proceed under water, possibly with advantage in some instances. While it is true a heavy current density would be necessary to carry on the work satisfactorily, the power required need not be large, as the voltage may be low. After the apparatus is set to work, it should not require much attention, and one man would certainly be able to take care of a good number of such drills. Thus, as the work can be carried on at a number of points simultaneously, the slowness with which the drilling proceeds at any one point would be, to a large extent, compensated for.

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THE MAGNETIC EFFECT OF ELECTRIC CONVECTION.

According to the views held by Faraday and Maxwell, the motion of a body electrically charged should produce a magnetic field, and a method was suggested by Maxwell for testing this, which was first carried out brilliantly by Rowland in 1876. The method consisted simply in revolving a charged ebonite disc in the vicinity of an astatic magnetic needle. Since the charge which the disc could carry was necessarily small, as compared with the quantities involved in current flow, and as the velocity of the disc was also small compared with that of light, the deflections expected, even with the most delicate apparatus, could be but small. Rowland's results, however, satisfied Helmholtz, in whose laboratory the work was done.

A Modified Method.

Later an attempt was made by Lecher to repeat the work, but without success, though Rœntgen, in one of his experiments, did observe a similar effect. In 1897 Crémieu undertook to investigate the subject by another method. If a moving charge sets up a magnetic field, a varying magnetic field, he argued, should exert a mechanical force upon a stationary electric charge. He was, however, unable to detect any such effect. He then modified his experiment, in this way: he replaced the varying magnetic field by a varying electric field, set up by rapidly charging and discharging a disc, and he sought for an electric current induced in a coil of wire placed parallel to the charged surface. This action should set up a varying magnetic field if the Faraday-Maxwell theory be true, and such a reaction could readily be detected by a coil placed parallel to the disc and connected to a galvanometer through a suitable commutator. The work was most carefully carried out but gave only negative results.

Rowland's Work Verified.

To disprove or verify Crémieu's work, Pender, working under Rowland, adopted Crémieu's apparatus and obtained decidedly positive results. He was even able from his data to calculate approximately the velocity of light, while Crémieu continued to obtain his negative results. To settle the matter, Pender was invited to repeat his work at Paris, in conjunction with Crémieu, and he here verified his former result. Pender obtained deflections with his galvanometer; Crémieu, none. However, by adopting Rowland's apparatus, Crémieu was convinced, though he was unable to account for his failures with his own apparatus. It was then noticed that he had covered the conducting surface of the plates which he charged with a dielectric. Upon repeating the work without this coating, he succeeded in obtaining the long-sought deflection.

What Effect Has the Dielectric?

This work disposes of the last doubt thrown on Rowland's work, but it has brought up an interesting question of the action of the dielectric. Vasilesco-Karpen attempted to answer this question, and modifying Crémieu's arrangement so as to intensify the effect by means of a condenser and by revolving the charged disc he obtained deflections when the charged disc was covered with various dielectrics, indicating that a magnetic field is set up in any case. This result is not in agreement with the observations of Crémieu and Pender, which remain unexplained.

POWER FOR LIGHTING CARS.

When electric lighting of cars was first suggested, the objection was doubtless raised against it by many, that to force the locomotive to furnish the additional power required by the lamps would be only throwing more work on an already overloaded machine. This is true, but the amount of power required to light a car is comparatively so small that that taken by a long train would hardly be felt by the large locomotives which are now in use. The steam locomotive for a heavy train would probably be rated at 1,000 horse-power, and it would be working at about its full output when running at a good speed. The lighting equipment of a Pullman car consists of about eighty eight-candle-power incandescent lamps. For such application only high-efficiency lamps would be used, so that the power consumed by each lamp would be small. In fact, two kilowatts per car would probably be sufficient to supply all the lights on the car. This, allowing for losses, would be about five horse-power at the axle, and would amount to only 0.5 per cent of the rating of the locomotive required by each car. It is highly probable that the car resistance itself during a run may vary so as to masque entirely the demands made by the lighting system, and the effect on the speed of the train would not be appreciable.

HELIUM AND RADIUM.

In a recent lecture before the London Institution, Sir William Ramsay, professor of chemistry at University College, London, made the interesting announcement that his experiments seemed to verify the suggestion, made some time since by Rutherford and Soddy, that during the so-called disintegration of radium, helium is formed. It will be remembered that Rutherford and Soddy showed that an emanation having the characteristics of a heavy gas which could be collected was given off by radium. This emanation seemed to undergo a change or disintegration, but some final product must remain, and this they suggested might be helium.

Spectrum of Helium Found.

Sir William Ramsay, in his work, collected the emanation of radium and examined it for helium. This was first detected by its spectrum, after the emanation had been kept for a couple of days, the characteristic lines of helium becoming brighter thereafter from day to day. The observation agrees with the deductions drawn from the recent work of Rutherford and Barnes, in measuring the heat given off by radium. They found that the heat given off by the emanation increased to a maximum after separation from the radium salt, an effect which was attributed to a second stage of disintegration, corresponding to that stage during which helium apparently is formed.

Evidence from the Chemist's Side Desirable.

The physicists seem to be making out a good case for their new ideas of the nature of atoms, but the evidence is not all in yet, and the theory can hardly be called proved. Some evidence upholding the chemist's atomic theory would be very interesting at the present time, particularly in regard to radioactive substances.

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THE MISUSE OF PHYSICS BY BIOLOGISTS AND ENGINEERS.[1]

BY W. S. FRANKLIN.

My chief object in presenting this paper is to call attention to some of the precise notions of thermodynamics and to point out the essential limitations of that subject.

A great deal is, I think, to be gained for science at the present time by insisting upon the sharp delimitation of those general ideas in physics which are related primarily to thermodynamics just as a great deal has been gained in the last half century by the sharp delimitation of those general ideas which relate primarily to mechanics. There is, I think, a widespread confusion of boundaries which makes this sharp delimitation a thing greatly to be desired, and I have chosen as the title of this preliminary paper "The Misuse of Physics by Biologists and Engineers" for the reason that, in my opinion, these men, more than any others, violate in their philosophy the essential limitations of systematic physics and confuse the boundaries between systematic physics and statistical physics.

Physics is divided into two branches, namely, systematic physics and statistical physics.

Systematic physics is again divided into mechanics and thermodynamics.

Mechanics, in the broad sense here defined, treats of those phenomena which can be to a high degree of approximation correlated in one-to-one correspondences to states of equilibrium and to simple types of sensible motion.

Thermodynamics treats of those phenomena which can be to a high degree of approximation correlated in one-to-one correspondences to states and processes involving thermal equilibrium and involving those permanently varying states which I have called steady sweeps.

Statistical physics is the study of all the actual physical phenomena of nature, some of which, indeed, may be described in terms of the notions of ideal mechanics to a high degree of approximation, and some of which, indeed, may be described in terms of the notions of ideal thermodynamics to a high degree of approximation, but all of which are more or less erratic and in their minute details infinitely manifold, and in all of which the notion of one-to-one correspondence or of cause and effect, if one prefers that mode of expression, fails.

[1] Abstract of a paper read before the American Physical Society on October 31, 1908.

The engineer is not far wrong in his application of the principles of mechanics, for the engineer is chiefly concerned with integral relationship between finite things.

In studies which require the application of the principles of thermodynamics, on the other hand, engineers are, I think, frequently in error.

The biologist is, I think, usually illogical when he attempts to make use of the ideas of systematic physics.

The biologist and the engineer need to have precise knowledge of themodynamics, inasmuch as it is thermodynamics chiefly which determines the limits of correct application of the ideas and methods of systematic physics to natural phenomena.

I—THERMAL EQUILIBRIUM.

When a substance is shielded from outside disturbance it settles to a state in which there is no tendency to further change of any kind. Such a state is called a state of thermal equilibrium.

When a substance has settled to thermal equilibrium it is said to have a definite temperature. The notion of temperature, that is the precise idea of temperature, as a physical fact is derived from the notion of thermal equilibrium. Also the idea of differences of temperature as physical facts (not as quantities) is derived from comparisons of states of thermal equilibrium.

II—REVERSIBLE PROCESSES.

A substance in thermal equilibrium is generally under the influence of external agencies. However, a substance can not be in thermal equilibrium when work is continually done upon or done by it, or when heat is continually given to or taken from it.

If the external influences which act upon a fluid in thermal equilibrium are made to change very slowly, causing the pressure and volume of the fluid to pass very slowly through a continuous series of valves, and in general involving the doing of work upon or by the fluid and the giving of heat to or taking of heat from the fluid, the fluid will pass slowly through a process consisting of a continuous series of states of thermal equilibrium. Such a process is called a reversible process, for the reason that the fluid will pass through the same series of states in reverse order if the external influences are changed slowly so as to make the pressure and volume of the fluid pass through the same series of values in reverse order.

The characteristics of a reversible process are therefore as follows:

(*a*) A substance which undergoes a reversible process must be under varying external influence. A closed system can not perform a reversible process.

(*b*) A substance as it undergoes a reversible process is at each instant in a state of thermal equilibrium.

(*c*) A reversible process must take place slowly, strictly with infinite slowness. An actual process, that is, a process which actually does proceed, can be only approximately reversible.

III—SWEEPING OR IRREVERSIBLE PROCESSES.

While a substance is settling or tending to settle to thermal equilibrium it may be said to undergo a process. Such a process can not, in general, be arrested and maintained at any stage short of complete thermal equilibrium, but always and inevitably proceeds toward that state. Such a process is, therefore, called a sweeping process or simply a sweep.

A sweeping process takes place in one direction only, that is, if A and B are two successive stages of a sweep, stage B following stage A, then stage B grows out of stage A inevitably, but stage A can not be made to follow or grow out of stage B by any means whatever. A sweeping process, therefore, is reversible.

Note 1—A fluid not in thermal equilibrium has no definite pressure, temperature or volume. The volume of a turbulent gas pertains only to the containing-vessel. Points in Watt's diagram can represent only states of equilibrium, and lines in Watt's diagram can represent only reversible processes.

Note 2—Writers on thermodynamics who are obliged to deal with irreversible processes or sweeping processes, that is to say, steam engineers, frequently introduce the notion of the integration of entropy and temperature. Now in the first place, when this method appears to give results a legitimate mode of calculating sweeps is really used, and the legitimate ideas involved are illogically expressed in terms of temperature and entropy. In the second place, temperature and entropy have no meaning as applied to the elements of volume, even of a substance in thermal equilibrium, not to mention the question of their application to the volume elements of a turbulent substance.

IV—SIMPLE SWEEPS.

The settling of a closed system to thermal equilibrium is called a simple sweep.

Example—The equilibrium of a mixture of oxygen and hydrogen in a closed vessel may be disturbed by a minute spark, and the explosion and subsequent settling of

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the aqueous vapor to a quiescent state without loss of heat constitute a simple sweep.

V—TRAILING SWEEPS.

When external influences change continuously, a substance in its tendency to settle to equilibrium never catches up, as it were, with the changing conditions, but trails along behind them, and we have what is called a trailing sweep.

Examples—The rapid expansion or compression of a gas in a cylinder is a trailing sweep. So long as the piston moves at a perceptible speed, the gas, in its tendency to settle to equilibrium, never catches up with the varying conditions.

VI—STEADY SWEEPS.

A substance may be subjected to external action which, although unvarying, is incompatible with thermal equilibrium. When such is the case the substance settles to a permanent or unvarying state which is not a state of thermal equilibrium. Such a state of a substance is called a steady sweep.

Examples—The two faces of a slab or the two ends of a wire may be kept permanently at different temperatures. When this is done the slab or wire settles to an unvarying state which is by no means a state of thermal equilibrium. Heat flows through the slab or along the wire from the region of high temperature to the region of low temperature, never from the region of low temperature to the region of high temperature. This flow of heat through the slab or along the wire is an irreversible process and it constitutes a steady sweep.

The notion of steady sweeps is of the utmost importance in thermodynamics, inasmuch as the thermodynamics treats directly of states of thermal equilibrium and of steady sweeps only.

The notion of entropy is involved in the notion of a steady sweep; and the notion of temperature is involved in the notion of thermal equilibrium.

VII—THERMODYNAMIC DEGENERATION AND REGENERATION.

A sweeping process always plays a certain havoc, or effects a certain degeneration in a system.

In a simple sweep the degeneration lies wholly in the relation between the initial and final states of the substance which undergoes the sweep, inasmuch as, in a simple sweep, no outside substance is affected in any way, no work is done on or by the substance which undergoes the sweep, and no heat is given to or taken from it.

In a trailing sweep the degeneration may lie partly in the relation between the initial and final states of the substance which undergoes the sweep, partly in the direct conversion of work into heat and partly in the direct transfer of heat from regions of high temperature to regions of low temperature.

In a steady sweep the substance which undergoes the sweep remains entirely unchanged as the sweep proceeds, and the degeneration lies wholly in the direct conversion of work into heat, in the direct transfer of heat from a region of high temperature to a region of low temperature, or both.

A substance which has undergone a sweeping process may be brought back to its initial state, or regenerated, by a reversible process; but when a substance is regenerated by a reversible process, the external action necessary to bring about the reversible process involves an equal degeneration of some external substance; that is, the regeneration of a substance by a reversible process always involves the creation of an equal external regeneration. This is, in fact, a statement of the second law of thermodynamics.

The following two propositions concerning the two kinds of thermodynamics degeneration (*a*) and (*b*) follow at once from a consideration of steady sweeps.

Proposition (A)—The thermodynamic degeneration represented by the direct conversion of work into heat at a given temperature is proportional to the quantity of work so converted.

Proof—Consider a steady flow of electric current in a wire. This process being steady, the amount of degeneration occurring in a given interval of time must be proportional to the time. The amount of work converted into heat is also proportional to the time. Therefore the amount of degeneration is proportional to the amount of work converted into heat. Of course the temperature must be invariable, or the process can not be thought of as remaining identically the same from instant to instant.

Corollary—The thermodynamic regeneration which is represented by the conversion of heat at a given temperature into work by a reversible process is proportional to the heat so converted.

Proposition (B)—The thermodynamic degeneration represented by the direct transfer of heat from a given high temperature T_1 to a given low temperature T_2 is proportional to the quantity of heat transferred.

Proof—Consider a steady flow of heat from temperature T_1 to temperature T_2 constituting a steady sweep. This process being steady, the degeneration occurring in a given interval of time must be proportional to the time. The quantity of heat transferred is also proportional to the time. Therefore, the amount of degeneration is proportional to the quantity of heat transferred.

Corollary—The thermodynamic regeneration which is represented by the transfer of heat from a low temperature T_2 to a high temperature T_1 by a reversible process is proportional to the heat transferred.

VIII—THE SECOND LAW OF THERMODYNAMICS.

(*a*) The degeneration of a system which accompanies a sweeping process can not be directly repaired, nor can it be repaired by any means without the creation of a compensating degeneration in some other system.

(*b*) Heat can not pass directly from a cold body to a hot body, nor can heat be transferred from a cold body to a hot body by any means without compensation.

(*c*) Heat can not be converted directly into work, nor can heat be converted into work by any means without compensation.

(*d*) A gas can not pass directly from a region of low pressure to a region of high pressure, nor can a gas be transferred from a region of low pressure to a region of high pressure by any means without compensation.

IX—ENGINES.

The further development of the subject of thermodynamics depends upon the establishment of the exact relation between the degeneration which is represented by the transfer of heat from a high to a low temperature and the degeneration which is represented by the conversion of work into heat. To establish this relation it is necessary to consider a reversible process in which the degeneration of heat from high to low temperature is compensated by the regeneration of heat into work, or *vice versa*.

The engine is a machine which determines such a process. The ordinary engine, indeed, is subject to friction, and the steam as it passes through the engine does not undergo a reversible process; but if the engine were frictionless, if it were driven slowly, if the cylinder were prevented from cooling the steam, if the steam were expanded sufficiently to prevent puffing and if the feed water were heated, in a "regenerative" feed water, to

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boiler temperature before entering the boiler, then the processes involved in the operation of the engine would be reversible. Such an ideal engine we will call a reversible engine or a perfect engine.

During a given interval of time the engine takes an amount of heat H_1 from the boiler at temperature T_1, it converts into work W a certain fractional part of H_1 and delivers the remainder H_2 to the condenser at temperature T_2.

The work W done by the engine is equal to the difference $H_1 - H_2$ according to the first law of thermodynamics. That is,

$$W = H_1 - H_2. \qquad (1)$$

Now, all the heat used in the engine comes from the region at temperature T_1, and the net result of the operation of the engine is: (*a*) to convert the quantity $W (= H_1 - H_2)$ of heat from temperature T_1 into work, and (*b*) to transfer the quantity H_2 of heat from temperature T_1 to temperature T_2. The result (*a*) involves an amount of regeneration which is proportional to W, temperature being given; this regeneration may, therefore, be represented by mW where m is a constant depending only on the temperature T_1. The result (*b*) involves an amount of degeneration which is proportional to H_2, temperatures being given; this degeneration may, therefore, be represented by $n H_2$ where n is a constant depending only on the temperatures T_1 and T_2. If the engine is reversible we must have

$$m W = n H_2, \qquad (2)a$$

or, using the value $(H_1 - W)$ for H_2, and solving for W we have

$$W = \frac{n}{m+n} H_1, \qquad (2)b$$

in which $n/(m+n)$ depends on T_1 and T_2, only, irrespective of the kind of engine and of the physical properties of the fluid employed in the engine, provided, only, that the engine is reversible. The fractional part $n/(m+n)$ of the heat H_1 which the engine converts into work is called the efficiency of the engine, and from equation (2) *b* it follows that the efficiency of all reversible engines is the same for given valves of the temperatures T_1 and T_2.

If the operation of the engine involves sweeping processes of any kind then the degeneration $n H_2$ exceeds the regeneration mW or

$$m W < n H_2,$$

or, using the value $(H_1 - W)$ for H_2, and solving for W we have

$$W < \frac{n}{m+n} H_1, \qquad (3)$$

in which m and n have the same values as in equation (1). Comparing this with equation (2) *b* it follows that any irreversible engine working between given temperatures T_1 and T_2, has less efficiency than a reversible engine working between the same temperatures.

X—THERMODYNAMIC DEFINITION OF THE RATIO OF TWO TEMPERATURES.

According to article 9 the ratio, H_1/H_2, of the heat taken from the boiler to the heat given to the condenser by any reversible engine working between the given temperatures T_1 and T_2 is invariable, and it can be easily shown that this ratio approaches unity as T_1 and T_2 approach equality. Therefore, the ratio of the two temperatures T_1/T_2 may be defined as the ratio of the two heats H_1/H_2. That is:

$$\frac{T_1}{T_2} = \frac{H_1}{H_2}. \qquad (4)$$

XI—ENTROPY. THERMODYNAMIC DEGENERATION.

The statement of the second law of thermodynamics can scarcely be looked upon as complete until a precise and complete numerical measure of thermodynamic degeneration has been established. This numerical measure of thermodynamic degeneration is called entropy. The notion of entropy may be completely developed by consideration of steady sweeps.

Referring to article 9 we may write the expression for the regeneration mW in the form $f(T_1) \cdot W$ inasmuch as m is a function of T_1 only.

The degeneration $n H_2$ may be written

$$[f(T_2) - f(T_1)] H_2,$$

inasmuch as the degeneration associated with the transfer of the heat H_2 from T_1 to T_2 may be thought of as (*a*) the regeneration of H_2 from temperature T_1 to work, and (*b*) the degeneration of this resulting work to heat at temperature T_2; in which case the regeneration (*a*) is $f(T_1) \cdot H_2$ and the degeneration (*b*) is $f(T_2) \cdot H_2$.

Therefore, equation (2) *a* may be written

$$f(T_1) \cdot W = [f(T_2) - f(T_1)] H_2.$$

Using equation (1) and equation (4) we have

$$\frac{f(T_2) - f(T_1)}{f(T_1)} = \frac{T_1 - T_2}{T_2}.$$

From which the function f is to be determined. Differentiating with respect to T_2 we have

$$\frac{f'(T_2)}{f(T_1)} = -\frac{T_1}{T_2^2} = -\frac{\frac{1}{T_2^2}}{\frac{1}{T_1}};$$

add, therefore, since T_1 and T_2 are independent of each other we have

$$f(T_1) = \frac{1}{T_1}.$$

That is to say, the thermodynamic degeneration associated with the conversion of an amount of work W into heat at temperature T_1 is equal to W/T_1, and the thermodynamic degeneration associated with the transfer of an amount of heat H_2 from temperature T_1 to temperature T_2 is

$$\frac{H_2}{T_2} - \frac{H_2}{T_1}$$

Absolute Values of Entropy—Entropy changes or entropy differences only have real physical significance. However, a certain state of a substance may be arbitrarily chosen as a zero state or reference state.

XII—SUMMARY.

The precise idea of temperature is associated with the notion of thermal equilibrium, and the precise idea of temperature has nothing to do with the sensations of hot and cold. The electric arc, for example, is very hot, but it has no temperature.

Not only is the precise idea of temperature limited to substances in thermal equilibrium, but it applies only to a finite portion of a substance. It is meaningless to speak of the temperature of a molecule.

There are many cases of steady sweeps, such as thermal conduction in a gas, steady radiation from a hot to a cold region, in which the sweeping substance, be it material or ether, is far from being in thermal equilibrium, although in a permanent or unvarying state. The precise idea of temperature is not applicable to such states.

In general, all cases of molecular motion and of ether motion (radiant heat) in which some definite and unvarying function exists expressing the distribution of energy among the various phases of the motion, are to be classed as steady sweeps. In all such cases the precise idea of temperature is inapplicable to the sweeping substance or space. Still, all such processes are amenable to precise and systematic treatment. This systematic treatment always depends upon a knowledge of the function of distribution of energy among the phases, and the characteristics of the sweeping substance or space are properly described in terms of this function, not in terms of temperature and entropy. It is true, however, that a generalized idea of entropy, for example, can be applied to steadily sweeping substances.

Entropy always increases in natural phenomena, and the notion of entropy is, perhaps, much more intimately related to the notion of time than any other physical notion whatever. The notion of entropy seems to me, indeed, to be the very foundation of the notion of time as a physical fact, although the numerical evaluation of time depends, in practice, upon the approximate realization of some of the precise ideas of mechanics.

Heretofore the idea of the increase of entropy associated with a sweeping process has been thought by the ablest writers on thermodynamics to be dependent upon the devising of a reversible process which leads to the same change of state as the given irreversible process. This is, I think, true in regard to sweeping processes in general, but it is not true in regard to steady sweeps.

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Electrical Notes from Europe.

An Automatic Wireless Telegraph Post, and the New Blondel-Carpentier Hysteresimeter.

(By Our Special Correspondent.)

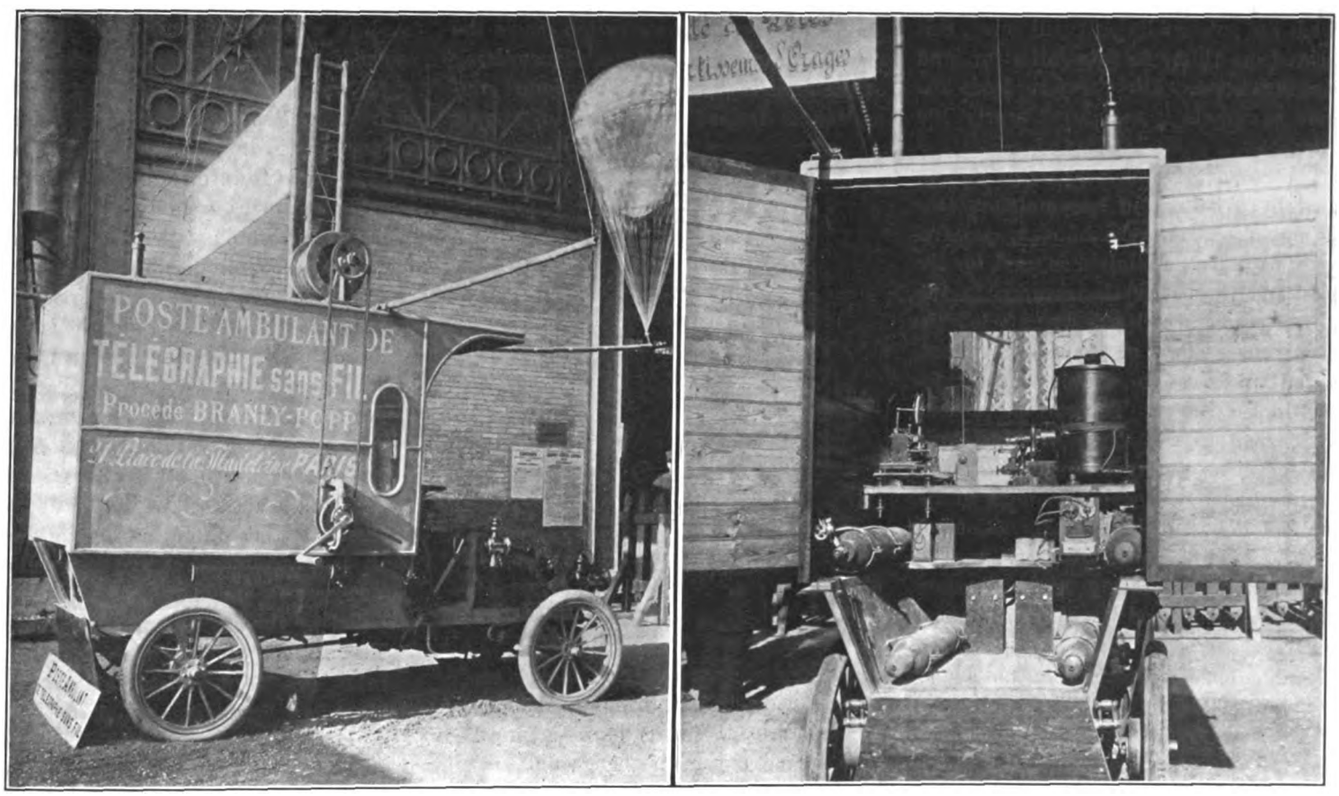
ONE of the novelties in wireless telegraphy is the automobile post which has been brought out by the Société Française des Telegraphes Sans Fil, of Paris, which controls the Branly-Popp aerial telegraphy system. The apparatus is mounted in a large automobile somewhat on the line of a delivery wagon, the interior of which has been fitted up as a traveling station. The automobile can travel quickly to the desired point and is then stopped, the mast-wire carried up by a balloon or kite and the post is ready to communicate with another station. Such a system will no doubt find a variety of uses, and is especially valuable for military work. One of the engravings shows the automobile post complete and in the second will be observed the arrangement of the apparatus in the interior.

Access is given to the inside by opening up two large doors and letting down a flap at the bottom. The main part of the interior, which contains the instruments and different apparatus, is partitioned off from the front, containing the driver's seat and a place for the telegraph operator. In the interior will be observed the main transmitting and receiving apparatus of the post, which is placed on a shelf or table about three by four feet. To the right is the apparatus for the transmission, with the receiving apparatus on the left. Below the main table is a second shelf which contains different apparatus, while the remainder, including the two accumulator boxes, is placed on the floor of the vehicle. The four hydrogen tubes for filling the balloon are attached against the sides and floor by iron straps.

As the apparatus is subject to considerable shocks from the movement of the automobile, special attention had to be paid to getting rid of the vibration as much as possible. The automobile body, in the first place, is given an extra spring suspension from the truck. The relay and receiving apparatus, which are the most sensitive, are mounted together upon a base which is then held upon the table by a spring suspension at the four corners, as may be distinguished in the engraving. This method of suspension has proved to be very effective in taking up the shocks, and no trouble has been experienced in practice from this cause.

The mast wire is rolled on a wooden drum of twenty centimetres diameter, which is mounted on the roof of the automobile, as the engraving shows. The drum is operated by a windlass which is mounted against the side of the car by means of a chain and sprocket-wheels. A band-brake upon the drum serves to regulate the feeding out of the wire. The drum can be blocked in position by a ratchet-wheel. The mast wire is carried by a kite of the cubical pattern, in case there is sufficient wind; if not, the wire is raised by small balloons which are carried on the car (one will be noticed on the right) and can be filled out with hydrogen from the tubes. In certain cases it may be impossible to use either kite or balloons, and to provide for this the automobile has been equipped with a mast of bamboo which is made in sections and can be quickly set up in place or taken down. The mast is braced upright by a set of bamboo poles which are fastened down upon the roof, as will be observed, and the ends of these pieces carry the stay wires which pass up to the top of the mast. In this way it is firmly held in position.

The automobile is of the gasoline type and is operated by a two-cylinder petrol



THE AUTOMATIC WIRELESS TELEGRAPH POST, SHOWING RAISING BALLOON AND INTERIOR APPARATUS.

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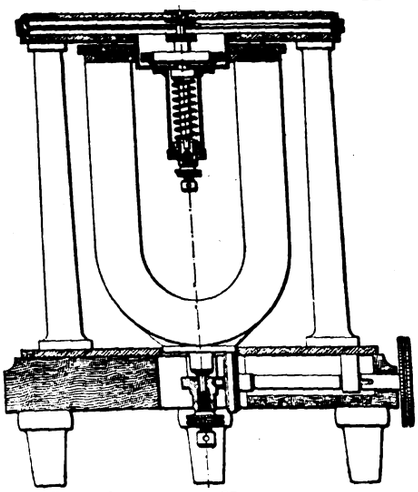
motor with electric ignition. The motor has a normal capacity of twelve horse-power. The weight of the automobile when completely equipped is about 2,850 pounds, including the two men in service. It can make an average speed of twenty-five miles an hour. The setting up of the wireless telegraphy post is easily carried out and can be effected by two men. When the automobile arrives at its destination one of the men unrolls the wire gauge sheet which forms the ground connection (noticed on the side of the vehicle) and spreads it on the ground. The second man fills out the balloon from the hydrogen tubes or mounts the kite, attaches the mast wire and unrolls the drum. Experiments show that the post can be set up and ready to send messages within ten minutes. As to the distance which the automobile post will cover, this varies from thirty to fifty miles for land communication. On the sea, from the shore to vessels it can cover nearly 100 miles.

The current for the apparatus is supplied by a battery of accumulators consisting of sixteen cells of sixty ampere-hours capacity. Celluloid is used for the cells, and the battery is mounted in two separate cases, which are stored below the main table. Two of the cells are connected up so as to supply current for the Morse receiver. The current capacity is sufficient to keep the apparatus working for about thirty hours. The transmitting apparatus which is used in the automobile post includes an induction coil giving a twenty-centimetre spark, with its condenser and vibrating contact-breaker; with the coil is used the new syntonizing apparatus of the Branly-Popp system which includes a condenser, an inductance coil and an oscillator. The contact-key for making the signals has a magnetic blowout for suppressing the spark.

The essential feature of the receiving apparatus is the new coherer which has recently been invented by Dr. Branly. The principle of this coherer has already been described and illustrated in the ELECTRICAL REVIEW. As will be remembered, the coherer is formed of a small metallic tripod which rests upon a polished steel disc, and the cohering action takes place between the points of the tripod and the disc. The whole is mounted upon the Morse receiver in such manner that the tapping arm of the instrument gives the shock which is needed for the decohering action, so that an independent striker is not needed, which simplifies the apparatus considerably. The Morse receiver, with its coherer, is provided with a sensitive relay of the Claude pattern, which works on half a volt, and also a syntonizing coil. A telephone can also be connected in the circuit to replace the Morse receiver if need be, and it is especially useful in carrying out the syntonization.

A hard drawn copper wire of 0.7 millimetre is used for the mast-wire; it is 500 metres long. To mount the wire, four balloons are provided. Two of the balloons have a capacity of two cubic metres, while the other two have but half that capacity. The larger balloons are used for mounting the wire to a great height when it is to be used for long-distance transmission. Each of the steel cylinders containing the hydrogen for the balloons carries 7,000 litres of hydrogen compressed at 150 atmospheres. A double-throw switch places the mast-wire upon either the transmitting or the receiving circuit. The ground connection is formed by a sheet of copper gauze ten metres long and eighty centimetres wide. By turning the handle of the windlass the wire gauze is unrolled and spread out upon the ground, where the numerous contacts with the soil are sufficient to make a good earth connection.



PLAN SECTION OF HYSTERESIMETER.

The new instrument which has been devised by Professor Blondel and constructed at the Carpentier establishment of Paris affords a very convenient method of determining the hysteresis coefficient of a given sample of iron by a single reading. It is intended to be used in industrial work. As the knowledge of the hysteresis value is of such importance in selecting iron for building electrical apparatus, there is no doubt of the practical utility and time-saving of such an instrument. The instrument measures the hysteresis coefficient η which characterizes a given iron, by a comparative method, using for the purpose a standard sample whose coefficient has been previously obtained.

The main part of the hysteresimeter consists of a permanent magnet of U-shape which is placed vertically and rotates around a central shaft. The magnet is caused to turn by a hand-wheel or large thumb-screw which acts upon the main shaft. The test-piece has the form of a ring which is built up of a series of rings cut out of the iron to be tested and pressed tightly together. The ring is placed flatwise between the branches of the magnet upon a support which is mounted upon pivots and can revolve about a vertical axis which coincides with that of the magnet.

When the magnet revolves, the flux which is produced in the ring is caused to shift within the mass, and the phenomenon of hysteresis is manifested by an effect which is quite analogous to that of friction. On account of this friction, the test-ring is drawn along with the magnet and tends to revolve. It works against a spring and turns around the centre until the opposing couple of the spring becomes equal to the couple due to the hysteresis. As the opposing couple is proportional to the torsion angle of the spring, the angular deflection of the test-ring gives a number which is proportional to the couple due to hysteresis. Experiment shows that this couple is practically independent of the speed of rotation of the magnet. The work which is absorbed by hysteresis (proportional to the couple) is therefore constant per revolution of the magnet and is measured by the angle which is read on the dial of the instrument.

The magnet which is placed in the apparatus has been constructed so as to produce an induction equal to 10,000 centimetre-gramme-second units. The air-gap which is allowed between the magnet and the test ring is such that the difference of permeability from one sample to another will be negligible, and in practice all the rings which are placed in the instrument take the same induction. Owing to this cause and on condition that the rings have always the same volume, the hysteresimeter allows of comparing different samples of iron with considerable exactness and to classify them as to the value of the hysteresis. To determine the value of the constant η for a given sample of iron, it suffices to compare it with a standard ring whose coefficient has been already determined by another method. In practice the magnet is revolved in one direction and the angle read; it is then turned in the opposite sense. The angle

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between the two readings thus formed is double that which is observed for one direction. The reading is thus more exact, and any errors due to a previous magnetization of the iron is eliminated.

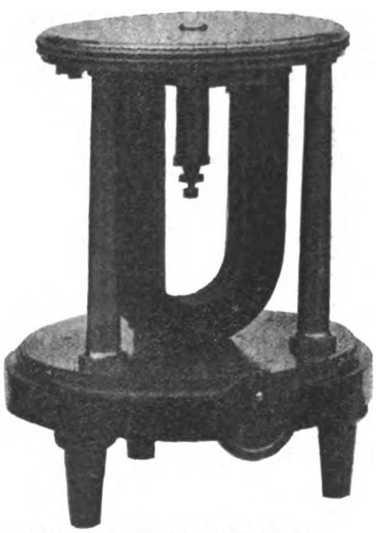
The apparatus is illustrated in the general view and in section. The horseshoe magnet with vertical branches rests upon a pivot at the lower end and is guided at the upper part by three rollers which are spaced around the circumference of a ring attached to the upper part of the magnet. This disposition allows of making the axis of rotation of the magnet coincide exactly with the geometric axis of the iron ring and so assure the uniform magnetization of the latter. The lower pivot is surmounted by a small disc lying just under the magnet, on which bears a leather-faced friction wheel which is turned by the milled wheel at the right-hand side. The iron ring to be tested is placed upon a brass supporting-plate which is fixed on the end of a vertical shaft. The shaft rests upon a pivot at the lower end and at the upper it is pivoted in a cap which is fixed in the glass cover of the apparatus. The ring which is thus mounted can revolve by turning the shaft, but the ensemble is held by a spring which will be observed. In order to prevent vibration which would be troublesome for the readings, the tube which contains the pivot, shaft and spring is filled with a thick oil whose viscosity is sufficient to make the instrument dead-beat. A needle is mounted on the shaft and it moves over a graduated scale which is placed on the glass cover of the instrument. By turning the cover around, the zero of the scale can be brought in line with the needle.

To test the iron by this method requires two operations, the preparation of the sample and the measurement. The iron ring which forms the sample should have fixed dimensions which correspond with the apparatus. Its thickness should be four millimetres, the exterior diameter fifty-five and the interior diameter thirty-eight millimetres. The sample thus prepared is placed upon the support of the apparatus by taking off the glass cover and removing the plate which serves to hold the ring. The sample is held in place by a pair of catches and is further fixed by a cross-pin. The whole is then put back into place.

To make the measurement, the milled wheel is turned at a speed which is sufficient to bring the needle to a steady position, say two or three revolutions per second. The glass cover and scale are then displaced with the other hand so as to bring the zero of the scale opposite the needle. The reading is taken and then the milled wheel is turned in the opposite direction and at the same speed. The needle is displaced and the deflection is read in degrees, say 250 degrees. If a reading has already been taken by using the standard sample in the instrument, the coefficient η of the sample being known and equal to 0.00200, for instance, and the reading of the instrument 275, the value for the sample under test will be

$$\eta = \frac{0.00200}{275} \times 250 = 0.001818$$

When the sample rings are cut out with care and the total number of rings is superior to four (which permits of neglecting completely the effect of Foucault currents) the apparatus gives results which are sufficiently exact and allows of



THE NEW BLONDEL-CARPENTIER HYSTERESIMETER.

obtaining the relative values of different samples of iron within five per cent, and more often within two per cent. This is quite sufficient in practice, seeing that the iron is not always homogeneous within these limits. It is to be noted that the results given by the apparatus show the hysteresis which is due to rotation, such as is produced when the direction of the flux is changed without altering its intensity; this is the effect which takes place in a dynamo. The coefficient of alternating hysteresis, which is developed in iron which is submitted to the action of a flux of constant direction (such as in transformers), seems to be somewhat smaller than the former.

The instrument as constructed at present is not likely to get out of order. The only changes that may occur with time are, first, that the magnet may become weakened. This cause of error has been rendered negligible by using only magnets which have been tested for duration and of good quality. Second, the coefficient of the sample ring may change. This phenomenon, known as ageing, is observed especially in iron which has a low hysteresis coefficient. On this account the sample ring is built of iron which has a coefficient of mean value and hence is not likely to change. Besides, the ring can be sent back to the constructor to be recalibrated, or this operation can be carried out from time to time by the well-known ballistic method.

The present instrument has the advantage of giving measurements which are sufficiently exact and at the same time can be carried out on an industrial scale; it is of solid and simple construction, and the readings are easily taken, the operation not requiring more than a minute. There is no doubt that it will effect a great saving of time in determining the quality of laminated iron for dynamos and transformers.

The Fourth Progress Report of the Committee on Photometric Value of Arc Lamps of the National Electric Light Association.

TO THE EDITOR OF THE ELECTRICAL REVIEW:

In the abstract of the "Fourth Progress Report" of the committee on photometric values of arc lamps of the National Electric Light Association, an unfortunate clerical error appears in the matter of the relation of candle-power to voltage in the single-glower Nernst lamp. In the sentence, "A special test given in the report shows that a change of one per cent in the voltage makes in this particular case a change of more than fourteen per cent in the candle-power." Value should be 6.38 per cent.

CHARLES P. MATTHEWS,
Photometrist to the Committee.

Drainage by Electricity.

The London *Electrician* reports that the drainage board of the Birmingham, Tame and Rea district (England), acting upon the suggestion of its engineer, Mr. J. D. Watson, has decided to carry out an electrical power transmission scheme in connection with the drainage and sewage disposal system under its control. Electricity will be generated at Saltley, near Birmingham, by two 175-horse-power steam engines, each directly coupled to a three-phase dynamo generating current at 2,300 volts, fifty cycles. The current will be led by an overhead line five miles in length, and will be supplied to eight small substations along the route. At these stations step-down transformers will reduce the pressure to 200 volts. At four substations centrifugal pumps, directly connected to induction motors, are to be installed for the purpose of pumping water from the main culvert on to the land. Other motors will be used to drive machinery for the different farms situated on the board's estate, and the principal buildings will be lighted electrically.

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130 MILES AN HOUR.

THE FAMOUS RUN ON THE HIGH-SPEED ELECTRIC ROAD FROM BERLIN TO ZOSSEN.

[*Dr. Reichel in a Berlin weekly, translated by the Scientific American.*]

All preparations have been made; a brake test has been carried out; the engineers have climbed into the car, and the military posts along the road have been informed that the car is soon to start. The motorman turns the controller very slowly through a few degrees. Fourteen thousand volts shoot from the lines to the motors. With a whirr the car starts on its memorable journey from Marienfelde at twenty-five minutes after nine o'clock. The overhead wires are swaying in a strong wind. As the car travels on, the strength of the electrical current fed to each of the four motors is gradually increased to 350 amperes. In other words, 2,300 kilowatts, or 2,600 mechanical horse-power, are being expended. A mile and a quarter has been covered. The speed indicator shows a velocity of seventy-five miles an hour. When Lichtenrade is reached, about half a mile further on, the car is rushing on at ninety-four and one-half miles an hour. Each second the speed increases. Just before the station of Mahlaw appears, a curve of 6,560 feet radius looms up. The speed is now one hundred and nine miles an hour. We seem to be leaping toward the curve. No bend can be seen; the track apparently ends abruptly. We know it is only a curve, and yet we are anxious; we brace ourselves for a shock. Just as we reach the curve the track seems to bend into a gentle arc into which the car runs easily.

The curve is passed. About a mile ahead of us a safety signal can be seen. We climb a grade of twenty-six feet to the mile—slight, to be sure, and yet to ascend it at full speed we must expend 300 horse-power more. The train is flying on faster and faster. We rush through Mahlow (four miles from Marienfelde) at a speed of 115 miles an hour. No vibration or shock is felt. It seems as if the car itself were not moving—as if buildings, poles, trees, were flickering past. Only the humming of the wheels assures us that it is we who are moving. The voltmeter shows that the current collectors are doing their work smoothly. No fear of increasing the speed need be felt. The last resistances of the controller are gradually cut out under the load of 2,300 kilowatts. The finger of the speed indicator slips along to a mark which shows that the car is making 121 miles an hour. At every crossing a loud ringing note can be heard, caused by the wheels.

Fragments of ballast as large as walnuts are sucked up into the air and fall back as the train rushes on. At first the speed is bewildering, almost stupefying. We in the cab are much nearer the track than is the engineer of a steam locomotive. On that account it seems at first as if the car is literally devouring the road by the mile. Gradually we become accustomed to the new sensation. The feeling of safety and comfort which overcomes the first shock of amazement gives rise to the desire to travel still faster. After the 120-mile-an-hour mark has been passed the excitement in the car becomes intense. Not a word is spoken. Only the click of the wheels over the rails is heard. Every eye that is not fastened on the speed indicator is glued on the track. Suddenly, at a distance of about half a mile, we see two men unconcernedly standing in the middle of the road calmly awaiting the car. The motorman jumps for the whistle string. As the danger signal shrieks, the two men on the track turn about with a frightened look, and then flee for their lives. No power can stop this ninety-three-ton car within a mile.

We whiz past the town of Dahlwitz. Dust, sand and large pebbles leap up behind us. We just catch a glimpse of people on the station throwing up their hats in joy. Suddenly a smashing blow is heard against the window of the cab, as if a man brought his fist heavily down upon a table. It was a bird, overtaken in its flight and killed. The speed indicator finger climbs up past the 124-mile mark. Rangsdorf is only one and one-quarter miles away (8.6 miles from Marienfelde). It is soon time to shut off the current. If the 4,000-horse-power engine at the power station at Oberspree does not help us we shall not reach the speed for which we are all hoping. The engineers at the power-house have not forgotten us. The finger of the speed indicator, as we near Rangsdorf, moves just a little further. And so we cover the last mile which we still have before cutting off the power at top notch speed, with 1,400 kilowatts, or 1,600 horse-power.

A quarter of a mile before reaching the curve near Rangsdorf we shut off the current and apply the full power of the brakes. The speed of the car drops to 102 miles. The curve is rounded in a noble swing. The brake is released, and the car glides along under its own momentum without any current whatever until Zossen is reached. In eight minutes we have leaped from Marienfelde to Zossen. We crowd around the telegraph instruments, which have recorded a speed never before attained in the annals of railroading. The telegrapher can harldy attend to his instruments, so many heads are pressing about him. Finally he succeeds in reading off the record—130.4 miles an hour. Every one smiles, hands are shaken, congratulations exchanged. An officer rushes off to the telegraph station to announce to his Majesty the Kaiser the feat which German engineers have succeeded in performing.

The front end of the car is covered with flies, bees and small insects, crushed as if by a thumb against the iron and glass.

Coal Storage Under Water.

Experiments upon the subsequent storage of coal have been made by Mr. John Macauley, general manager of the Alexandra Docks and Railway, Newport, Monmouth, England. It appears from these that coal thus stored loses an inappreciable amount of its calorific value, compared with that lost by the alternative method of storage with access of air. Mr. Macauley attributes this effect to the more complete retention by the coal of its original chemical properties than takes place when stored in air, due to the depression of natural volatile constituents, to oxidation and weathering effects of sun, wind, rain and frost. He estimates that at present at least a fifth of the coal power is lost unnecessarily, owing to storage in air. The alternative method of storage under water is simple and cheap and readily practicable everywhere.

Brooklyn Rapid Transit Company Makes Changes in Its Transit System.

The Brooklyn Rapid Transit Company has inaugurated several changes in its transfer system. On December 1, the company stopped giving a transfer on a transfer, as under the old conditions those so disposed could arrange a trip and make it possible to ride for miles from either of several termini to a destination and return on a single fare. It is surprising how many combinations of this nature could be worked out.

A number of new transfer stations have been established and this makes it possible to reach all points quickly and for one fare. On short lines continuing trip tickets are issued and a transfer is given on these.

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INDUSTRIAL ELECTROCHEMISTRY AND ELECTROMETALLURGY—II.[1]

NOTES ON PROGRESS IN EUROPE AND AMERICA.

BY JOHN B. C. KERSHAW.

The Aluminum Industry in Europe.

The report presented to the shareholders of the British Aluminum Company for the year 1902 is an improvement upon that of the previous year, since a profit of $103,000 is shown on the year's working; but as this surplus does not entirely cover the debenture interest, there is still ample scope for the new management to improve the financial position of the company. The most reassuring statement in the chairman's address at the annual meeting of the shareholders in London in July last was, that the sales of aluminum by the company had greatly increased, and that the heavy stocks of metal held by the company had been in consequence reduced to normal proportions. The average quality of the aluminum produced at Foyers was stated to be 99.4 per cent, and the output was to be increased in order to meet the growing demand. The international arrangement between the various producers of aluminum was also stated to be working more satisfactorily, and the prospects of the British company were therefore greatly improved as compared with the position twelve months ago.

Further capital expenditure upon the plant and workmen's dwellings at Foyers is necessary, and an outlay of $200,000 will shortly be required.

As regards the Neuhausen Aluminum Company, the report for the year 1902 recommends a dividend on the ordinary share capital of fifteen per cent, as compared with thirteen per cent in 1901, and this company is extending its operations by obtaining control of a second water power in Austria. The new power centre is located near Lend-Rawris, and 6,000 horse-power will ultimately be developed at this spot. The total power controlled by the Neuhausen company will then amount to 24,000 horse-power, and the number of its separate works to four. The company will therefore rival the Pittsburg Reduction Company in the extent and magnitude of its resources for aluminum manufacture. Calcium carbide and other products are, however, included in the manufacturing operations of the Neuhausen company, and no very reliable information is available as to the proportion of the total power which is now being devoted to production of the light metal.

Electrolytic Alkali and Bleach in Europe.

The open competition which has been occurring between the various European producers of alkali and bleach since January 1, 1903, and the reduction in price of the latter chemical from $30 to $16 per ton, have had a marked influence upon profits and dividends. The inauguration of a period of free trade in bleach has resulted in the closing down of some of the less well-managed, or well-designed, electrolytic plants on both sides of the Atlantic, until higher prices are obtainable for this product. The American Alkali Company, which had worked the rhodin mercury process at Sault Ste. Marie for some months in 1902, was one of the first to succumb to the fall in value of bleach, and this plant was shut down toward the end of 1902.

In Europe, two of the Swiss electrolytic alkali companies are reported to be in an unsatisfactory position, and the writer believes that manufacture of alkali and bleach in their works has ceased. The difficulties here, however, were partly due to the high cost of fuel for evaporating the soda liquors, and were only indirectly caused by the low price of bleach.

As regards the two English electrolytic alkali companies, both have presented reports which show a marked decrease in profits since the commencement of the present year. It would appear that in one case the present price of bleaching powder still admits of its production by the mercury process without incurring an actual loss. The accounts of the Castner-Kellner Alkali Company only cover three months of 1903, and show a net profit of $208,000 on the year's working. A dividend of six per cent was paid on the ordinary share capital, and $65,000 was carried forward to the next account. This company possesses a reserve of $275,000, and is therefore in an exceptionally strong financial position.

The chairman stated in his address to the shareholders at the annual meeting in May that the directors intended to take up other manufactures than that of soda and bleach, and it was intimated that portions of the reserve fund would be expended upon the necessary alterations to the plant at Weston Point.

The report of the Electrolytic Alkali Company, which works the Hargreaves-Bird process at Middlewich, covers eight months of 1903, and is less satisfactory than the Castner-Kellner report. The net profit for the twelve months is only $2,400, and no dividend can therefore be paid on either the ordinary or preference share capital.

In view of the above facts and figures, relative to some of the more important electrolytic alkali companies, the report of the United Alkali Company, of Liverpool, for the year 1903, will be awaited with interest. If this company, which operates the old Le Blanc process and practically controls this branch of the industry, has failed to earn sufficient profit in 1903 to pay the interest on its preference capital, it is probable that a truce will be called to the present war between the producers of bleaching powder, and that the old arrangement as to production and price will be revived. If, on the other hand, the company which controls all the Le Blanc works in England has not been very heavily handicapped by the period of open competition, and has been able to earn fair profits in 1903, the war of prices is likely to continue until several of the weaker electrolytic companies have been compelled to go into liquidation. The writer believes, however, that the revival of the concordat relating to prices is the more probable development of the situation.

Water Power Centres and Electrochemical Industries.

The recent labor troubles at Sault Ste. Marie, Canada, serves to emphasize the need for caution in sinking huge sums of money in water power developments far in excess of present requirements. At Massena, N. Y., the power company pursued a similar policy, and found itself twelve months ago with a very large installation of electrical plant and machinery, but no large consumers of electrical current. The inevitable result was that the bondholders foreclosed on the property, and the finances of this undertaking are now being reorganized. Mr. Clergue had benefited by the experience at Massena, and had recognized the need for creating at Sault Ste. Marie the industries which should utilize the electrical power when developed. A large number of subsidiary companies were therefore floated to develop these new industries at the "Soo." The cessation of work at the plant of the American Alkali Company, referred to in note 1, and the failure to carry out the original plans for the erection of a large nickel-smelting works at Sault Ste. Marie, also no doubt contributed to Mr. Clergue's difficulties, and hastened the financial collapse.

In time, no doubt, Sault Ste. Marie and Massena will each become a centre of electrochemical and electrometallurgical industry, only second in importance to that at Niagara. But I am much afraid the original shareholders in these two power companies will not have found their investment of a very profitable character.

[1] The first series of these notes by the author appeared in the ELECTRICAL REVIEW, January to April, 1903. For index to the same see issue of April 18, 1903.

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ELECTRICAL MINING NOTES.

BY SYDNEY F. WALKER.

The British National Association of Colliery Managers is unique, in that there is one qualification which entitles a man to become a member, and no other will admit him—the possession of a first-class certificate as a colliery manager. Since the passing of the first Mines Regulation Act, every colliery is under the control of a manager, who holds a first-class certificate. This certificate is obtained by passing an examination before a board consisting of mining engineers, after having served not less than five years in practical work in a mine. Second-class certificates are also granted after examination and five years' practical experience in a mine, entitling the holders to the position of under manager. The qualifications of holders of first-class certificates are a knowledge of the Coal Mines Regulation Act, of the principles and practice of surveying and drawing, and a general education in arithmetic. Holders of second-class certificates must possess a smaller quantity of the same knowledge as holders of first-class certificates, and are supposed to be on their way to become holders of first-class certificates.

The National Association of Colliery Managers is a replica, on a small scale, of the Institution of Mining Engineers. It has branches in each coal-mining district, each branch having its own president, committee and secretary, and holding meetings in its own district, under its own officers, usually every month. There is a council of the whole association, consisting of members from each branch, and there is a president of the whole association. There is only one meeting of the whole association during the year, and there are no papers presented for reading at that meeting. The outgoing and incoming presidents of the association usually read addresses, and the remainder of the time, two days and one evening, is devoted to excursions, partly instructive and partly recreative. The papers read before the branch meetings are often of great value, as giving the results of actual experience with different apparatus, and the association awards prizes for the three best papers during each year. The annual meeting is rather one of old friends who meet once a year, than one for instruction. The addresses of the presidents of the association are usually well worth listening to; that of the president at the recent meeting was unusually so.

The only matter in connection with electricity that came up in the president's address was the recent enquiry into the use of electricity in coal mines by the Home Office. The president strongly expressed the view, which is common among old colliery managers, that whatever rules are made in connection with the matter must not hinder the development of the use of electricity in mines. His opinion is that for the economical working of collieries, in the future, it is absolutely necessary that electricity shall be employed, and any regulations which hinder its adoption will increase the cost of placing the coal on the market. Incidentally, in connection with this question, the point has arisen, what is a fiery mine? Every witness at the enquiry was of the opinion that no electric motor should be allowed to run where gas was present, and this has been taken to mean by some that no electrical apparatus shall be used in fiery mines, and the definition of a fiery mine is not at all an easy one. Mining engineers are very much divided as to what constitutes a fiery mine, that is to say, a mine which is dangerous. If it be taken to be a mine in which safety lamps are used, the restriction of the use of electrical apparatus to those in which naked lights are used would cut off more than half of existing mines. On the other hand, witnesses were almost unanimous that an electric motor properly constructed is no more dangerous than a miner's lamp.

THE OPPOSITION TO THE USE OF ELECTRICITY.

The great use of meetings of this kind, as already pointed out, is the chance of comparing notes, which it enables men who have been working independently for the previous year to take advantage of. One of these opportunities occurred at the meeting in question. The excursion on the day after the reading of the president's address was to the collieries of Messrs. Henry Briggs, Sons & Company, the manager of which, Mr. Isaac Hodges, is president of the Yorkshire branch of the association. There is no electrical apparatus about the place, and costs are stated to be lower at these collieries than anywhere else. I had a conversation with Mr. Hodges on the subject, and put the question perfectly straight to him, "Why have you so little electrical apparatus?" "Because," he said, "I do not think that anything is gained by it. The efficiency of electrical distribution is undoubtedly higher than that of compressed air, but it only gives a saving in cost of one cent per ton in cutting the coal, and the danger may easily cost considerably more than that." Mr. Hodges uses compressed air for pumping underground and coal cutting, but he uses gas engines wherever they are practicable, as at the shaft bottoms. The haulage is largely worked by steam engines on the surface, which drive haulage drums at the pit bottom that can be clutched in or out at will by the attendant at the pit bottom, the power being transmitted to the bottom by means of band ropes. Most elaborate arrangements have been worked out for stopping and starting the haulage engine on the surface from the pit bottom. The secret of the whole thing is, the gas engines are worked and the boilers fired by a very rich gas which is made at the works as an offshoot of the colliery firm.

I venture to think that the time will come when those band ropes in the shafts will be done away with and electric motors fixed at the pit bottoms to drive the haulage drums. The arrangement which enables the attendant to stop and start the engine on the surface, from the underground haulage chamber, is very beautiful, and works well, but it is neither as simple, as quick, nor as convenient as an electric motor would be. Mr. Hodges told me that the cost per horse-power for all his work was only £2 per annum. Still it appears to me that there is no reason why he should not have the advantages of the cheap gas, and of electric distribution too. Cables are troublesome in a pit shaft, but so are gas pipes, and the care which will enable gas pipes to work economically, will keep the repair of cables at a very small figure.

In the very early days of electric lighting, I put in a plant at a colliery in the county of Durham, to light the pit top. Previously to this, it was lighted by gas from the company's own works about one and one-half miles away. The manager at the colliery told me that the cost of repairs would pay interest and upkeep of the new plant and leave a good margin. Joints were constantly leaking, etc. At the same time, it is as well for those who are endeavoring to push colliery work to know what they have to overcome. At another colliery in the Midlands, a few days ago, I saw a very complete system of rope haulage. One installation in particular struck me. The coal-picking belt was in a shed several hundred yards from the colliery, and it was worked by a rope which ran across country on pulleys to the shed, and then turned sharply at right angles, ran along the side of the shed, and round the driving pulleys of the belt, passing on its way several other ropes do-

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ing somewhat similar work. I ventured to prophesy here, that those ropes would disappear, whenever an electrical power plant came on the ground. I was told that when the plant was put in, the figures were carefully taken out for rope and electricity, and rope was much cheaper. Meanwhile it does its work well, and there are numerous men about the colliery districts who reap a handsome living by splicing the ropes from time to time. The mechanical engineers of the collieries in the Midlands also have acquired a good experience with rope haulage.

Mr. Hodges is also working at the compressed air problem, and has already done a good deal. He told me that he had succeeded in working the air which is used to drive a coal-cutting machine expansively. This is an immense step in advance. If air can be worked at high pressures, similar to those used in the United States, leakage suppressed, and the air used expansively, it will supplant electricity for all work at the face of the coal, and wherever gas is feared.

The little apparatus for lighting locked safety lamps, I expect all readers are familiar with. There are two arrangements in this country for the purpose, one that has been invented and reinvented several times, in which a heated platinum wire lights the lamp, and the other, which is new, so far as I am aware, within the last few years, in which ignition is obtained by means of a spark from an induction coil. The miner's oil lamp consists of a hollow cylinder forming the oil well, with the wick in the centre. The oil well is screwed on to a brass ring which forms the base of the glass and chimney of the lamp. The glass, which is made only high enough to allow the rays of light to come out in a horizontal direction, is held between two brass rings, which also hold stout brass wires that protect the glass from mechanical injury. The upper brass ring forms the base in which the gauzes which form the chimney of the lamp rest. There are three gauzes, one inside the other, the outer one protected by a steel bonnet from mechanical injury. The upper part of the bonnet is perforated with holes about one-quarter inch in diameter, all round, and these are the only points of egress for the products of combustion. Air is supplied to the lamp by a similar series of holes in the lower brass ring, inside the glass, the holes being covered with gauze. It will be understood that the apparatus so arranged, while not absolutely safe—no miner's lamp is, where an explosive mixture is present and is being transported along the workings at a high velocity—does not give very much light, from one-third to two-thirds of one candle-power when the lamp is first lighted, and it is very easily extinguished. The miner is not allowed to open his lamp to relight it, if it does go out. Various penalties await him if he does, and is caught, and various plans have been adopted to prevent him making the attempt. If it does go out at the working face, or anywhere in the mine, the collier has to take it to the lamp station, which is situated as far in the workings as it is considered safe to use naked lights, and there a man who is told off for the purpose opens it, relights it, and again locks it. Any method which enables the lamp to be relighted without opening enables the lamp station to be fixed very much farther toward the working face, and saves considerable time, as well as removing temptation from the miner. While the lamp is being taken to the lamp station, the collier and his "butty" have to stop working, as the "butty's" lamp is required to light the man on his way to the lamp station. In some collieries this trouble is met by sending lads round periodically with lighted lamps to all the working faces, but in the majority of cases the men have to lose the time taken.

With both systems of electrically relighting, the oil well is made to form one side of the circuit, and an insulated contact rod passed through the well forms the other side. With the hot wire, a second small rod is fixed near the first and a fine platinum wire stretched between the two, which can be turned over the wick, or away from it. With the spark system, the spark is made to pass through the vapor of the oil to the body of the lamp. In either case, a circular table is arranged, just large enough to admit the base of the lamp, with contacts corresponding to the oil well, and when the lamp is placed on the table, either a spark passes or the wire becomes hot, and the lamp lights. In one colliery in South Wales, where some 2,000 lamps are in use, considerable time is saved by this arrangement. The lamps are not lighted, as they usually are, by the lamp trimmer, but are given out ready trimmed. Each man, as he receives his lamp, passes on past one of the tables described, dumps his lamp down, takes it up lighted, and goes on to the pit top. Similar tables are fixed at the lamp stations. Under the tables are carried the induction coil, where the spark method holds, and two secondary cells, or only secondary cells where the batteries are used in the lamp room, there is an arrangement for unlocking the lamps by means of an electromagnet, which is also concealed under the table. The lamp is locked by a steel pin which fits into a slot provided for it, and is held there by a spiral spring. As long as the pin is in the slot the oil well can not be revolved, and so can not be unscrewed from the ring above, so that the lamp can not be opened. When the pin is pulled down by the electromagnet, the well can be turned, and the lamp filled. At Messrs. Briggs collieries, where the battery method is employed, the lighting in the lamp room is done by means of current furnished by a small dynamo driven by a belt from the shafting which runs the lamp cleaning machinery.

The Electric Railway at La Mure, France.

The coal basin of La Mure, France, is rich in anthracite, but on account of the grades the steam railroad was not able to handle the traffic and develop the mines. To correct this defect, an electric system has been installed which will greatly increase the capacity of the road. The road is about eight kilometres long and seventeen trains are run in each direction. The electric locomotive is here described by M. A. Soulier. The Thury system of continuous currents was selected. The locomotive weighs fifty tons, is 13.18 metres long with a cab in the centre and is carried on two four-wheeled trucks. Power is collected from two overhead wires by four bow collectors. The two wires and the track form a three-wire system with 2,400 volts across the outers, the track being the neutral. Four motors, one driving each axle through gears, are connected permanently in series, each supporting 600 volts. They are rated at ninety kilowatts, run at 400 revolutions per minute when taking 185 amperes and have six poles. The controller contains two cylinders, one having twelve and the other eight contact positions, thus making ninety-six possible positions for controlling the motors. The cylinders are turned by means of a handle with a multiplying motor. The rheostat is formed of coils of wire and is used in starting and for braking the cars, the motors being connected to it for this purpose. There are in addition, a hand brake and an air brake, operating brake shoes on all the cars.

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THE INTERSTATE INDEPENDENT TELEPHONE ASSOCIATION.

THE REGULAR ANNUAL CONVENTION OF THE INTERSTATE INDEPENDENT TELEPHONE ASSOCIATION WILL BE HELD AT THE AUDITORIUM HOTEL, CHICAGO, ILL., DECEMBER 8, 9 AND 10.

The Interstate Independent Telephone Association was organized in Chicago, Ill., April 9, 1902. The initial gathering was held at the Sherman House, and delegates to the number of about 500, including practical telephone men, exchange promoters and manufacturers, gathered from the states of Indiana, Illinois, Kentucky, Iowa, Wisconsin and Michigan. Dr. I. A. Lumpkin, of Mattoon, Ill., was elected temporary chairman. He delivered an address in which he sketched briefly the advantages that an association of this character would bring, by holding in closer touch the representatives of exchanges in the closely allied states included in the organization.

On the evening of the inauguration day, a banquet was tendered to the delegates and visitors by the telephone manufacturers of Chicago. Informal toasts were responded to by the telephone men, and from this auspicious occasion there sprang into being one of the most successful and influential telephone organizations of the country.

A permanent officiate was elected on Thursday, April 10. The president chosen was Mr. Henry Clay Raney, of Fairfield, Iowa. Mr. Raney died on August 21, 1903, at Fairfield, Iowa, and in his death independent telephony lost a vigorous exponent. His knowledge as a lawyer of corporation affairs made him a master of many intricacies which the formation of such an organization involved. He was the organizer of the Jefferson County Telephone Company, of which he was president.

The vice-president chosen was Dr. I. A. Lumpkin, of Mattoon, Ill.; the treasurer, Mr. J. C. Harper, Madison, Wis.; the secretary, Mr. E. M. Coleman, of Louisville, Ky. Mr. Coleman is secretary of the Home Telephone Company, of Louisville, Ky., a man of large affairs in the telephone field, and one well suited to carry out this executive department of the association's affairs. Mr. Coleman has since succeeded himself twice, and is probably the logical candidate for succession once more.

The executive committee was chosen as follows: H. K. Cole, Owensboro, Ky.; J. B. Ware, Detroit, Mich.; Charles E. Hull, Salem, Ill.; George N. Bandy, Perry, Iowa; J. W. Layne, Carthage, Mo.; A. L. Hutchinson, Weyauwega, Wis., and L. A. Frazee, Connersville, Ind.

A number of interesting and instructive papers was read by Dr. C. F. Bennett, of Waterloo, Iowa; Richard Valentine, of Janesville, Wis.; H. C. Raney, of Fairfield, Iowa; L. A. Frazee, of Connersville, Ind.; E. M. Coleman, of Louisville, Ky.; E. R. Conklin, of Aurora, Ill.; W. H. Crum, of Chicago; A. L. Hutchinson, Weyauwega, Wis., and Dr. H. S. Herr, of Ottumwa, Iowa.

Early in September of 1902 a meeting was held by the officers of the association, and the date of the next meeting was decided on as December 9, 10 and 11, 1902. Dr. I. A. Lumpkin and Charles E. Hull were members of this committee.

The second general meeting was opened with a good attendance and sentiments of greatest harmony at the Auditorium Hotel, Chicago, on December 9, 1902. President Raney called the convention to order, and Mr. J. W. Keelyn, chairman of the Chicago entertainment committee, introduced the Hon. Lawrence E. McGann, comptroller of the city of Chicago, who, as the representative of the mayor, delivered an address of welcome to the delegates. President Raney made an eloquent and masterful response to this address, and Senator Charles E. Hull, of Salem, Ill., made the report for the executive committee.

THE LATE HENRY C. RANEY.
First President of the Interstate Independent Telephone Association.

The secretary's annual report showed the condition of affairs to be promising, and put forward a number of valuable suggestions for the unified carrying on of the association's work.

The representatives then selected one member for each state, to serve on a committee on nominations. The following members were subsequently chosen: W. Guy Jones, Columbus, Ohio; Dr. H. S. Herr, Ottumwa, Iowa; W. F. Goodrich, La Crosse, Wis.; William Robinson, Muskegon, Mich.; L. A. Frazee, Connersville, Ind.; Senator C. E. Hull, Salem, Ill.; W. F. Hall, Clinton, Mo., and H. K. Cole, Owensboro, Ky.

At this session important committees were established to consider the question of whether men who were affiliated with Bell companies were eligible for attendance at the association's meetings; and also on the important question of an indiscriminate making of toll contracts with other than strictly independent companies.

At the meeting on the next day, December 10, the committee on eligibility for membership made two separate reports to the convention. One was to the effect that the association pledge its members not to patronize supply houses selling material to new companies that were formed to compete with independent companies already in the field and giving satisfactory service.

On the other question, the decision was made that, as toll connections with Bell companies would have a tendency to discourage the building of independent toll lines, no one should be eligible for membership in the association who had any contract for toll or instrument connections with a Bell company, unless in certain special cases where permission might be granted by two-thirds of the membership committee of the state, interstate or national association. These two resolutions were carried.

Several papers were read at this session, one by Mr. George N. Bandy, of Perry, Iowa, on "Rates-Measured Service." This was followed by the reading of a paper by Dr. H. S. Herr, of Ottumwa, Iowa, on "Sliding Scale Rates for Exchanges." Miss Flora B. Herr, Dr. Herr's daughter, read this paper in his absence. H. H. Robinson, Cleveland, Ohio, read a paper on "Toll Rates."

The programme at this point was interrupted to allow Professor W. E. Goldsborough, chief of the Department of Electricity, Louisiana Purchase Exposition, to address the convention. Dr. Goldsborough set forth the many advantages which St. Louis would offer as a convention city during the early summer of 1904. A resolution was offered by J. W. Layne, to the effect that the association meeting of 1904 should be held in St. Louis. As the exposition will close about December 1 of

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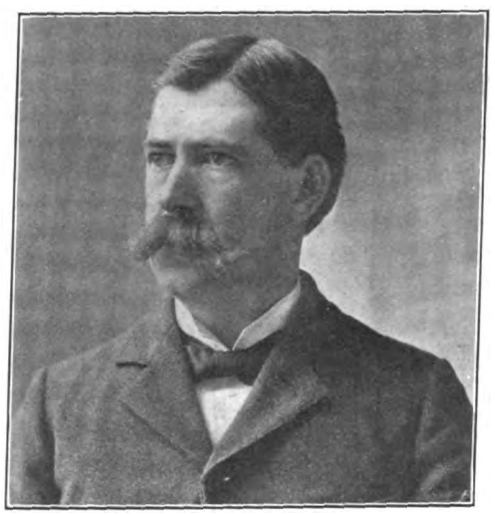
that year, the constitution of the association would have to be amended in order that a meeting could be held before that time. This matter was finally referred to a committee, which was required to report upon the resolution and also introduce a motion removing the constitutional restriction for this particular occasion.

An interesting feature of this meeting was a series of papers from members representing the nine states covered by the association, on "Restrictions by Municipal Authority and Synopsis of the Law." Notwithstanding the expectation that there would be responses from nine states, but three representatives undertook the debate on this subject. These were W. F. Laubach, of Akron, Ohio; E. W. Pickhardt, Huntingburgh, Ind., and M. Savage, Champaign, Ill. Mr. J. B. Ware addressed the meeting on this subject, however, and gave considerable information as to the municipal restrictions in the state of Michigan.

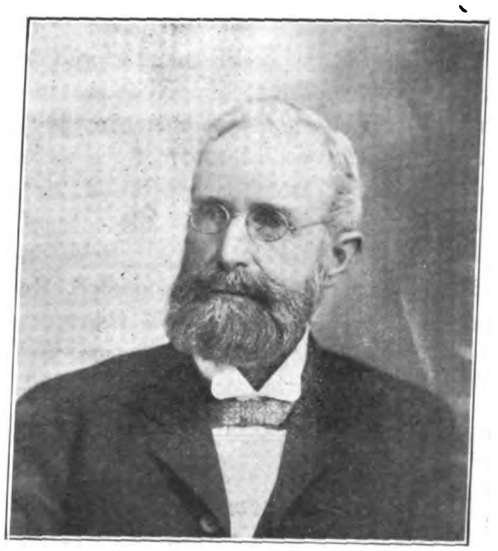


SENATOR CHARLES E. HULL.
President, Interstate Independent Telephone Association.

After this meeting had adjourned, the delegates were made the guests of the Chicago Automatic Telephone Company, and investigated the subways which this company was building under the streets of Chicago.

The first business of the session on Thursday, December 11, was the introduction of a resolution by the committee appointed to act on the invitation issued by Professor Goldsborough, on behalf of the St. Louis Exposition. This resolution favored the association's holding its annual convention in 1904 at St. Louis, at such time as the executive committee might determine, and recommended that the constitution be amended as to the time of holding meetings, so that the convention of 1904 might be held during the month of November. This resolution was unanimously adopted.

W. F. Hall, of Clinton, Mo., and A. L. Hutchinson, of Weyauwega, Wis., addressed the meeting, and these were followed by H. E. Ralston, of Maitland, Mo.; Colonel J. D. Powers, of Louisville, Ky.,



MR. JOHN W. LAYNE.
Treasurer, Interstate Independent Telephone Association.

and J. W. Layne, of Carthage, Mo., who spoke on practical telephone subjects.

Mr. J. J. Nate, Chicago, Ill., read a conclusive paper on "The Telephone Transmitter, Its Early History, Its Present Status with Relation to the Berliner Patent." The last paper on the programme was by Senator Charles E Hull, of Salem, Ill., on "Suggested Methods for Improving Long-Distance Telephony."

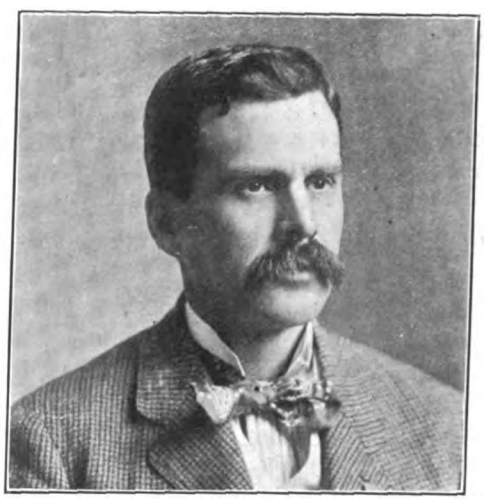
DR. HENRY S. HERR.
Representative to Interstate Independent Telephone Association from Iowa.

Following this, the committee on nominations reported, and officers for the ensuing year were elected as follows: president, Charles E. Hull, Salem, Ill.; vice-president, L. A. Frazee, Connersville, Ind.; secretary, E. M. Coleman, Louisville, Ky.; treasurer, J. W. Layne, Carthage, Mo. Executive committee: Ohio, W. Guy Jones, Columbus; Iowa, H. S. Herr, Ottumwa; Wisconsin, A. L. Hutchinson, Weyauwega; Minnesota, E. H. Moulton, Minneapolis; Michigan, J. B. Ware, Detroit; Indiana, O. Rex, Manchester; Illinois, A. B. Conklin, Joliet; Missouri, W. F. Hall, Clinton; Kentucky, David Prewitt, Winchester.

The association received an invitation from R. H. Watrous, of Milwaukee, Wis., to hold its next convention in Milwaukee. The matter of the date and place of meeting, however, were left to the discretion of the executive committee.

In the evening an elaborate banquet was tendered to the delegates, toasts being given by a number of prominent telephone men and by several executives of the city.

The third general meeting of the association will be held at the Auditorium



MR. A. L. HUTCHINSON.
Representative to Interstate Independent Telephone Association from Wisconsin.

Hotel, Chicago, Ill., December 8, 9 and 10, 1903. An elaborate programme has been arranged, including papers by prominent men on important subjects. In addition to this, a banquet will be given, which the committee in charge promises will surpass all previous ones. A large orchestra has been engaged to render several musical programmes, and there is no doubt that this convention will be as successful, at least, as those which have already been held.

The following programme has been announced:

Tuesday Morning, December 8—Reception of members and friends by the executive committee and officers, at the secretary's headquarters.

Tuesday Afternoon—Address of welcome, by the Hon. Carter H. Harrison, Mayor of Chicago; response and annual

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address by the president, Senator C. E. Hull, Salem, Ill.; report of the secretary and report of the treasurer will be read; selection of executive board; selection of nominating committee, and revision of constitution and by-laws.

Wednesday Morning, December 9—The officers and executive board will take charge of the delegates. Visiting exhibits.

Wednesday Afternoon—Wednesday afternoon will be devoted to addresses as follows: "Should the Territory of the Interstate Independent Telephone Association Be Enlarged, and if so, Why?" by the Hon. John Van Nortwick, Appleton, Wis.; "Are Our Telephone Periodicals Sufficiently Careful as to the Business Relations Sustained by Contributors?" by W. H. McDonough, New York, N. Y.; "Standardization of Apparatus," by Professor J. C. Kelsey, Purdue University; "Standardization of Construction," by W. C. Polk, Kansas City, Mo.; "Competition Between Independent Companies and Farmers' Mutuals," by O. Rex, North Manchester, Ind.

Thursday Morning, December 10—"Independent Toll Line Systems, and Is the Time Ripe for Merging," by J. S. Bailey, Jr., Toledo, Ohio; "Where Should the Line Be Drawn Between Independent Operating and Manufacturing Companies, and the Bell Company," by the Hon. Henry A. Barnhart, Rochester, Ind.; "What Should Be the Representation in Connection of the Interstate Independent Telephone Association in Voting?" by David Perwitt, Winchester, Ky.; "Who Is Who? What Are the True Ear Marks?" by the Hon. Theodore Gary, Macon, Mo.

Thursday Afternoon—Officers and executive board will take charge of and entertain the attending delegates. Visiting exhibits.

Mr. John W. Layne, treasurer of the Association, has been an active business man in the States of Indiana, Ohio, Illinois and Missouri for the past fifty years. About five years ago he entered the independent telephone field, purchasing the Carthage Telephone Company, of Carthage, Mo. He rebuilt this system, and under his management the plant grew until it absorbed five other independent systems. This expansion continued until Mr. Layne was president, manager and chief owner of the third largest independent system in Missouri, operating as the Mineral Belt Telephone Company, with its central office at Joplin. After four years of vigorous upbuilding Mr. Layne sold this system to a new syndicate, and Mr. Theodore Gary, of Macon, Mo., became active manager and president, the name being changed to the Home Telephone Company. Mr. Layne was made, and now is, vice-president of the new company, and although having passed his sixty-seventh year is still a vigorous worker in the telephone field.

Dr. Henry S. Herr, the member of the executive board from Iowa, became interested in independent telephony in 1900. He has made a careful study of the various elements of telephone operation, and has always been an earnest advocate of a sliding scale of rates. His articles on this subject have been widely quoted. He was one of the organizers of the Interstate Independent Telephone Association and placed in nomination for first president, the late Henry C. Raney. Dr. Herr is also president of the Iowa Telephone Association and of the Southern Iowa Independent Telephone Association.

MR. O. REX.

Representative to the Interstate Independent Telephone Association from Indiana.

Mr. A. L. Hutchinson, the member of the executive board from Wisconsin, was born at Weyauwega, Wis., January 25, 1859. He lived on a farm near the village from the age of three to twenty, and taught in the district schools in Wisconsin and Iowa for two years. He read law in the office of Pike & Vankusen, Oshkosh, and was admitted to the bar in March, 1881. In October, 1882, he was appointed postmaster of Weyauwega, and served in this capacity for three years. He was elected district attorney of Waupaca County in 1886 and reelected in 1888. Mr. Hutchinson edited a local paper from 1886 to 1893 and was delegate to the National Editorial convention which visited the City of Mexico in 1888. He was an alternate delegate to the National Republican convention at Minneapolis in 1896. In 1894 Mr. Hutchinson became interested in a small independent telephone company and after three years gave up his law practice to devote his entire time to independent telephony. He organized and was first president of the Independent State Telephone Association of Wisconsin. He is at present secretary and general manager of the Interurban Telephone Company and president and general manager of the Independent Consolidated Telephone Company.

Mr. O. Rex, the member of the executive board from Indiana, is president of the North Manchester Telephone Company. Mr. Rex is a pioneer telephone man, and gave Wabash County its first independent toll line service and the only telephone connection which it had with adjoining counties for more than three years. He started in the telephone field in 1894, and has been active ever since in promoting independent telephone operations.

The Universal Exposition Handbook.

Dr. Charles M. Kurtz, assistant chief, Department of Art, Louisiana Purchase Exposition, has prepared an illustrated handbook on the universal exposition, commemorating the acquisition of the Louisiana territory, which will be held at St. Louis, Mo., 1904. The frontispiece of this handsome book is a photogravure reproduction of the Hon. David R. Francis, president of the Louisiana Purchase Exposition. The book sets forth in detail the preparation for and the scope of the St. Louis world's fair of 1904, giving interesting bits of history showing the development of the territory since its acquisition by the United States Government. Half-tone portraits of all of the prominent officers of the exposition are given, together with illustrations of the numerous buildings in various stages of completion.

National Electric Light Association.

Mr. Ernest H. Davis, the secretary of the National Electric Light Association, announces that there have been so many requests from non-members for the report of the Chicago meeting, now in press, that it has been decided to present a copy of this book to all companies making application for membership for the year 1904, provided their applications are received before the end of the present year. A number of applications has already been received on this basis, and there is every indication of a large increase in membership during the month remaining. A copy of the recent reports of rates for lighting and power will also be sent to new members.

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THE COMPARATIVE BEHAVIOR OF FLOATING AND BOOSTER-CONTROLLED BATTERIES ON FLUCTUATING LOADS.

(Concluded.)

BY LAMAR LYNDON.

CASE III—BATTERY WITH BOOSTER IN POWER STATION.

Since with a booster-controlled battery the generator load is kept practically constant, it matters little what kind of generator is used in the power station, it being only necessary to settle on the best average station voltage. Assuming 550 volts as the desired electromotive force at the station, a 550-volt battery, the same load and general conditions as in case 1, the size of battery is to be determined. Since the average load is 600 amperes, and the maximum 1,000, a battery to discharge 400 amperes is required. If the one-hour rate is not to be exceeded, an 800-ampere-hour battery is necessary. The maximum load, however, comes on the system, but infrequently, as shown by the load diagram and as it lasts only five seconds, a 700-ampere-hour battery, having a one-hour rate of 350 amperes, will be ample as it will only have to give out seventeen per cent in excess of its rating, and then for a negligible time. Even a 600-ampere-hour battery would work satisfactorily on this load.

Assuming a 700-ampere-hour battery in the station, practically all the fluctuations in load will be absorbed and the generator load curve becomes a straight, or rather a wavy line. The station voltage being constant, the feed point electromotive forces at various line loads are not quite so satisfactory as are furnished by a compound-wound generator. If the minimum voltage at the feed point is to be 350, the resistance must not exceed 0.2 ohm or 0.1418 ohm for the copper resistance, requiring 805,000 circular mils as against 665,000. The generating equipment, however, is reduced in size from 550 kilowatts to 350 kilowatts and the fuel economy greatly increased.

COMPARISON OF CASES I AND III.

As compared with the shunt-wound generator working with a floating battery in the power station, the generating equipment is 330 kilowatts as against 440; the copper, 805,000 circular mils as against 945,000; the load variation six per cent as against forty-seven per cent; the voltage variation at the feed point nineteen per cent as against twenty per cent—these two factors being practically equal, because of the greater amount of copper in the line fed from the floating battery.

CASE IV—BATTERY AND BOOSTER OUT ON LINE.

If the floating battery out on the line has a booster auxiliary working with it, the current passing over the feeder will be maintained constant, and the average load only will be transmitted from the power station. If, as in the previous cases, the voltage is not to fall below 350 volts, the resistance (assuming 550 as the generator voltage) will be 0.333 ohm total or 0.2751 ohm for the copper; equivalent to 415,000 circular mils. This, however, is not so advantageous as it seems, for the voltage at the point where the booster is located is constant and the electromotive force will neither fall below 350 nor will it rise above it. Taking 420 volts as a satisfactory pressure, the resistance of the line becomes 0.217 ohm = 0.1588 ohm for the copper = 720,000 circular mils. This allows the maintenance of a satisfactory potential which varies so slightly as to be practically constant.

COMPARISON OF CASES II AND IV.

Compared with the floating battery on the line, the booster-controlled system gives a higher and more satisfactory voltage; the copper is 720,000 circular mils as against 495,000 circular mils. This is not a real comparison, however, in view of the higher voltage maintained. The load on the generating equipment is kept constant within six per cent as against a variation of seventeen per cent; the power-house capacity required is 330 kilowatts against 385 kilowatts.

While the booster-controlled battery out on the line is theoretically superior to a similar equipment in the power station, it requires extra attendance, which in many cases offsets its advantages and makes it advisable to put the booster and battery in the station and add a little more copper to the line, or install a floating battery at the feed point.

Furthermore, the usual condition in practice is that of a power plant supplying current to numerous feeders, no single one of which carries sufficient current, or is enough longer than the others, to warrant a battery installation only to take care of its load and voltage. Generally, therefore, in order to regulate the station load, the battery and booster must be in the power station.

The advantages shown by the booster-controlled batteries over those floating across the circuit do not include a most important one; namely, the ability to obtain full battery discharge even when the stored energy in the cells is nearly exhausted and the voltage decreased below normal. The battery characteristic (Fig. 1) shows that the minimum voltage, when discharging at the hour rate, is 1.915 volts per cell. This is the case only when the battery is worked nearly fully charged, and the output and input are so nearly equal that the state of battery charge is practically unchanged. If, however, any unusual condition or event should raise the average load on the system, the output might exceed the input for several hours, and the battery so far exhausted that the voltage would fall to 1.7 per cell when discharging at the one-hour rate. This is a decrease of 0.215 volt per cell—or fifty-eight volts in a 550-volt battery—below the minimum voltage of discharge when the battery is working at a point near full charge. Obviously, without a booster the battery in this condition would not be of any assistance at all in the power station, and its regulating ability out on the line greatly impaired.

Another advantage offered by the booster is that the necessary overcharge is not attended by a troublesome manipulation of water barrels, with the usual accompaniment of heavy grate-bars and a jug of sulphuric acid.

CASE V—BOOSTER IN STATION; BATTERY ON LINE.

The final method of installing the battery, that is, with the booster in the power-house and the battery out on the line, is peculiar in that only one type of booster may be used, and there must be a separate feeder from the booster to the point where the battery is located. In the foregoing discussions a single feeder from the power station to the feed point has been assumed to simplify the comparison, which is just as valid in its results as if the load had been distributed over the length of various feeders. If the circuits in the cases discussed were merely a simple trolley and track with distributed loads, any of the four described applications could be used, except that the booster system shown in Fig. 15 would not be suitable as the auxiliary for the battery floating on the line.

Character of Booster—A particular arrangement of the type of booster shown in Fig. 15, causes it to allow only a practically unvarying current to pass through its armature. Referring to Fig. 16, G is the generator; B the booster armature; *f* a shunt field; S a series field; E the battery, and MM the motors or variable load. The voltage across the mains at X is obviously the generator voltage, while the potential at the terminals of MM is

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equal to the voltage at X plus that of the booster. As in the case of the booster shown in Fig. 15, the shunt and series fields are in opposition; but at normal load, the magnetization of the shunt field exceeds that of the series field, and an electromotive force is generated in the booster armature, which is added to that of the generator to produce normal voltage across the mains. The battery being connected directly across the mains, its normal voltage is equal to that of the generator, plus booster.

If an excess load should come on the system, the generator tends to send additional current to the line, strengthening S and reducing the booster voltage and consequently the potential across the mains. The battery then discharges. The converse occurs on increase of load; the booster voltage rises, and current flows into the battery. This system allows only a constant current to pass through the booster armature and is therefore known as the constant-current booster.

In Fig. 17 is shown the method of applying this machine to the case in hand. The symbols are the same as in Fig. 16; T is the trolley; R the track and F feeder from the booster. The shunt coil *f* is connected across the line and coil S in series with the feeder F.

Line Drop—In Fig. 18 the curve A represents the voltage which obtains along a line fed from one end and with the load uniformly distributed along its length.

In the figure, the drop at the distance L, from the source of is seen to be 350 volts. If from P only one-half the circuit is supplied with current, there will be a decrease in the drop due to lowered resistance, and a further decrease due to the fact that only one-half the current flows over the feeder. If the distributed load from P to E is 1,000 amperes and the drop 350 volts, the load over one-half the distance is 500 amperes and the resistance of the circuit one-half that from P to E, so that the drop is one-fourth of 350 or 87.5 volts, if the circuit extend only to N. This shows that the drop at the end of a main supplying current to a given distributed load varies directly as the square of the distance over which it feeds.

Data of System—Assume the same conditions as in previous cases and shown in Fig. 19, taking the load as being equally distributed along the line, which, in this case, however, is five miles in length instead of two miles, as before. Computations for drop on a two-mile line with this system show the cross-section of the copper to be so small that it has not the requisite current-carrying capacity. The copper which extends along the entire length of the circuit will be taken as 400,000 circular mils inclusive of the trolley wire. The resistance per mile of circuit is 0.1424 ohm for the copper and 0.0291 for the track, making 0.1715 ohm per mile, or 0.8575 ohm total. The drop on distributed load is 429 volts at the far end of the line when 1,000 amperes pass over it. This is shown by curve No. 1 in Fig. 20. It is desired so to place the battery on the line as to reduce the drop to 150 volts, putting the booster in the power station, and adding such an amount of copper as may be necessary.

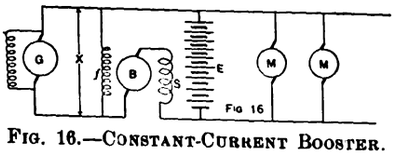

FIG. 16.—CONSTANT-CURRENT BOOSTER.

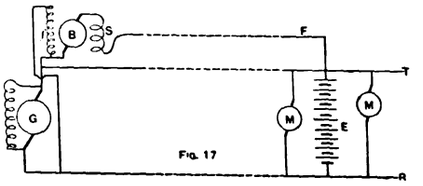

FIG. 17.—BOOSTER CONNECTIONS.

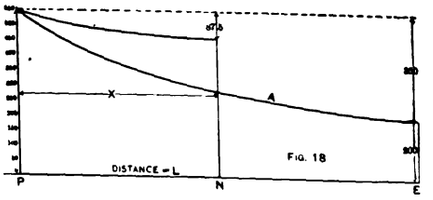

FIG. 18.—LINE DROP CURVES.

Location and Voltage of the Battery—Since the drop from the power station varies as the square of the distance over which a distributed load is supplied, the distance X to which the original copper can feed at a drop of 150 volts, is computed by the proportion:

$X^2 : (5)^2 :: 150 : 439$, from which

$X = 2.89$ miles, which is shown at point B.

The remaining distance, or 2.11 miles, is to be divided into two equal parts and the battery so located that it will feed in each direction 1.055 miles, which is its distance from the end of the line. Point C shows its position. Its voltage Y is fixed by the condition that the line voltage must not fall below 400 volts. Applying the above proportion:

$$(5)^2 : 429 :: (1.055)^2 : Y$$

$$Y = \frac{429 \times (1.055)^2}{(5)^2} = 19.1 \text{ volts}$$

= drop for the distributed load on either side of the battery, which is located at C.

19.1 + 400 = 419.1 = battery voltage when discharging at maximum rate or 1.915 volts per cell.

$$\frac{419.1}{1.915} = 219 = \text{number of cells in series.}$$

$219 \times 2.025 = 443.7$ = voltage at C, with normal load on system, battery neither charging nor discharging, 2.025 being the open-circuit voltage per cell as shown in the characteristic (Fig. 1). Voltage per cell is 2.14 when charging at maximum rate.

$2.14 \times 219 = 468$ = volts at battery at maximum charge.

Feeder to Battery—The total current to that portion of the system past B away from A, must be supplied by the feeder F (Fig. 18), and this current Z is determined by the proportion.

$(5 - 2.89) : Z :: 5 : 600$, whence

$Z = 253.2$ amperes.

The size of the feeder F is now to be decided on. If its current-carrying capacity be sufficient to allow 253 amperes to flow, its resistance is of little moment so far as the operation of the system is con-

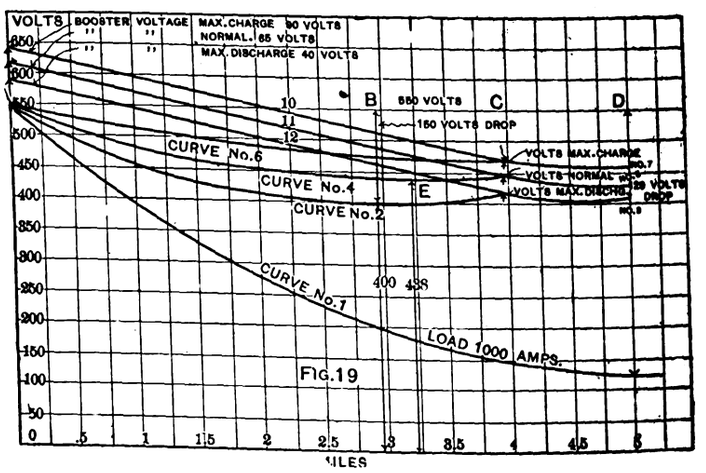

FIG. 19.—DATA FOR LINE FIVE MILES IN LENGTH.

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cerned, since the voltage of the booster can be made sufficiently high to compensate for any feeder drop. This resistance, however, is commercially a serious factor, since the booster energy input is lost. The question then, is to determine the most economical cross-section of copper, which is beyond the scope of this paper. For purposes of the discussion assume it to be 400,000 circular mils; resistance, 0.1424 ohm per mile. Resistance of circuit = 0.1424 + 0.0291 = 0.1715 ohm per mile; or 0.1715 × 3.95 = 0.6774 ohm, total. The drop then to C = 0.6774 × 253 = 171.4 volts. 443 + 171.4 = 614.4 = voltage of generator plus booster at the station. 614.4 — 550 = 64.4 = booster voltage when average load is on the line. Since the current is constant, the drop to C is also constant, hence for variation of battery voltage to cause charge or discharge, the booster voltage must vary as indicated at A. The straight lines 10, 11, 12 show the drop along the feeder.

Changes with Load Variations—As the load decreases and the line voltage rises, the distance that the line will feed toward the battery is increased as shown by curves 4 and 6, while curves 5 and 7 show the corresponding rise of potential at the end of the line. At normal load of 600 amperes total, the minimum voltage is 438 and the point of lowest potential has moved outward to E, the station now feeding from A to E. When the minimum load of 260 amperes is supplied the drop from A to C is only seventy-three volts, making the line voltage at C 477, which is five volts higher than that of the battery on charge. Therefore, the line will supply all current from A to C, and also send enough into the battery to bring the voltage at the line down to 468; which extra current to the battery is nine amperes.

BATTERY CAPACITY.

Since the battery regulates 2.11 miles of the system, the average current as shown is 253 amperes, while the maximum is

$$\frac{1000 \times 2.11}{5} = 422 \text{ amperes.}$$

Therefore, the one-hour discharge rate should be 422 — 253 = 169 amperes, making the battery capacity 340 ampere-hours. The constant current from the booster, however, must be taken care of. On light load the line is furnishing all current up to C, and also nine amperes to the battery, making 262 amperes flowing to this point. The current consumption from C to D is only $\frac{260 \times 1.055}{5}$ = 54.8 amperes; 262 — 54.8 = 207.2 amperes, going to the battery which should not be in excess of the one-hour rate of charge. This necessitates the use of a 414-ampere-hour battery.

Results—This system then distributes current over five miles with a maximum current of 1,000 amperes: the minimum voltage is 400, the average 438; the fluctuations on the system are from 260 to 1,000 amperes, on the generator from 458 to 831. This is accomplished by the use of nine miles of 400,000 circular mils feeder, a twenty-four-kilowatt booster, a 450-kilowatt generator, and 261 cells of 400-ampere-hour capacity.

This paper has covered, it is true, only one set of conditions, but from it can be learned the method of investigation applying to any particular set of conditions; and it also shows that the setting forth of any general formulas or deductions to be applied indiscriminately is practically impossible.

The Telephone.

[*Editorial from the New York Times.*]

In an address delivered before the Underwriters' Club in this city on November 24, Mr. C. J. H. Woodbury, of Boston, an officer of the American Bell Telephone Company, gave some figures of exceeding interest respecting the telephone development in this country which will assist one who considers them thoughtfully to appreciate the extent to which the simple and familiar act of sending or receiving a communication by this method sets in motion titanic forces and to understand the magnitude and mechanical perfection of the plant provided for his convenience.

The amount of line built and maintained by the companies operating the Bell system averages 3.29 miles to each instrument, and, excluding the long-distance lines, fifty per cent of the wire is underground. When a call is made, the average amount of line placed at the disposal of the person who makes it is 6.58 miles. That anything like intercommunication is possible becomes the more a cause for wonder when it is remembered that the modern switchboard is a marvel of complexity in design and construction. It is the evolution of a quarter of a century, resulting from the collaboration of many experts working together for a purpose. Its mechanical intricacy will be better appreciated when it is remembered that even with the advantage of modern machinery and skill in manufacture it requires as long to build and install a switchboard as to build and equip a merchantman for foreign trade, the time being from one to two and a half years, and the cost varying from $500 to $600 per square foot for the smaller installations adequate for cities of 50,000 inhabitants, to $1,200 per square foot for the larger switchboards. The central station equipment, however, is but a small part of the whole cost of a telephone system, although it represents the greatest concentration of value in relatively small space. The life of a switchboard is usually short. Constant repairs, replacements, and extensions rapidly deteriorate it, and the effect of wear is distanced by the more rapid progress of invention and improvement. In a few years it becomes obsolete and the costly apparatus is burned to recover the copper it contains.

The result of systematic work in the perfection of appliances and the training of operatives has reduced within the past five years the average time of making complete local connections 3.9 seconds. This may appear to be a very little net gain, but as applied to all the telephone connections of the Bell system it amounts to 10,098 hours a day saved of the subscribers' time, or about three and nine-tenths years for each business day of eight hours. The system provides for 9,322,951 calls per day, or nearly 2,500 calls a year originating at each telephone in service. As one telephone is called for each one used, the average employment of each telephone in use is 5,000 times a year.

When one uses a long-distance telephone a large amount of property is placed at his service. For example, speaking from Boston to Omaha, as one business concern does every morning, the apparatus used, at the present price of copper, represents an investment of over $283,000, and it requires the service of nine skilled operators to make the necessary connections. The weight of the copper wire in the connection is 1,131,000 pounds, or 565½ tons, and it seems very like a miracle that the human voice can cause this immense mass of metal to vibrate in unison throughout its several parts, even to the delicate shades of tone which distinguish one voice from another, and that the instrument at the end is so sensitive that it can catch and repeat these vibrations and transmute them into articulate speech.

And it is all so new. Less than thirty years ago the telephone was an "over-capitalized" dream, and the stock of the Bell company could scarcely be quoted low enough to find a purchaser. Twenty years ago it was the luxury of the rich. What it has become in the past ten years we can best appreciate by reflecting what would happen if for any reason the telephone lines should be put out of use for a week.

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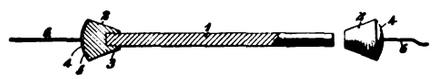
Electrical Patents.

A new insulating material has been patented by Mr. George T. Pratt, of Westbrook, Me. The object of the invention is to produce a substance which will have a high degree of efficiency as an insulator and which shall at the same time have the necessary tensile strength, hardness and toughness and which shall be waterproof. The foundation of the material is leather pulp formed into a suitable sheet by any well-known means, the leather pulp having mixed with it a suitable strengthening fibre, such as sulphite wood pulp. In forming the sheet, preferably above seventy-five per cent of the leather pulp is mixed with about twenty-five per cent of sulphite pulp to give it the necessary tensile strength. The sheet is formed on a paper machine in the ordinary manner, and it is pressed lightly as it runs through the rolls, so that after being dried it will be as porous as possible, so as to retain as much as possible of the impregnating material. After the sheet is formed, it is dried and then dipped in the melted impregnating material, which in practice is composed of about seventy per cent of ozokerite or mineral wax, twenty per cent rosin, and ten per cent of alum, these last two ingredients being used to harden the ozokerite and give the necessary hardness to the material. An insulating material formed in this manner, it is asserted, is found to be very efficient.

Henry N. Potter, of New Rochelle, N. Y., has patented a new idea in glowers for electric lamps, which patent has been assigned to George Westinghouse, of Pittsburg, Pa. The aim is to provide a terminal, the metal portion of which shall cover a large amount of surface and every point of which shall be equidistant from a given point in the glower axis. On account of the extremely high temperature at which glowers of the character above indicated are operated, it has been found necessary to employ leading-in wires which are not only good conductors of electricity, but the material of which has a high melting point and is substantially non-oxidizable in the atmosphere. Platinum wire is usually employed for this purpose, and various methods of making connections between such wires and the ends of the glowers have been devised. As shown in the illustration, the left-hand terminal 2 is attached to the glower body 1, while the right-hand terminal is shown as detached. The terminal body 2 is shown as of frusto-conical form, having a recess 3 in its smaller end and as having an outer end 4 in the form of a segment of a sphere. This outer end is shown as provided with a cup-shaped spiral 5 of platinum wire, the inner end of which terminates in a leading-in wire 6, the spiral being either pressed into the body 2 of the terminal or fastened thereto by means of a suitable cement coating. The terminal may be of different shape from that specifically illustrated, and its metal portion may also differ structurally from what is shown, though the cup-form is desirable as is also an open-work formation of such other surface irregularity as shall ensure a secure gripping engagement between the metal and the body of normally non-conducting material. The end of the glower body 1 may be inserted in the recess 3 in the end of the terminal 2 and be cemented therein by a paste of material like or similar to that of the glower body, or a paste formed of such material and certain salts which will calcine when heated—such, for example, as one or more oxychlorides or nitrates of suitable metal. Instead of forming the terminal bodies 2 separately from the glower body 1 and cementing them in position, the entire glower structure may of course be moulded in a single piece,



TERMINAL FOR ELECTRIC LAMP GLOWERS.

or the glower may be moulded in two parts and fused together after being roasted, or the bodies 2 may be cemented or fused directly to the ends of the glower body without the recesses 3. In fact, any known and practicable method of construction may be employed, the essential feature of the invention residing in the distribution of the metal portion of the terminal, so that every part of it shall be substantially equidistant from a given point in the axis of the body of the glower, whereby the current flowing into the glower will be distributed over a large surface instead of being confined to a single point or other comparatively small surface, and all parts of the terminal shall perform substantially the same service.

Many substances, especially those which have a high evaporating point—such as the oxides of calcium, magnesium and strontium, and other alkaline earths—have been introduced into the ordinary electrodes as used in arc lighting with a view to increasing the luminous efficiency of the arc. In some cases such substances will form deposits after having passed through the arc, which, gradually accumulating, form rings obstructing the emission of light. Mr. Hugo Bremer, residing in Neheim, Germany, has found that the slag can be rendered harmless by adding to the carbon a suitable quantity of a flux, such as boric acid, silica (silicic acid), or an alkaline borate of silicate or sodium chloride, these substances having the property of fusing at the temperature of the arc and then absorbing the basic slag by forming a borate or silicate or a luminiferous metallic base, which falls off in drops or small particles. Instead of adding a metallic base and a flux to the carbon separately, they may be chemically combined before they are mixed with the carbon. In other words, a borate or a silicate of a metallic base may be used. As the nature of a flux is well known, for instance, in ceramic arts, and in the working of blast furnaces, and depends, of course, on the particular material which it is intended to liquefy or absorb, it will not be necessary or practicable to specify every substance that may be used as a flux in the manufacture of carbons containing luminiferous mineral matter. In other words, as soon as the composition of the luminiferous mineral matter in the carbon is known a chemist acquainted with ceramic or glass industry will also know what materials may be used as a flux for that particular kind of carbon. The quantity of luminiferous mineral matter to be mixed with the carbon may be from ten to fifty per cent of the mixture of material from which the carbon electrodes are made, preferably from twenty-five to thirty per cent. The quantity of the flux depends partly upon the nature and quantity of the luminiferous base and partly on the nature of the flux. The total quantity of mineral matter contained in the carbon—that is to say, the luminiferous salts and the flux—should be at least twenty per cent, and not more than eighty per cent, of the carbon mixture, or from one-fourth to four times the quantity of carbon used. A higher percentage would be too detrimental to the strength of the electrode and to the temperature of the arc. On the other hand, if the quantity of luminiferous mineral matter is much smaller than those specified above, as has been the case in the earlier attempts, the least inequality of distribution causes considerable fluctuation of the arc, because the particles of mineral matter are placed far apart and cause a sudden flicker when the arc reaches the same. For this reason and others such carbons have not come into extensive use. If the slag produced

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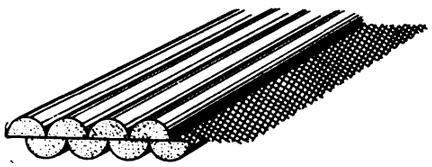
by the burning of the upper carbons forms a viscous liquid which falls off in drops and if the lower carbon is uncoated, the drops which fall upon the edge of the lower carbon will adhere to the same and the consecutive drops will gradually form on the edge of the lower carbon a ring which interferes with the burning of the carbon, as well as with the emission of light. If, however, the lower electrode has a glassy coating of borax, a silicate, or other suitable material, the drops of slag from the upper electrode will congeal immediately after they have separated and will slide down along the lower carbon without producing any injurious effect.

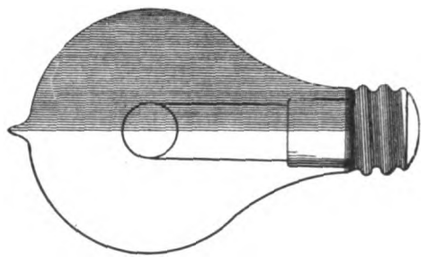
Mr. Johanne Justus, of Berlin-Halensee, Germany, has patented in this country a process of manufacturing plates of insulating material. Single bars of insulating material are first pressed out of suitable substance and are preferably of semi-circular or segmental section. These bars are then laid on their flat sides, closely side by side, and against a flexible



VIEW OF A NUMBER OF INSULATING BARS JOINED TOGETHER BY MEANS OF PRESSURE ON BOTH SIDES THE WIRE FABRIC.

foundation, such as wide-meshed wire fabric. They are united with the fabric by pressure or the use of an adhesive. The insulating substance may also be provided to the other side of the flexible foundation or wire fabric, whereby an entire covering of the wire fabric is obtained, together with a better connection of the insulating bars therewith. The plates formed of these semi-circular bars have, owing to the rounded groove or furrow between the separate bars, great flexibility which renders them very suitable for encasing strongly curved bodies. Preferably, the bars are so located that those lying against one side of the fabric alternate with those bearing against the opposite side, and, consequently, an insulating plate of wavy or corrugated section is formed having a central foundation of wire which is of uniform strength.

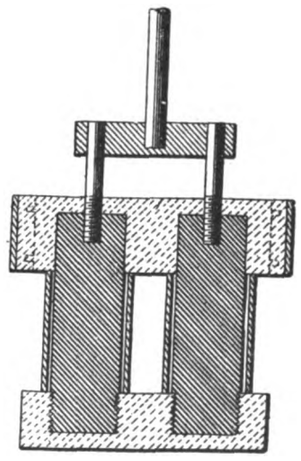
A new process of coating glass or fabrics has been devised by Mr. Henry Keppler, of Brooklyn, N. Y. In carrying out this process, a luminous powder is first mixed in medium bronze lacquer and applied evenly over the surface of the glass. This gives the surface a frosted appearance, and by reason of the illuminating properties of the composition thus formed when applied to one-half of a light globe acts as a reflector. The lacquer serves, of course, to form an adhesive base for the powder. The second step is to mercerize



SHOWING AN APPLICATION OF THE NEW COATING FOR GLASS OR FABRICS.

white rubbing-varnish and apply this evenly over the first mixture, after the latter has been thoroughly dried. The third step is to dust this surface before drying with gold-bronze powder. The surface is then dried, and finally the article thus coated is subjected to a copper bath, after which it may be painted or enameled. When this process has been applied to an electric light or other globe, it will be apparent that the portion thus treated will be entirely opaque and that the inner surface of said coating will act as a reflector.

Charles E. Acker, of Niagara Falls, N. Y., has patented a carbon electrode and conductor, designed particularly for use in those electrolytic operations in which high-current densities are employed. There is provided a carbon block, the lower active surface of which is corrugated or grooved so as to permit the ready escape of evolved gases. These grooves are deepened somewhat toward the periphery of the electrode, affording upwardly inclined surfaces, along which



SHOWING VERTICAL SECTION OF ELECTRODE, WHEREIN A PLURALITY OF CONDUCTORS ARE APPLIED TO A SINGLE BLOCK.

the gases may readily travel. In addition to affording paths of escape, the grooves serve to increase the active surface of the electrode in contact with the electrolyte. A carbon shank is secured to the block by screw threads or by dovetailing, or in any other suitable manner, and a metallic conductor is screwed to the end of the shank opposite the electrode. The carbon shank is protected by a tube or shell surrounding the same and constructed of fire-clay or other refractory material which prevents access of atmospheric oxygen to the heated carbon. This tube or sheath is supported upon the carbon block and may be let into the upper face thereof. If desired, a plurality of shanks may be employed for each block and these shanks can be connected by metal rods to a common metallic conductor. It is desirable also to protect the juncture between the carbon shank and the metallic conductor, and this is effected by means of a casing formed of soapstone slabs connected by plates or grids, the casing being filled with cement. This refractory casing is of somewhat greater area than the carbon block, and when the series of electrodes are assembled in the furnace, the casings constitute a cover which substantially prevents loss of heat and escape of gas. Furthermore, when so assembled, although the casings are in contact, the carbon blocks are sufficiently spaced to permit the furnace charge being fed between them.

Annual Report of the United States Commissioner of Education.

Vol. i of the report of the United States Commissioner of Education has been issued. This is a large volume of about 1,200 pages, and gives some very complete statistics of the state school system, the laws relating to land grant colleges, a discussion of Franklin's influence on American education, and a number of addresses on educational subjects. The educational systems of Canada and European countries are considered, and many statistics on various phases of the subject are included.

The Electrical Trades Society of New York.

The eighth annual meeting of the Electrical Trades Society, of New York, will be held on Tuesday, December 8, 1903, at Muschenheim's "Arena," 41 West Thirty-first street, New York city, at six o'clock P. M. There will be reports read, addresses, and the regular election of officers. An informal dinner will follow the annual meeting at 7.30 P. M. The dinner tickets are $2 each. Mr. A. P. Eckert, the secretary of the society, has issued a cordial invitation to all of the members to attend this dinner. All arrangements must be made in advance, and the secretary announces that he will be glad to hear from the members at the earliest possible moment.

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Reviews of Current Engineering and Scientific Literature.

A High-Lift Centrifugal Pumping Plant for the De Beers Mines.

Two high-lift centrifugal pumps, operated by three-phase induction motors, have been installed by the de Beers Mining Company, of South Africa. One of the pumps contains four chambers and is designed to lift 1,000 gallons of water per minute against a total head of 320 feet. The pump is driven through a flexible coupling by a three-phase induction motor, taking power from a fifty-cycle circuit at a pressure of 220 volts, and giving 150 horse-power at 730 revolutions per minute. This motor is started by a water rheostat. The second high-lift pump has two chambers, and is arranged to lift 1,000 gallons of water per minute against a total head of 160 feet. It is driven by a three-phase induction motor giving seventy-five horse-power at 730 revolutions per minute. In designing these motors, a high efficiency was sought, because when installed in the mine ventilation would be poor and the work would be continuous.—*Abstracted from the Mechanical Engineer (London), November* 14.

Field Telephone Switchboard of the United States Signal Corps.

The switchboard developed for use in the United States Signal Corps in field work is here described by Mr. Harold Cramer. The switchboard for this class of work must be small, compact and portable. A ten-line switchboard, with its complete equipment, is contained in a stout wooden box fifteen inches high, fourteen and one-half inches wide, nine and one-half inches deep, weighing, completely equipped for service, about thirty-four pounds. The equipment consists of ten 500-ohm tubular drops, ten ringing keys, thirty connecting keys, three listening keys, combined receiver and transmitter for the operator's set, an operator's coil, a magneto hand generator, a night bell and a switch, together with four cells of dry battery. The equipment was mounted on a hard-rubber panel set in the front of the box, the drops being mounted in one row at the top of the panel, with the ringing keys directly below them and the connecting keys in three rows ten inches below the ringing keys. Three listening keys are mounted on the front of the board below the equipment already mentioned. The operation of any two connecting keys in the same row serves to connect together the lines to which the keys correspond. There can therefore be three separate connections through the board at the same time.—*Abstracted from the American Telephone Journal (New York), November* 21.

Electric Automobile Batteries for Quick Charge Rates.

The cause of buckling in accumulators is attributed by Mr. E. Kilburn Scott to poor mechanical design. The men responsible for these types have been too much the electrician, and too little the engineer. The author has investigated some recent types of accumulator designed for rapid charging. One of these, the Elieson, has its plate formed of strips of lead, alternately straight and crimped. They are united together by a central core of lead, from each side of which the strips extend like the hairs of a feather. At the top and bottom, cross pieces of wood give support to the ribs. As the strips are held at one end only, the oxidized material is free to expand and contract, and buckling is avoided. A cell containing three such negatives and two positives, measuring eight inches by five and one-half inches by three-eighths inch, and weighing twenty-two and one-half pounds complete with acid, is rated at 115 hours capacity at a five-hour discharge rate. Under test this cell, when nearly charged, was discharged at a rate of twenty amperes down to a voltage on no load of 1.5. It was then completely charged in seventy-five minutes, commencing at a rate of 120 amperes and finishing at a rate of forty-five amperes, the total charge being 110.69 ampere-hours. It was again discharged at the twenty-ampere rate and continued until the voltage dropped to 1.5, the discharge capacity being in this case 101.66 ampere-hours, showing an ampere-hour efficiency of approximately ninety-two per cent. The discharge was then continued at the rate of twenty amperes until only 0.5 volt was registered. The cell was short-circuited and left for forty-eight hours. A charge of 120 ampere-hours was again made in one hour, the rate for about twenty minutes being nearly 150 amperes. An extra forty-ampere-hour charge was then made in one hour, and the cell left for four days. At the end of this time the discharge made at the high rate was fifty amperes for one and one-half hours, and for a further forty-five minutes, at lower rates, showed a capacity of 106 ampere-hours, demonstrating that no loss of capacity had been caused by severe usage. Sir W. H. Preece tested a similar five-plate cell, and found it could easily absorb its charge in three-quarters of an hour.—*Abstracted from the Electrical Engineer (London), November* 13.

The Work of the Reichsanstalt.

This article gives a summary of the work of the Physikalisch-Technische Reichsanstalt, of Charlottenburg, during the year 1902. Much important electrical work has been done. Many thermal and conductivity tests of many metals have been made. The results in the case of cadmium point to a straight line law for the connection between the temperature and electric conductivity of pure cadmium. Measurements of electrolytic conductivity have been extended. The temperature coefficients of the ionic mobilities appear in the case of monovalent monoatomic ions to be functions of the ionic mobilities. Official testing stations have been opened at Ilmenau, Hamburg, Munich, Chemnitz and Frankfort-on-Main. These distribute fully tested instruments in different workshops, where they are in practical use, and verify them at intervals. Alternating-current measurements are still made by the quadrant electrometer. Motor tests have been made with brakes which give results agreeing with those computed by Heyland's diagram. Experiments on the various current losses in motors, made after the methods of Dettmar, Hummel, Kapp and others, did not give concordant results. Of the 127 Clark cells, ninety-five were certified. Twenty-eight were rejected because they deviated by more than 0.001 volt from the normal value, 1.4328. A new charge in regard to the inconstancy of the Weston cells has been disproved by Steinwehr. Fifty cadmium cells, prepared in 1900 by the Reichsanstalt, have been compared with those made in previous years, but the older cells now show 0.0001 volt too low. Methods of testing iron have been investigated, and a simple relation has been established between the

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coercive force, remanence and maximum permeability. Thirteen thermo couples used as electrical thermometers, have been returned for retesting. Most of the thirteen were found unchanged, though they had been put to hard use. One of these had been in use since 1896, exposed to the flue gases and flames of a boiler. This indicated eight degrees too low at 1,100 degrees. Another, used in a coke oven flue since 1897, indicated seventeen degrees too low at 1,000 degrees. These were the worst cases, and in both of them the soldered joints had been repeatedly renewed.—*Abstracted from Engineering (London), November* 13.

Measurements of the Frequency of Very Rapidly Alternating Currents.

A paper published a year ago by Mr. J. W. Salmonson gave the results of some careful measurements of high-frequency currents. As these results have been questioned, Mr. Salmonson has devised a method for testing the accuracy of his previous work. An arc lamp is shunted by a condenser and an inductance, the latter consisting of the primary of an induction apparatus of the Dubois-Reymond type, from which the iron core has been removed. The secondary circuit of the induction coil is completed by a hot wire galvanometer and a mica condenser in series. If periodic currents are generated in one of the circuits, by establishing a singing arc, an impressed electromotive force will be set up in the secondary circuit, which will have the same frequency as that of the primary current. By varying the constants of the secondary circuit, it may be brought into resonance; and if the values of the inductance and capacity are known, the frequency of the current can be calculated. For these tests the inductance was carefully determined, and a condenser with a variable capacity was used. In this way sinusoidal currents with a frequency of more than 400,000 cycles per second have been produced. Up to 100,000 per second the results agree with those obtained by Peukert's method. The author thinks that his results show that, under certain conditions, the resistance of the electric arc remains negative, even at high frequencies, and this being the case, he does not see why a frequency of a million or more might not be reached. For getting these high frequencies the voltage of the arc should be as low as thirty-five, and the arc itself should be only a few tenths of a millimetre in length. To verify the results obtained by this method, photographs of the arc were taken by means of a rotating mirror. The results agreed with those computed from the constants of the circuit. The author thinks that the seeming discrepancy between his results and those of his critic is caused by the fact that there seems to be a critical potential difference at the carbons, or a critical length of arc above which the resistance of the arc ceases to be negative. With small frequencies this critical potential difference may be as high as forty-two to fifty volts, while with higher frequencies the critical potential difference is lowered, until, with the highest obtainable frequencies, it is not more than about thirty-five volts.—*Abstracted from the Electrician (London), November* 13.

Recent Development of the Metropolitan Electric Supply Company's Installations.

This article gives some particulars of the recent additions to the London Metropolitan Electric Supply Company's installation. At the Willesden station, two 1,500-kilowatt and two 3,000-kilowatt generating sets have been added. This is the second largest electrical supply company in London, the total output of the various stations being rated at nearly 23,000 kilowatts. The station building, as originally designed, was too low for the new units, and to accommodate them the floor was lowered ten feet. The 1,500-kilowatt sets are similar to those previously installed. The engines for the new 3,000-kilowatt units were supplied by Sulzer Brothers, of Winterthur, and the engines by Kölben & Company, of Prague. They are of the vertical compound type, with one high-pressure and two low-pressure cylinders. They are designed to give a full output with saturated steam at 150 pounds per square inch, either condensing or non-condensing, at a speed of seventy-five revolutions per minute. They are guaranteed to give the following results with dry or saturated steam: at full load, the steam consumption per indicated horse-power-hour will be fifteen pounds, and the mechanical efficiency, excluding auxiliaries, will be 92.5 per cent; at three-quarters full load, the steam consumption per indicated horse-power-hour will be fourteen pounds and the mechanical efficiency ninety per cent; at one-half full load, with a consumption of fourteen pounds of steam per indicated horse-power-hour, the mechanical efficiency will be eighty-six per cent. It is thought that the steam consumption will be reduced about one and one-half pounds per indicated horse-power-hour when superheated sixty-five degrees centigrade. The engine can easily carry an overload of twenty-five per cent under normal conditions. The generators are of the two-phase type with revolving fields, rated at 3,500 kilowatts each at 10,000 volts, sixty cycles per second. They will give 3,000 kilowatts at any voltage between 10,000 and 11,500, and will carry a non-inductive load of 3,000 kilowatts at 11,000 volts for twenty-four hours with a temperature rise not exceeding degrees Fahrenheit. They will also carry an overload of twenty-five per cent for four hours. The pressure drop at constant speed and excitation does not exceed eight per cent, and by calculation the pressure drop with a power-factor of eighty-five would be less than eighteen per cent. The efficiency with non-inductive loads, including excitation and air friction, is, at full load, ninety-six per cent; at three-quarters full load, ninety-five per cent, and at one-half full load, ninety-three per cent. The armature spider, of steel, carries ninety-six poles of soft cast steel of elliptical section with laminated pole shoes. The cores are dovetailed into the periphery of the wheel, and can be slipped out sidewise complete with the windings. Each alternator carries its exciter on an extension of the main shaft. The bore of the armature is 300 inches, and the air-gap is 0.315 inch. The gross width of the armature core is 29.1 inches; the net width, 21.5 inches, and the depth of core, 7.2 inches. There are 576 slots, each containing ten conductors. These are connected in two parallel circuits, each containing five conductors in series. The section of the pole cores is 80.5 square inches; the dimensions of the pole shoes, 29.1 by 6.5 inches, and there are thirty turns per pole. The switch gear is of the Ferranti type, and in the boiler house, six Babcock & Wilcox boilers have been installed. At the Amberly road substation twenty-one transformers, each rated at 100 kilowatts, have been installed. These are mounted on wheels, so that each can be drawn out of the bank for inspection. Each transformer has a regulating switch whereby the pressure on the secondary bus-bars, which work at 1,000 volts, may be varied by 120 volts in twelve steps.—*Abstracted from the Electrical Review (London), November* 13.

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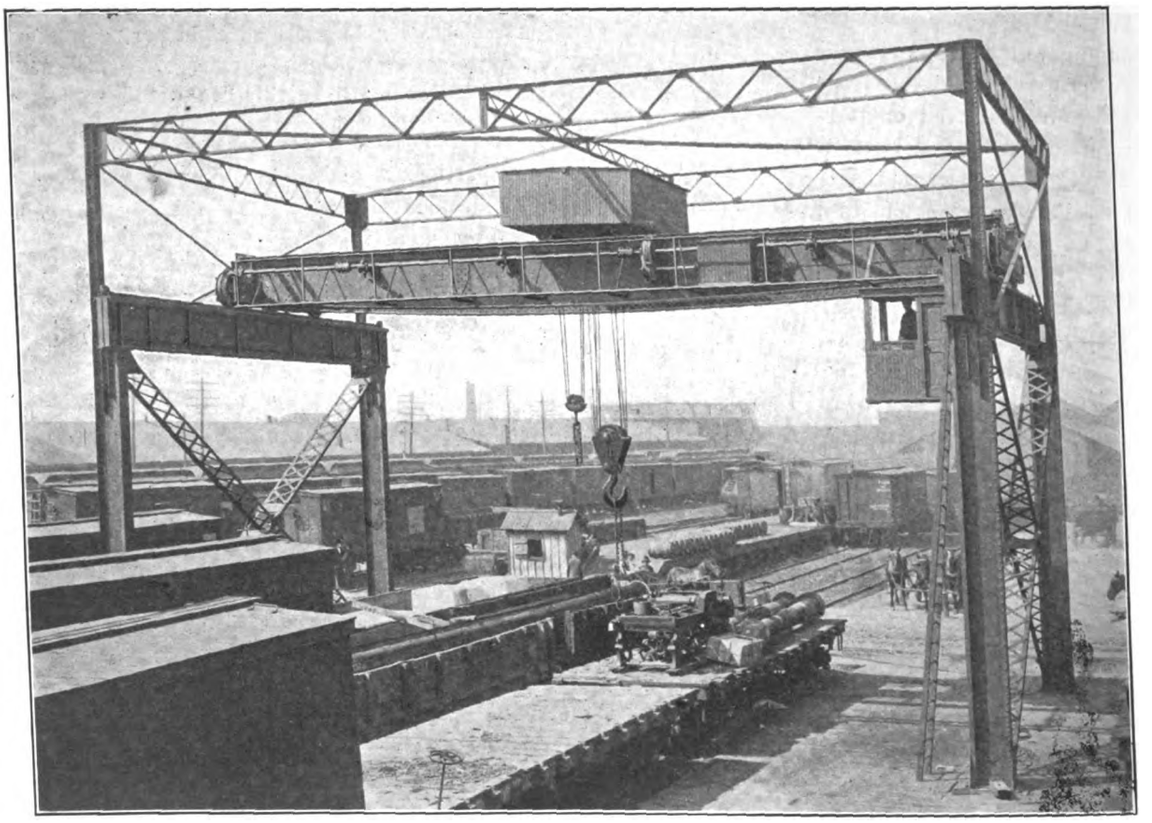
INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

A Heavy Service Overhead Electric Traveling Crane.

The following illustration shows the latest type of an approved and economical apparatus for the handling of heavy and bulky freight in a railroad yard. The illustration shows a portion of the yard of the Buffalo & Allegheny Valley Division of the Pennsylvania Railroad Company, and includes a forty-ton Niles overhead electric traveling crane, forty-eight-foot span, and a substantial structural steel runway forty feet long. The crane spans three tracks, and leaves a wide passageway which gives ample approach for teams and trucks on one side of the cars covered by this apparatus. In addition to the main hook, a quick running auxiliary hook of five tons capacity is provided for the rapid and efficient handling of light loads, which performs by far the greater part of the service of the crane. The bridge consists of two heavy curved girders, of box section. It is driven longitudinally on the runway, by motor located on the front girder which is geared to the truck wheels on either side, the motion being controlled by a foot brake located in the operator's cage which acts directly upon the armature shaft of the motor. A foot bridge is provided the entire length of the span, with customary guard rail. The bridge trucks are securely fastened with the utmost rigidity to the girders, provided with heavy cast steel, double flanged truck wheels with threads accurately finished to uniform diameter. The trolley is the standard type used on overhead cranes, consisting of heavy side frames securely bolted together and kept in perfect alignment by a separator. All the gearing is cut from the solid and runs encased in oil, which gives the entire mechanism an unusually high mechanical efficiency. Both hoists are provided with mechanical and electric brakes, also circuit-breaker and limit switches to prevent overwinding and consequent damage to the crane or its load. The trolley, operator's cage and bridge-drive motor are of the enclosed type, affording suitable protection from the weather. The runway is built up very substantially. It consists of four columns carrying runways of riveted plate and channel construction, and is laterally braced. It will be readily appreciated that an equipment of this character has a much greater capacity than the average pillar or swinging crane which is usually installed at railroad freight stations. If at any time it is desired to cover increased acreage by the hook, the length of runway is readily increased by adding additional spans. This crane is notable because of the extra height of lift, which enables the loaded hook to clear the top of box cars or other obstructions while performing the functions of its regular service of loading and unloading. The complete apparatus was manufactured, installed and erected by the crane department of the Niles-Bement-Pond Company, Meadow and Mifflin streets, Philadelphia, Pa.



SHOWING FORTY-TON NILES OVERHEAD ELECTRIC TRAVELING CRANE, FORTY-EIGHT-FOOT SPAN, LOCATED IN THE BUFFALO & ALLEGHENY VALLEY DIVISION FREIGHT YARD OF THE PENNSYLVANIA RAILROAD COMPANY.

Wireless Telegraph Experiments.

Professor Alexandro Artom, of the Royal Industrial Museum, Turin, is reported to have been successful in carrying on wireless telegraphic communication simultaneously between two pairs of stations in the same locality. Experiments were made for a distance of thirty-five miles, near Rome. Professor Artom is said to have employed a special instrument of his own invention in these experiments.

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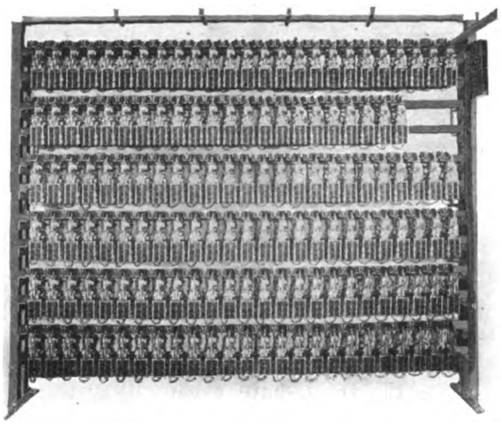
Latest Type Automatic Telephone Switchboard.

The Automatic Electric Company has recently made a change in its method of mounting the switches at the central station in that it uses steel angles for the switch shelves instead of wood. The accompanying illustration shows an automatic switchboard of the latest type with



NEW TYPE STEEL FRAME AUTOMATIC TELEPHONE SWITCHBOARD.

the switches mounted upon steel frames. The illustration is taken from a six-shelf switchboard, a section of an exchange of 10,000 stations. It has been found that the steel mounting is more rigid and no heavier than the wood, and there is no sagging in the shelf on account of the weight of the switches. Two light strips of wood are used in the rear of each shelf angle for the purpose of insulating, and with this exception there is no wood on the switchboard. This method of construction is not only more modern, but gives to the switchboard a neater appearance.

Machine vs. Hand Numbering in Metals.

The operation of numbering name-plates and metal parts has, until recently, remained a most unsatisfactory one, and the old method of employing individual figure stamps and hammer was not only crude, slow and expensive, but errors and irregularities constantly occurred and the appearance of the work was far from attractive. The machines here described are designed with a view of meeting every requirement—eliminating the many difficulties which have heretofore existed and performing in an hour what was before considered a good day's work, enhancing, rather than destroying, the appearance of the parts upon which a number is to be placed. By their use consecutive numbering is accomplished with absolute accuracy, and any numbers which skip backward or forward, such as type and voltage numbers, may be impressed on the parts themselves, or upon tags or plates to be attached to them. These machines are already in use to such an extent that the maker states that their practicability has been fully successfully tested, while it has been demonstrated that they are important factors in the saving of labor.

Fig. 1 shows the new model No. 43 which is designed for consecutively numbering gold, silver, steel, brass, copper, iron, tin, hard rubber, fibre, leather-covered and wooden instruments or parts of any kind, size or shape, such as name-plates, sewing machine slides, iron castings, electric, gas and water-meter tags, brass checks, steel keys, locks, watch cases, watch movements, steel bars, plates, etc.

It may be operated in any punch, screw or lever press. The shank is made straight or to any taper and length desired. It is set up in the same manner as an ordinary punch, but the stroke of the press must be limited and carefully adjusted to the depth of the impression required.

As the discs revolve, the figures are brought into correct alignment, are equally spaced apart and all are sunk pre-

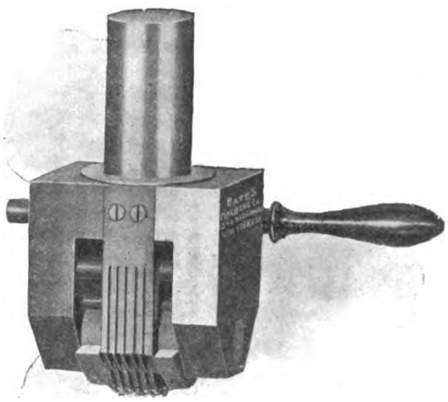


FIG. 1.—FOR CONSECUTIVE NUMBERING.

cisely the same depth, thus ensuring perfect uniformity. The lever-bar may be attached to any stationary part of the press, and the number will then advance automatically in consecutive order with each stroke. The figures and letters are made to any size or style desired, and are cut upon "tool steel" wheels, carefully hardened and tempered.

Fig. 2 shows the new model No. 44 which is designed for stamping the style, size, grade, type, ampere, voltage and power numbers upon name-plates, tags or parts of motors, dynamos, electric meters, etc. Any combination of letters and figures may be set instantly—skipping forward or backward—as is required for numbers which do not progress consecutively. Each numbering disc or wheel is provided with a lever which operates it independently of the others. The ends of these levers form a small keyboard. Remarkable speed is invariably attained as soon as the operator becomes practised. This experience is very easily acquired by an ordinary machine hand. The figures or letters which are in stamping position are always shown by the indicators on the front of the wheels just below the keyboard.

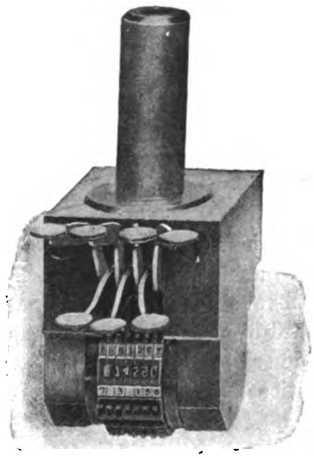


FIG. 2.—FOR COMBINATION NUMBERING.

Fig. 3 shows the new model No. 34 which is designed to facilitate the operation of models Nos. 42 and 43, but any punch, screw or lever press may be utilized. Adjustment gauges are usually provided to which the pieces or parts to be numbered are fed. A toggle joint ensures maximum power with comparatively slight pressure upon the lever. A model No. 43 consecutive machine is shown in the illustration.

A catalogue describing these machines

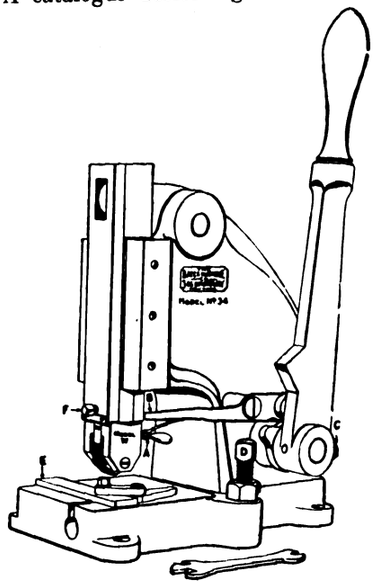


FIG. 3.—AUXILIARY PRESS FOR NUMBERERS.

will be forwarded upon request to the maker, the Bates Machine Company, who is widely and most favorably known as a manufacturer of high-grade numbering machines. The general offices are located at 346 Broadway, New York, and it has branches in Manchester, England, and in Brussels, Belgium.

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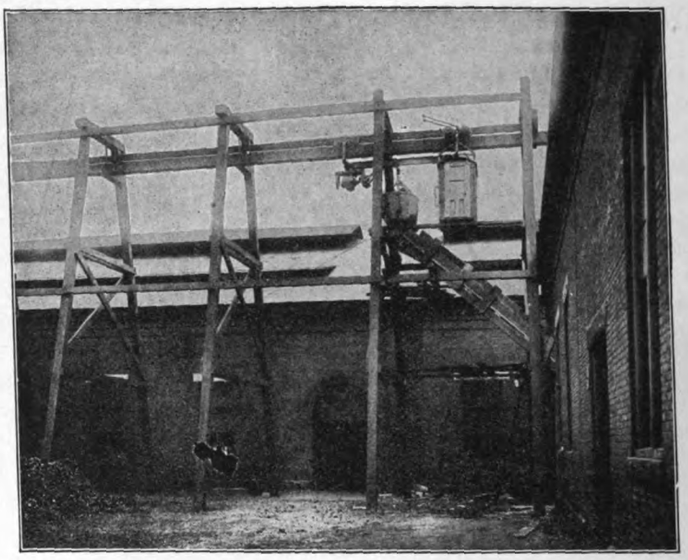
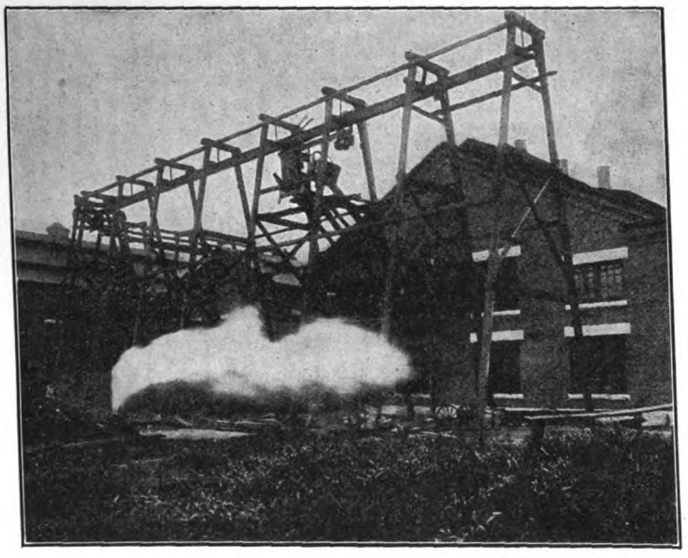
Telpherage in Coal Handling.

The large quantities of coal being consumed by gas companies, railroads, waterworks, electric railways, electric light companies and manufacturers make it imperative that a storage should be provided of sufficient capacity to forestall any scarcity that may occur from any cause. The model coal storage is such that either anthracite, bituminous or run of mine coal may be received either by boat or rail, placed in the storage, and then removed with great rapidity and with a minimum of labor and expense, crushed and delivered to the boiler houses or places of consumption. In the method of storing indicated in this article, it is the purpose to show how all these points may be accomplished by means of the telpher. One type is described of which there are many modifications. The same machinery, telpher and hoist may be used for removing ashes as well as storing the coal.



Telpherage unloads the ships at wharf, the car on siding; deposits the coal in elevated coal pocket or bins and on the storage ground; charges the water gas retort with but one handling; receives the coke from the quencher a few feet from the ground, and places in a pocket and upon screens or in crushers forty feet from the ground. One man attends to all the hoisting, conveying and depositing.

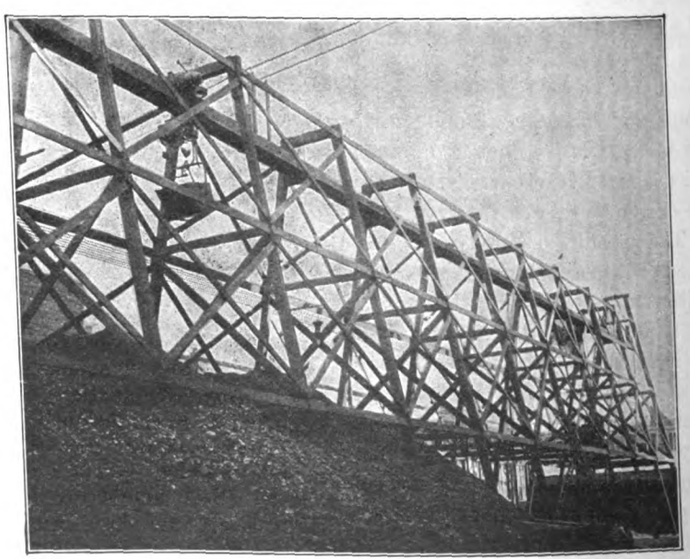


An example of exceedingly high bents or supports to pass over intervening buildings. For raising coal or coke to a height and dumping the same over screens and distributing into chutes. One man in the cab attends to the whole work of elevating, transporting and distributing.

Coal may be removed from boats by unloading towers, either movable or stationary, of the standard type used for such work, or by means of projecting track. In this latter form the telpher must run out over the boats on the projecting track, and, by means of its hoist and bucket, take its load direct from the vessel.

In case conveying alone is desired, a telpher with a train of buckets is used, and after the buckets have been loaded from the hoppers in the towers travels to the storage yard, where the load is discharged, and then returns for another load. The hopper which is higher than the telpher track, feeds the coal into the buckets, which are generally bottom dumping. These four buckets, which constitute the train, have a capacity of two tons each, and can be fed by four chutes from the same hopper simultaneously, or by one chute, the train being moved along as each one is filled. In the first case much less time is consumed. The entire eight tons conveyed in this train are handled by one man, who is stationed in the cab. By means of a controller of a special type, he may start the train or stop it at any desired point, and by means of a wheel or lever at the end of the bucket may dump the entire load without moving from his seat or losing time. This is due to the fact that the entire number of buckets are coupled together by universal couplings.

Should it be desired to take from storage, the telphers are fitted with grab or clam-shell buckets and hoists.



The track is elevated upon exceedingly high bents for the storage of thousands of tons of coal within a limited area. The line is automatic, being controlled from the terminal. The trestle is strongly braced and built to withstand the pressure of the coal.

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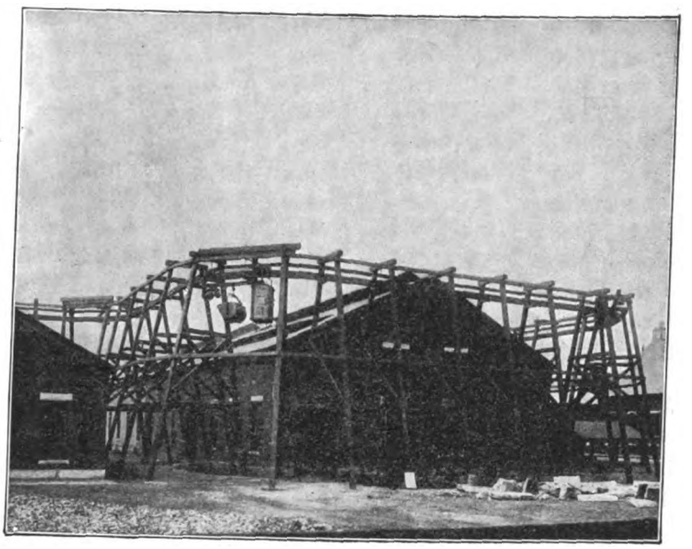
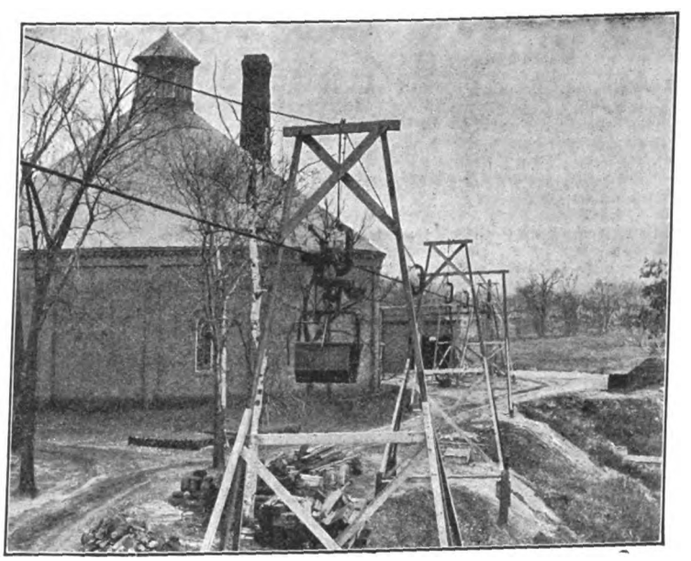


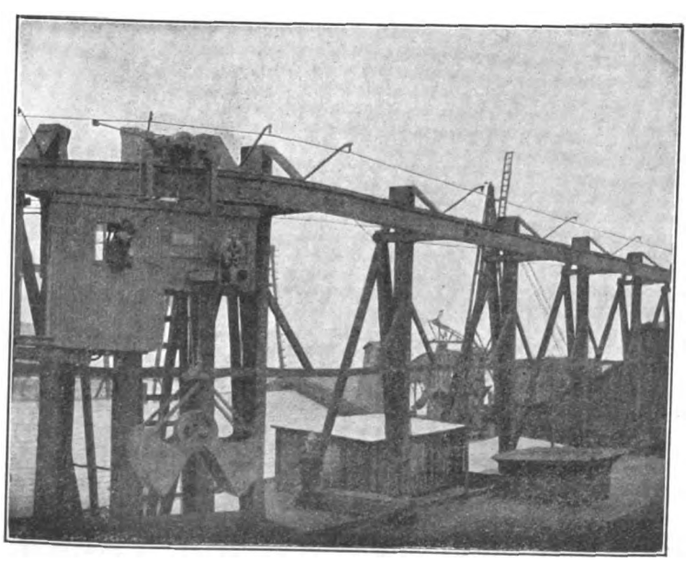
A sixty-foot vertical lift of 3,000 pounds; a sinuous run of several thousand feet at 1,200 feet per minute; a deposit at the end of the run and at intermediate points, on the ground or fifty feet above.

In special storage unloading towers are provided on the docks similar to those before mentioned. The track is laid out in such a manner that there need be no fear of congestion at any time, in case it is desired to run a number of trains over the system. In fact, the number of trains, which can be made longer if necessary, can be so arranged as to present an almost continuous line of two-ton buckets. This gives a very good idea of the great capacity of the telpherage system.

The telpher train receives its coal from the towers, proceeds along the telpher track, around the large circle which forms the storage yard, thence to the crushers, delivers its coal and returns. If, however, it is desired only to store the coal, then the telpher passes from the towers, across the rotary telpher tracks, dumps the coal and returns by the other side. As soon as the coal is piled up to the proper height, the tracks are then moved, say five to ten feet, and the process is repeated. In this way the top of the coal is left practically level and all the space utilized. It will be noted that in the centre of the storage space is placed a pedestal for the large rotating telpher tracks. These are supported in the middle by the pedestal, and the ends are allowed to move upon the circular track, making what might be called a continuous moving switch. By means of these the coal can be taken from the towers and dumped into storage yard, while at the same time other telphers, by means of clam-shell buckets, take the coal from the storage and carry



Coal from cars to reserve storage, and from reserve storage to gas works and boiler house. Automatic plant with cable track.



The bucket is lowered open upon the coal or like divisible material, "grabs" the same, and the electric hoist closes the bucket and elevates the load, while the Telpher does the conveying. Telpher upon a curve works equally well upon a grade. Load with bucket, three tons. Speed, 1,000 feet per minute. Electricity does the work of eighteen men, one man directing.

it to the crushers or the retorts. It will therefore be seen that by means of this rotary movement, effected either by electricity or by hand, according to the size of the telpher or the frequency of movement, gives us the command of the entire area within the large storage space. As stated above, should it be deemed advisable, however, to go direct to the crusher, it can easily be accomplished by revolving this rotating telpher track until it assumes the second position; then the telphers go direct to the crushers.

The method of taking from storage is practically the same as placing in storage, the only difference being that the telphers are supplied with clam-shell buckets and hoists. The same telphers can be used for taking coal from storage or from the cars. The telpher track runs parallel to the railroad tracks. The cars may then dump

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into pits, thus enabling the clam-shell bucket to act more efficiently than if it takes out of the cars direct.

The principle involved in this lateral moving track is the same as in the rotating telpher track, the difference being, as their respective names imply, one rotates and the other travels laterally. In this last method the layout of the tracks takes the form of a rectangle. We will suppose it is desired to take coal from the railroad cars; we run the telpher alongside the railroad tracks, and take our supply either from the cars direct or from coal pits by means of clam-shell buckets, as before. This, however, could be a water front, where towers would be employed. The telpher takes its load and moves along the side of the rectangle, crosses on the movable telpher track, deposits its load at whatever point is deemed best by the telpherman, and returns for another load on the opposite side of the rectangle, thus preventing congestion in case two or more machines are employed. The lateral moving telpher track may be moved in any desired position, either by electricity or by hand, along the rectangle which forms the storage, thus allowing the telpher to cover every square foot of enclosed area. This storage may be extended at any time by simply adding more track on at the open end, thus lengthening the rectangle. It may be used inside of a coal shed, in which case the uprights of the shed may be used for supporting the lateral moving track and telpher track; these two methods may be employed in conjunction with each other or separately, as is most desirable. The telphers used in either of the methods can be run on either system.

The small number of moving parts to the telpher, namely, the motors, reduce the wear and tear to a minimum. The fact that it is all accomplished by electricity, and that the moment a machine is stopped no power is being expended, the entire system can, therefore, be shut down at a moment's notice; also the fact that one man can handle eight tons with ease, thus reducing manual labor to a minimum. The flexibility and adaptability of the system all go toward making it the ideal machine for handling any material at a low cost. The amount of knowledge required to operate one of these machines is not great, and can be learned by the average man in a few hours. The fact that the track is elevated gives an advantage over other systems for capacity, and, also, there being no danger of obstructions occurring, such as all surface lines are subject to. Speed can be developed without danger to any one, and this can be attained, as before stated, by the average man, with no fear of consequences to others by fast running or inexperience. At any time the line may be increased by merely adding more track. By means of projecting track, where it is not necessary to handle enormous quantities of coal a day, the unloading towers may be dispensed with, as in the case of barges, and projecting track be substituted, thus doing away with the two men in the unloading towers, and allowing the telpherman to run his machine out over the projecting track and lower the clam-shell bucket directly into the barge and hoist and convey the load away, dump, and return for another trip.

As the machines run on a standard T-rail, which it is well known by years of experience and experiment to be the best adapted to take up the wear of traction, the maker sums up the advantages of the telpher and telpherage as follows:

Simplicity of construction, few moving parts to wear, unlimited capacity, adaptability to all conditions, no more limit to length of line than would occur with a trolley road, low cost of maintenance, large reductions in manual labor, no skilled labor required, and freedom from all obstructions common to transportation.

By means of electricity, adapted and applied for conveying, with the same skill as employed in the electric street railway service, with portable electric hoists for elevating, most economical and satisfactory results have been achieved. In some of the views as given, self-dumping buckets are illustrated, but in other cases, where very large quantities of material are to be handled in a short time, clam-shell or grab buckets are shown. In this latter case the telpherman goes with the telpher and attends to the loading, hoisting, conveying and dumping the loads. It is interesting to note in one of the views that the material is to be dumped into a number of hoppers, showing its adaptability to dumping into chutes or openings, for filling coal bunkers on steamers, locomotive tenders, gas retorts or generators, coal hoppers, or other places where the coal or divisible material is to be dumped into a restricted space.

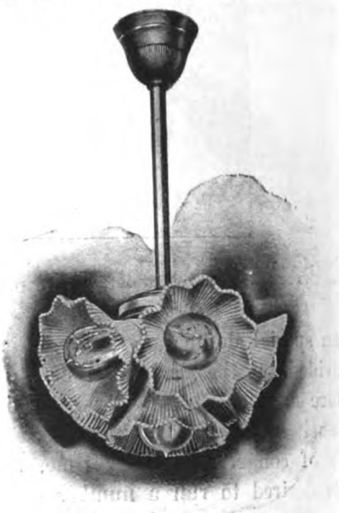
This apparatus is manufactured and installed by the United Telpherage Company, 20 Broad street, New York city.

Consolidation of Electric Light Companies in Milan.

At a meeting of the stockholders of the Società Fecnomasio Cabella, which was held at Milan, Italy, on October 4, 1903, it was decided to consolidate with the Società Italiana Brown, Boveri & Company, Milan, thus forming one large electric company in the city of Milan.

Wireless Cluster Incandescent Lamp Fixtures.

The accompanying illustration shows a six-light wireless cluster incandescent lamp fixture, manufactured by the Benjamin Electric Manufacturing Company, of Chicago, Ill. The cluster has five lamps in a circle, with one straight down at the end of the stem. The shades fit directly on the lamp and require no shade-



SIX-LIGHT CLUSTER INCANDESCENT LAMP FIXTURE.

holders, the effect being a hemisphere of light of ornamental appearance.

The Benjamin cluster is especially adapted for this class of work, the lamps being clustered closely together. The wireless feature, whereby only the stem wires are required, makes these clusters very desirable and the Benjamin company reports a heavy demand for this fixture.

It will be noted that this cluster is

DESK LIGHT EQUIPPED WITH HOLOPHANE GLOBE.

equipped with "Pagoda" shades, made by the Holophane Glass Company. These shades are very popular for all forms of lighting.

Another illustration shows a new desk light equipped with a Holophane globe. The New York office of the Benjamin Electric Manufacturing Company is at 27 Thames street, and V. R. Lansingh & Company is the Chicago sales agent of the Holophane Glass Company, at 18 East Adams street.

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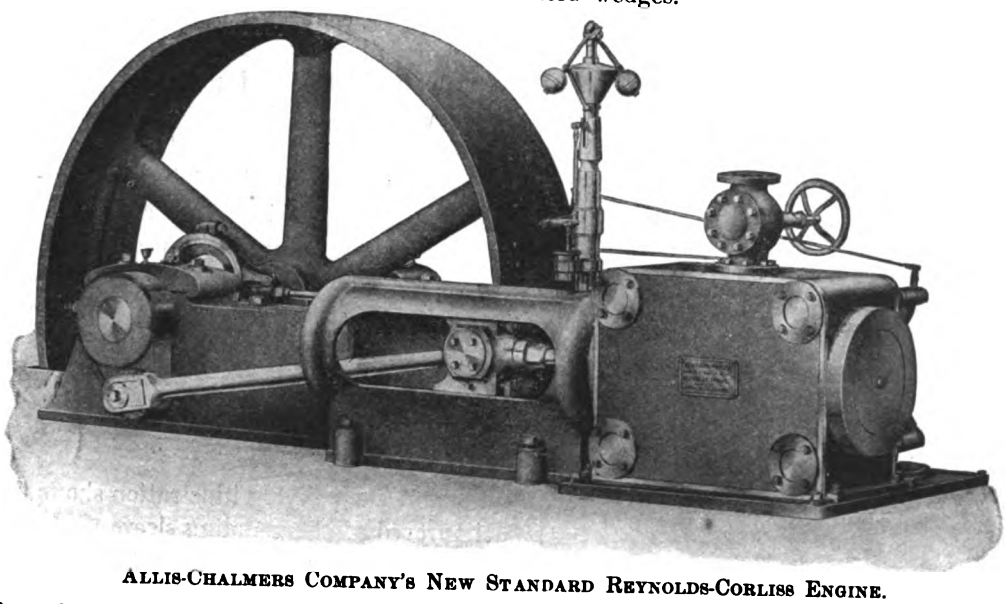
Allis-Chalmers Company's New Standard Reynolds-Corliss Engine.

The accompanying illustration shows a new Corliss engine which is being brought out by the Allis-Chalmers Company from the designs of Irving H. Reynolds.

Engines of the type illustrated are being built in seven sizes, ranging from 50 to 500 horse-power, and are designed for steam pressures up to 150 pounds. They are built of somewhat shorter strokes than have heretofore been customary in Corliss engines, with the idea of economizing in space and making the construction more rigid. The speeds are also somewhat higher than usual, ranging from 110 to 150 revolutions per minute, although these speeds are not higher than those at which the Reynolds-Corliss engines of older design are frequently operated.



ALLIS-CHALMERS COMPANY'S NEW STANDARD REYNOLDS-CORLISS ENGINE.

The frame is cast in one piece with the slide, the construction being of the box type, resting on the foundation for its entire length. The main bearing shells are bored into the frame, thus ensuring a solid bearing and also permitting the easy removal of the shells by rolling them out around the shaft.

The slide is of the barrel type with bored guides. The crosshead is fitted with babbitt-faced shoes with wedge adjustment. The piston rod is screwed into the crosshead and held firmly with a steel lock nut. The cylinder is of the round-cornered type, is fitted with double-ported steam and exhaust valves, lagged with planished steel. The cylinder is set on a cast-iron base-plate, which extends under the valve gear, serving as a drip pan.

The valve gear is of the usual Reynolds-Corliss type, the wrist plate being of skeleton pattern and fitted with a new type of disconnecting device which, while clamping the hook rod firmly, is very easily detached by hand.

The dashpots are of differential plunger type without leathers or packing of any kind.

The regulator is of the high-speed, weighted type, designed to control the engine within narrow limits of speed variation.

The connecting rod is of steel with solid forged ends, fitted with bronze boxes, babbitt lined on the crank-pin ends, the boxes being adjustable by means of screw actuated wedges.

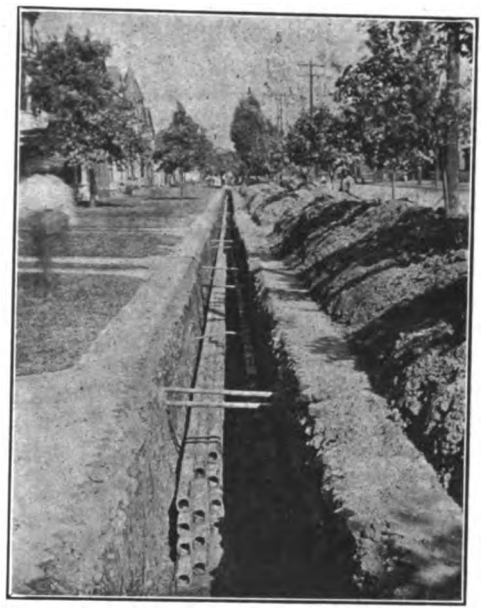
The crank is of plain type, polished on the face, and is protected by a planished steel oil guard.

The engines are fitted either with belt flywheels, as shown, or with square rim wheels where used with direct-connected electric generators. The crank and crosshead pins and main journals are of a size ordinarily used with heavy duty engines.

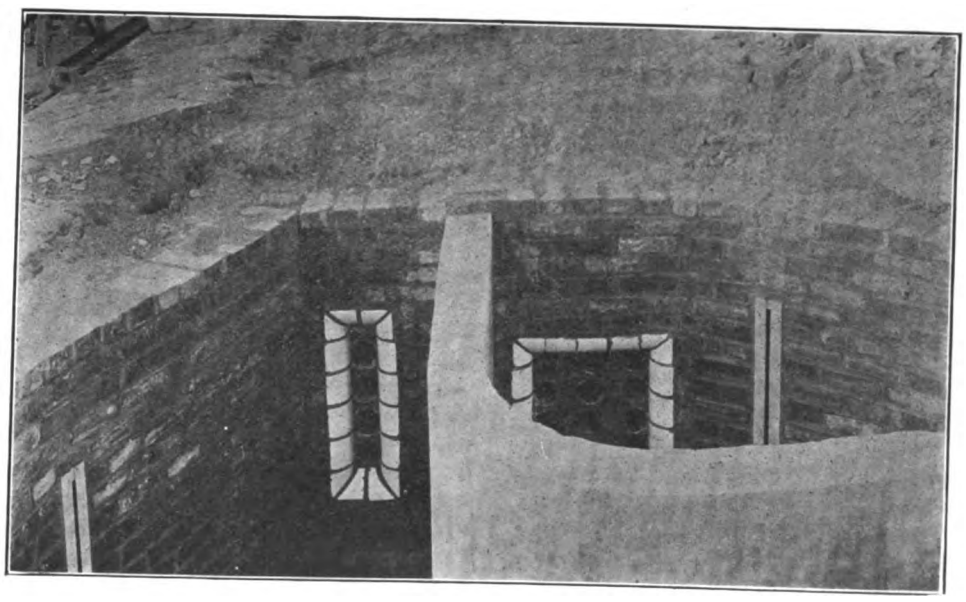
In brief, the engine is strong, simple and compact, and while nothing has been added for ornamentation, nothing contributing to economy or durability has been omitted, and the machine should find a large sale among power users who appreciate quality.

Conduit Systems.

An instance of modern conduit work is shown in the recently completed systems in Louisville, Ky., for the Louisville Street Railway, which was equipped for high or low tension, over 500,000 feet of duct being used. The system was equipped throughout with modern improvements, and the new Gest cable hanging rack and terminals were used. The contract for this system was given to G. M. Gest, New York city, N. Y., and was completed in ninety days from the time work was commenced.



UNCOVERED SECTION OF CONDUIT IN OPEN STREET.



CONDUIT TERMINAL, PARTITION AND CABLE-HANGER SLOTS.

Fig. 1 shows an uncovered section of the system running through one of the thoroughfares at Louisville, Ky. Fig. 2 shows a Gest terminal of the system. In relief is the concrete division wall which separates the two series of conduits, one running into a terminal duct and the other ready for continuation. To the right and left are the cable-hanging slots, a new improvement recently instituted by the contractor for this work.

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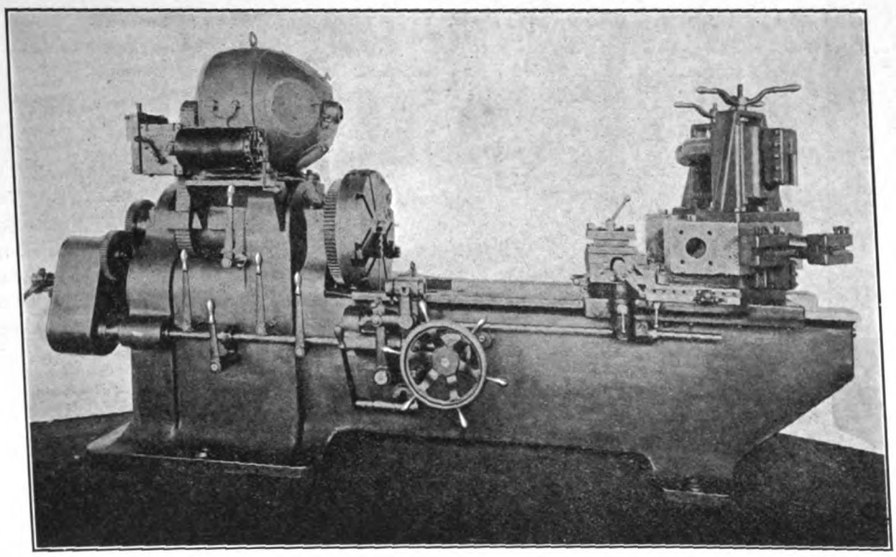
A Heavy Turret Lathe.

In the accompanying illustration is shown a Conradson twenty-four-inch semi-automatic turret lathe. This machine is manufactured by the American Turret Lathe Manufacturing Company, of Warren, Pa., and is intended for heavier work than is usually imposed upon a turret lathe. It has a massive bed construction, a large turret and is designed to swing twenty-seven inches for a distance of twelve inches from the chuck. Twelve rates of spindle speed and eight feeds of the turret are possible with each speed of the motor. The gear combinations for all of these are protected and may be operated and effect a change in speed while the machine is running. The levers for the various gear clutches are shown under the head. The turret has universal facing heads and provides thirteen tool positions, though sel-



HEAVY MOTOR-DRIVEN TURRET LATHE.

dom more than five are used at one time. An auxiliary turret which will accommodate four tools and has power cross-feeds is on one side of the main turret. The latter has rapid power traverse in either direction afforded by a separate motor, and a slower travel through the feeding mechanism driven from the spindle. Rotating, indexing and clamping of the turret head are all automatic, and an independent "knockout," or feed stop, serves each face.

The spindle is driven through a Renold silent chain by a ten-horse-power Crocker-Wheeler semi-enclosed motor mounted above the headstocks. An M-12 controller in the current supply allows the motor twelve speeds, ranging from 876 to 130 revolutions per minute. With the combination of electrical and mechanical means the highest and lowest possible chuck speeds are ninety and one and one-fifth revolutions per minute, respectively. For the operation of the turret a three-horse-power Crocker-Wheeler fully enclosed motor is used. This runs continuously at a constant speed of 1,100 revolutions per minute on a two-wire supply and drives a steep-pitch lead screw through bevel gearing. A longitudinal shifting of the driven shaft clutches one or the other of two bevel gears producing direct or reverse rotation, or in the central position releases both.

The New Worthington Plant.

An extensive pump manufacturing plant, the largest in this country and probably in the world, is now under construction at Harrison, N. J. It is to be occupied by the firm of Henry R. Worthington, which employs about 3,000 men in its present works at South Brooklyn, L. I., and Elizabethport, N. J. The new plant at Harrison will accommodate from 4,000 to 5,000 men and will cost in the neighborhood of two million dollars. It consists of a main machine shop with side galleries over 1,006 feet long, an erecting shop 592 feet long and of the same section as the machine shop, and a high erecting shop 210 feet in length and four galleries in height in the side bays connecting the two shops. The main foundry is 600 feet in length and there is also a special foundry for small work 410 feet in length, with a building 200 by 60 feet in size for cleaning castings connecting the two. The pattern building is four stories high and 550 feet long, and is divided by wire walls into four sections. The north section will be used for offices and drafting rooms; the adjoining section for the pattern shop, and the balance of the structure for pattern storage. The power-house, which will be equipped with the most modern boilers, engines and generators, is a building 172 by 102 feet. Electric power distribution is to be employed throughout, and the grounds will be illuminated by electric arc lights. There are many other buildings which will be used for packing, storing and shipping goods, etc. The buildings are so arranged that additions can be built when the work demands it. All will be connected by a complete system of railroad tracks entering the ends of the buildings and placing the works in direct communication with the Delaware, Lackawanna & Western, the Erie and the Pennsylvania Railroad systems. The new plant will be devoted entirely to the manufacture of waterworks machinery, water meters, cooling towers, condensers, feed-water heaters, centrifugal pumps and steam pumps of all kinds.

An Improved Solid Expanding Sleeve.

The accompanying illustration shows the improved solid expanding sleeve manufactured by James S. Barron & Company,

SOLID EXPANDING SLEEVE.

New York city, N. Y. It is used principally for fastening telephone backboards, etc., to brick, stone and cement. The sleeve is made of one piece, and is equally suitable for screws with either wood or machine threads. The company furnishes the sleeves with or without screws, as desired.

A Novel Use for a Refrigerating Machine.

In some electrical tests, where exact results are required, it is important that certain instruments, or baths, or chambers, be maintained at a constant temperature, and in other tests it is quite necessary that the air be comparatively dry. To secure these desirable conditions in its new laboratories at Eightieth street and East End avenue, the Lamp Testing Bureau has installed a refrigerating machine which will cool the air of one room to the temperature required and freeze the moisture from the air of another room when the humidity is higher than it should be for the best working conditions.

The company hopes to have its new laboratories ready for work about January 1, when it will abandon its present temporary quarters at 14 Jay street, New York city.

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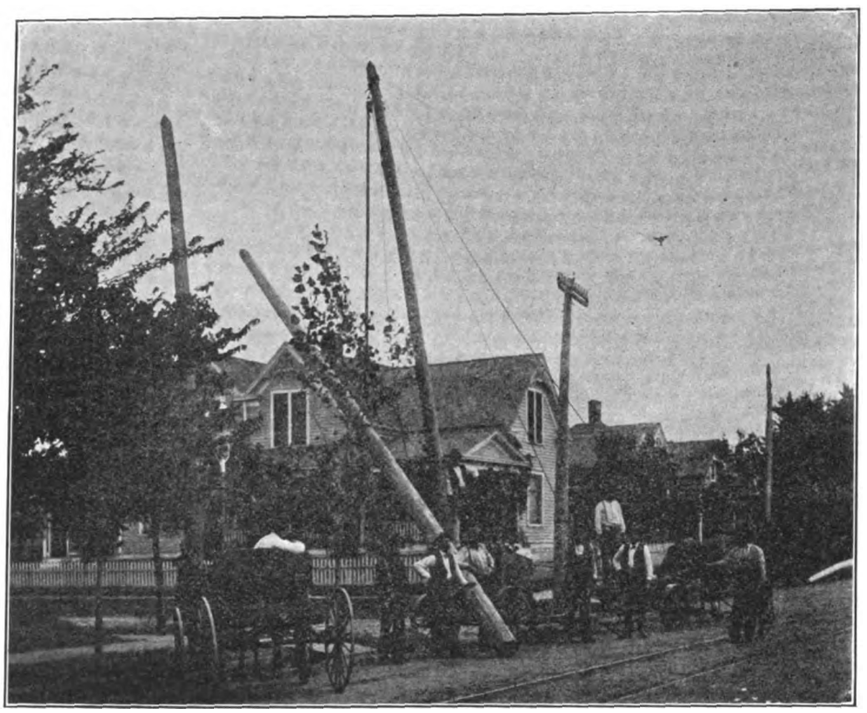
Rapidity in Telephone Line Construction.

There is under construction at Lincoln, Neb., a Strowger automatic telephone system, which is expected to be completed and in operation by January 1, 1904. The installation consists of twenty-five miles of underground conduit, seventy miles of pole lines, thirteen miles of aerial cable, eleven miles of underground cable, 700 miles of overhead wires, and the installation of 3,000 Strowger automatic telephones; more than 150 carloads of material being used in the work.

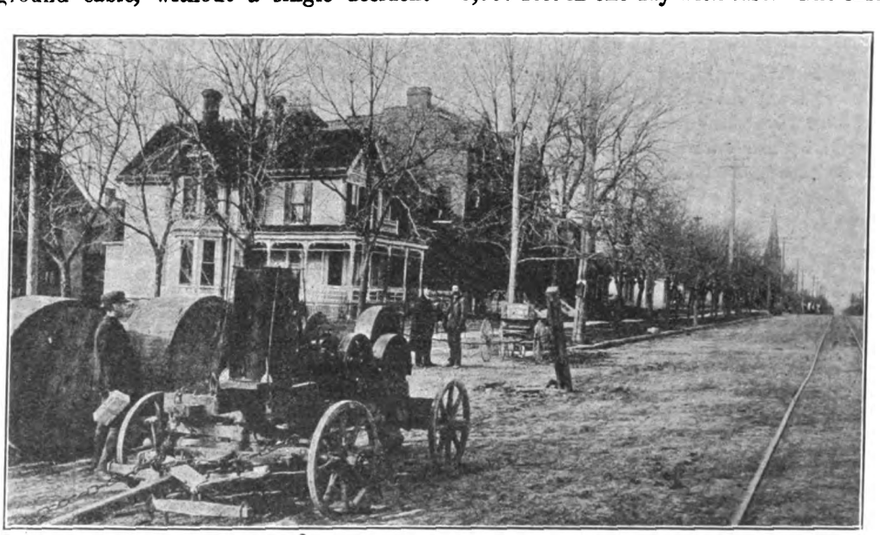


PORTABLE POLE-RAISING DERRICK.

The contract for this installation was let to the General Engineering Company, of Chicago, and it has been encouraged to use its utmost speed in the completion of this plant, by the offer of a large bonus for each day saved under the time limit allowed by the contract. How well it has carried out the wishes of the Lincoln Telephone Company in this regard will be best understood by stating that ninety per cent of the work is now completed and the time elapsed since the beginning of the work is ninety-two working days.

A number of labor and time-saving devices have been designed that have contributed largely to the results secured. Among them may be mentioned a portable pole-raising derrick, which has a record of setting 102 poles, ranging from forty to fifty feet, in eight and one-half hours, with six men and one driver.

One of their devices which will at once attract the attention of practical telephone men is a portable power wince for drawing underground cable through their ducts. An illustration of this device is shown, the photograph having been taken just as a 450-foot pull of a 250-pair cable was being started. The fact that the machine here illustrated, though hastily constructed from plans prepared by the General Engineering Company, has pulled to date 50,000 feet of heavy underground cable, without a single accident and without a cent of repairs on the machine itself, would seem to warrant the most conservative telephone engineer in giving this device his careful consideration.



PORTABLE CABLE-PULLING APPARATUS.

A satisfactory machine for this service must be portable, self-containing, durable and of ample power, and the first cost and maintenance must not be excessive. The record this machine has made in Lincoln, together with the view here shown of it, seems to indicate that all of these conditions have been fulfilled. The weight complete, with water and gasoline tanks full, is less than 2,600 pounds. A single team handles it easily, and on paved streets it may be moved from manhole to manhole by four men. A gasoline engine is employed, and in this particular case the ignition spark is furnished by dry batteries, though the company recommends a regular sparking dynamo for the purpose. The engine develops six brake horse-power at 600 revolutions per minute, which is the normal speed. This is geared down to a cable speed at the drum of thirty feet per minute.

Considerable attention has been given to the friction clutch, which operates the hoisting drum, and to the strap brake. The arrangement is such that the friction clutch throws itself out, unless constantly held in position by an attendant. A very slight motion of the hand, requiring no appreciable strength, disengages the clutch, and the drum instantly ceases to revolve. This clutch enables the load to be picked up slowly and the speed gradually increased to the maximum, avoiding all undue strains on engine, hoist or cable.

The gears, shafting and bed-plate are extra heavy and all gears are protected. The consumption of gasoline is about two gallons per day, and this, with the addition of a little lubricating oil and the time of one attendant, represents the entire expense of operation.

A pull of 450 feet of 250-pair cable is made regularly in twenty minutes, and a crew of six men and one team has pulled 5,000 feet in one day with ease. The cable speed can, of course, be increased, but it is doubtful if it is safe to pull faster than thirty feet per minute. The hauling cable is of three-quarter-inch crucible steel rope, six-strand and hemp centre, nineteen wires to the strand.

In addition to its use as a cable-pulling machine, the General Engineering Company finds its gasoline engine a convenient tool for operating a concrete mixer, and for other applications about its plant.

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CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

NEW ELECTRICAL BUILDING FOR NEWARK, N. J.—Plans and specifications have been prepared for a new thirteen-story building to be erected in Park Place, Newark, N. J., by the Public Service Corporation of New Jersey, and the contract will be awarded at an early date. The structure will be completed in about a year, and will cost more than $1,000,000. The building will be occupied entirely by the various departments of the corporation.

RAPID PRINTING TELEGRAPH—It is announced that .Wilhelm von Siemens, of Siemens & Halske Company, Berlin, exhibited on November 26, before an audience of postal and telegraph experts, a new telegraphic apparatus on which he and Dr. Franke, Dr. Thomas and Dr. Ehrhardt have been working for several years. Perforated ribbon paper is used in the apparatus, and the experiment showed that 2,000 words a minute could be sent over long distances. The message is received on a strip of sensitized paper, which emerges with the letters fully developed.

WANTS $500,000 DAMAGES—An action to compel the payment of damages said to approximate $500,000 has been brought by the Hudson River Water Power Company against the United Traction Company, of Albany. The plaintiff company supplies the defendant with power for the operation of its roads in Albany and Troy, and it is alleged was unable to secure payment for power supplied when due. After repeated demands the power company threatened to cut off the power at once. The traction company was then compelled to make a new contract at a much higher rate, calling for an extra expenditure of $150,000. Now the power company sues for damages, yet to be computed, for the breaking of the original contract.

BIG DAMAGES TO ALUMINUM COMPANY—Last month the United States Court of Appeals in New York rendered a decision in favor of the Cowles Electric Smelting and Aluminum Company, of Cleveland, against the Pittsburg Reduction Company, of Niagara Falls, N. Y., for infringements of patents since 1892. The decision involved $2,900,000. The Pittsburg Reduction Company has made a compromise settlement by the payment of a large sum of money. The payment covers the damages of infringement for ten years and also royalties for the manufacture of pure aluminum under a special license granted by the Cowles company. This means that the Pittsburg Reduction Company will continue the operation of its extensive aluminum plant at Niagara Falls, and the Cowles plant at Lockport will make alloys.

CHICAGO MUNICIPAL LIGHT—Mayor Harrison, of Chicago, Ill., has declared that the city would enter the electric lighting field at once in competition with the gas and electric companies. The attempt to enter the field by selling to corporations and private individuals electric current made in the municipal plants, it is expected, will result in an appeal to the courts by the big lighting corporations. This, Mayor Harrison declares, is what the city would invite, as it will determine its right to deal in public necessities. "It is just as well to meet this matter at once," said Mayor Harrison. "The earlier we enter the field the earlier we will be prepared to take advantage of the development of the power at the mouth of the great drainage channel connecting the waters of Lake Michigan and the Mississippi river."

REDUCES STREET CAR FARES—Directors of the Philadelphia Rapid Transit Company are seriously considering an entirely new feature in the present fare system—namely, the sale of tickets either six for twenty-five cents or twenty-five for $1. The tickets, it is said, will be put on sale early next year. By selling tickets either six for twenty-five cents or twenty-five for $1, it is said the company will gain the free use of several millions of dollars every year, and just at this time, when many millions are needed for constructing the Market street subway and elevated road, this money would be doubly welcome. The company is carrying daily approximately 1,000,000 passengers. Directors of the company are favorably impressed with the ticket idea, and they figure that fully $1,000,000 worth of tickets will be sold every month.

LIGHTING AND TRACTION COMBINE—The stockholders of the Utah Light and Power Company and the Consolidated Railway and Power Company will meet December 15 and 16 to decide whether or not the two companies will consolidate. If the consolidation is decided upon it will be effected by January 1. It is believed that the new corporation will be capitalized for about $7,000,000 or more. The authorized capital stock of the power company is $3,500,000 and the issued stock is a little over $3,000,000, with the bond issue about the same. The railway company is similarly bonded and capitalized. It is probable that a new company will be organized with a capital at least as large as the two combined, taking over the other two organizations. A new bond issue may then be put out, secured by a blanket mortgage on all the assets of the consolidated company. It is quite likely that provision will be made for some improvements and that from $200,000 to $300,000 will be spent annually in improvements by the new company. Bonds will probably be issued to cover the cost.

NEW TUNNEL FRANCHISE GRANTED—The Board of Rapid Transit Railroad Commissioners of the city of New York has granted a franchise to the Hudson & Manhattan Railroad Company to run a tunnel under the North river, from Exchange place, Jersey City, to Cortlandt street, Manhattan. The tunnel, which will enter New York city at Cortlandt street, will run to Church street and then form a loop running back through Fulton street to the point where the tunnel enters Manhattan. There will be a spur from the station in Church street, and this spur will connect at Broadway and Dey street with the lower Broadway spur of the rapid transit subway. The franchise gives the company a twenty-five-year grant, with the privilege of two renewals, one at ten and the other at fifteen years, with varying rates of compensation to the city, equivalent to three per cent of the capital invested and of the estimated earnings of the company. Mr. William G. McAdoo is president of the company. Mr. McAdoo is also president of the New York & New Jersey Railroad Company, which has received a franchise to run a tunnel under the North river, entering Manhattan at the foot of Christopher street.

THE CHELSEA, LONDON, ENGLAND, POWER STATION—The electrical and steam equipment for the huge power station now under construction at Chelsea, London, S. W., for the purpose of generating current to operate the extensive system of underground and surface lines in and around the British metropolis, in which Charles T. Yerkes is primarily interested, has been announced. The initial capacity will be no less than 75,000 horsepower. There will be ten turbines of 7,500-horse-power capacity each. The generators will have a normal rating of 5,500 kilowatts. The boiler equipment will be of Babcock & Wilcox build. There will be eighty-four units of 520-horse-power capacity each. The cost of the power-house will be about $6,250,000. The motors—for each of the 480 cars to be used on all the lines—will aggregate 500 horse-power. The cars will be built in England. The Underground Electric Railways Company, of London, Limited, has been incorporated under the British Limited Liabilities Act for the purpose of constructing and operating the lines. Charles T. Yerkes is chairman of the company. The other American directors are James A. Blair, of the Wall street banking house of Blair & Company; James Speyer, of Speyer & Company; L. F. Loree, president of the Baltimore & Ohio Railroad; T. Jefferson Coolidge, Jr., president of the Old Colony Trust Company, of Boston; James H. Hyde, of the Equitable Life Assurance Society of New York, and Robert H. McCurdy, of the Mutual Life Insurance Company of New York. To convert the Metropolitan District Railway from steam to electricity and to construct and take over the various other lines in and around London in which the Underground company is interested no less a sum than $85,000,000 will be expended, half of which will be American capital.

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PERSONAL MENTION.

LORD KELVIN received the degree of D. Sc. from the University of Wales on the occasion of the Court of November 13, 1903.

MR. J. J. LOWTHIAN, representative of Baker & Company, gold, silver and platinum refiners, was a visitor to Chicago last week.

DR. HENRY S. PRITCHETT, president of the Massachusetts Institute of Technology, has resumed his official duties after a brief foreign trip.

MR. HOWARD S. KNOWLTON, formerly with Stone & Webster, Boston, Mass., has joined the engineering department of the Colorado Telephone Company, at Denver, Col.

MR. W. W. BOSTWICK, JR., formerly with the Lambert Schmidt Telephone Manufacturing Company, has been appointed New York manager for the Couch & Seeley Company, of Boston, Mass.

MR. R. A. DARLING, instructor in mechanical engineering at the University of Nevada, has been granted a year's leave of absence in order to take up advanced work at the Leland Stanford, Jr., University.

MR. CYRUS O. BAKER, JR., the platinum importer and refiner, who possesses a very large circle of friends in the electrical fraternity, is again at his office in New York city after a severe illness of several weeks.

MR. WALTER M. SMITH, junior engineer in the United States Engineering Office, Portland, Me., has been transferred to the United States Engineer's Office at Charleston, S. C., where he was to report for duty December 1.

MR. ROBERT McF. DOBLE, consulting engineer, has returned to San Francisco, Cal., after an absence of several months in Mexico, having completed the installation of the hydroelectric power plant of the Guanajuato Power and Electric Company.

MR. A. W. HUTCHINS, president of the Ballou-Hutchins Electric Company, Providence, R. I., manufacturers of automatic time switches, was a New York visitor last week. The demand for the new product of this company is meeting with much favor in electric lighting circles.

PROFESSOR S. HOMER WOODBRIDGE, formerly associated with Stone & Webster, electrical engineers, in the S. Homer Woodbridge Company, has severed his connection with the company, and is now associated with Mr. Andrew D. Fuller, consulting sanitary engineer, Boston, Mass.

MR. LAMAR LYNDON, on Tuesday evening, December 1, delivered his second lecture on "The Storage Battery; Its Practical Operation, Deterioration and Management," at the Automobile Club of America, 753 Fifth avenue, New York city. This was illustrated with lantern slides and experimental demonstrations.

MR. HENRY L. SHIPPY, treasurer of the John A. Roebling's Sons Company, of New York, has been confined to his room for several weeks past with a severe illness and was threatened with an attack of appendicitis. His host of friends in this country and abroad will be very glad to learn that he is now convalescent and soon expects to be at his office again.

MR. GEORGE E. BERNECKER, manager of the exchange of the Cumberland Telephone Company, Jeffersonville, Ind., on December 1 took charge of the exchange in New Albany, Ind., and will hereafter manage both exchanges. Mr. Horace Gooch, who has been manager of the New Albany exchange, will go to Texas, where he will be in charge of an independent telephone system.

MR. CHARLES V. WESTON, of Chicago, has severed his connection with the Chicago Engineering and Construction Company, of which he was president. His duties as chief engineer of the South Side Elevated Railroad Company, which is about to build extensions, naturally calls for much of his time along with other consulting practice which he enjoys.

MR. THOMAS L. MILLER, M. I. C. E., of Manchester, England, has arranged with Mr. C. H. Wordingham, M. I. C. E., of the same place, to take over his consulting electrical engineering practice, as Mr. Wordingham has been appointed to the post of electrical engineer-in-chief of the English Navy. Mr. Miller will continue Mr. Wordingham's practice from 190 Brazennose street, Manchester, Tower Building, North Water street, Liverpool, and at 61 Old Broad street, London, E. C., under the name of Miller & Collins. In order to cope with the great amount of work, Mr. Miller has arranged to take into partnership Mr. H. W. Wilson, who has been engineer to the Lancaster branch of the British Thomson-Houston Company, Limited.

MR. CHARLES T. YERKES, the head of the syndicate which is equipping London, England, with a series of surface and underground electric lines, arrived last week from London, where he has been for some time promoting the interests of his company. The Metropolitan District Railway is being converted from steam to electricity, and the Baker Street & Waterloo Railway, which was acquired from the London & Globe Finance Company, is being extended at both ends. The Great Northern, Brompton & Piccadilly Railway has been acquired, and plans are under way to control the Charing Cross, Euston & Hampton Railway. The underground lines will also include the London United Tramways. It is stated that the syndicate is spending some $85,000,000 in its operations, and that about $40,000,000 of this is American capital. The greater part of the work is expected to be finished by April of next year.

ELECTRIC LIGHTING.

DETROIT, MICH.—Wingham has voted $20,000 to buy the electric light plant.

CAZENOVIA, N. Y.—The electric light wires in Cazenovia are being laid underground.

DOYLESTOWN, PA.—It is stated that Schuylkill Haven's electric light plant will probably be enlarged.

SIOUX CITY, IOWA—At a recent election the Eagle Grove people voted a franchise to the Eagle Grove Electric Light and Heating Company.

BOSTON, MASS.—Foundations are being put in for a $40,000 electric light plant to be built at Mansfield. The contracts for the work have been given to a Providence firm of builders.

WORCESTER, MASS.—The directors of the Ware Electric Company have decided to increase the capacity of the plant at an outlay of from $20,000 to $30,000. A new building will be erected, fifty by eighty-two feet, and practically fireproof.

MEYERSDALE, PA.—At a meeting of the borough council a resolution was adopted, authorizing the light committee to draw up plans and specifications and advertise for bids for a suitable electric light plant, to be owned and operated by the borough.

VERSAILLES, MO.—The election held here for the purpose of voting on a proposition to issue bonds to the amount of $10,000 for the purpose of erecting an electric light plant resulted in favor of bonding the city for that amount. Work will be begun on the plant at once.

GREENFIELD, MASS.—Work on the power-house for the Electric Light and Power Company has commenced. The building will be of stone, 150 by 60 feet. There are to be three boilers, furnishing altogether 750 horse-power, and two engines, one of 300 and one of 500 horse-power.

READING, PA.—It is reported on good authority that 100 representative men, each paying $250, are about to form an organization to supply the borough with an electric light plant, with a prospect, however, that the borough will become the purchaser of the plant after such time when the funded debt of the borough is reduced sufficiently.

BEDFORD, MASS.—The special committee appointed at the November town meeting to investigate the subject of electric street lighting made its report at the adjourned meeting and recommended that electric lights be substituted for the present system of street lighting by oil lamps. Without discussion it was voted unanimously to authorize the board of selectmen to contract for electric lights for the three miles of streets within the village limits. Current will be furnished by the Lexington Electric Light Company, which will extend its system to this place. Work upon the new line will be begun at once. This company will also furnish current for commercial lighting, and many of the village residents will use electricity for lighting their residences and places of business.

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TELEPHONE AND TELEGRAPH.

BRIDGETON, PA.—The Interstate Telephone Company has placed its new system in operation.

WEST UNION, IOWA—The Iowa Telephone Company will build another line west from West Union.

PHILADELPHIA, PA.—The Standard Telephone Company will extend its line from Doylestown to Lansdale.

MONTGOMERY, ALA.—The American Telephone and Telegraph Company has filed articles of incorporation with a capital of $100,000.

WATERLOO, IOWA—The Cedar Valley Telephone Company plans to rebuild its local exchange, installing either a central energy or an automatic system.

BOONE, IOWA—A large telephone merger has been completed by the purchase of the Ogden Telephone Company's system at Ogden by the Boone County Telephone Company.

CINCINNATI, OHIO—The local Bell telephone company's name has been changed from the City & Suburban Telegraph Association to the Cincinnati & Suburban Telephone Company.

ST. PAUL, MINN.—Red River Telephone Company, of Moorhead, has been incorporated with a capital of $50,000. The incorporators are P. H. Lamb, L. H. Baker and Leslie Wetter, all of Moorhead.

YORK, PA.—The Codorus Telephone Company has been organized to build a line from Spring Grove to Sticks. Eli Sterner has been elected president; J. C. Brodbeck, secretary, and S. B. Brodbeck, treasurer of the company.

POUGHKEEPSIE, N. Y.—The State Line Telephone Company has increased its capitalization from $1,000,000 to $10,000,000. The Dutchess County Telephone Company is affiliated with this company, and the local line will be placed all over Dutchess County.

BUFFALO, N. Y.—The certificate of incorporation of the Eden Telephone Company has been filed in the office of the county clerk. The company is capitalized at $3,000. The directors are Duran and Byrena Palmerton, G. C. and M. A. Bartoo, and others. The company purposes to connect Eden, North Collins, Hamburg and other places with Buffalo and each other by telephone.

OAKVILLE, IOWA—The Oakville Telephone Exchange Company has completed the work of changing and operating in its new office. It will start out with nearly four hundred subscribers, which will be added to as soon as it can place the telephones. The new company consists of E. B. Conkling, president; F. C. Edwards, vice-president; S. R. Gawthrop, secretary and general manager, and J. C. Thomson, treasurer.

BAY CITY, MICH.—The Northeastern Telegraph and Telephone Company has completed its new telephone lines along the northern division of the Michigan Central to beyond Gaylord, having nearly reached Wolverine. Three metallic circuits are being constructed, although only two will be carried as far as Mackinaw City. The company has three circuits to Tawas and two through to Alpena. The Bay City-Mackinac lines branch off at Standish.

SIOUX CITY, IOWA—Sioux City's new telephone company, the Sioux City Telephone Company, has announced that it will spend $350,000 to establish its plant here. Its exchange building will be a three-story fireproof structure; its equipment will be of the latest type. The poles will be set this winter, and wires and cables will be strung before spring. The underground work will not be started until April, when all the wires which the company will have between Third and Seventh streets will be placed underground. Already almost 1,000 subscribers for two years have been secured.

TROY, N. Y.—The Port Henry Telephone Company has been organized with a capital of $15,000, $6,000 of which has already been subscribed. The following officers have been elected: president, John R. Sherman; vice-president, Nestor Berman; secretary, S. F. Lane; treasurer, P. C. Kelley; directors, L. F. Sprague, H. F. Greene, George S. Kidder, Michael Moore and Aaron H. Weston. Work on the line will be begun at once. The new line will connect with Willsboro and through independent lines to Albany. A cable will be laid across the lake, giving connections with Addison County, in Vermont. It is expected that connection with Plattsburgh will be made after the independent company in that city begins to operate.

ALTOONA, PA.—It has been announced at the offices of the Pennsylvania Railroad Company here that work on the new trunk telephone line between Philadelphia and Pittsburg will begin immediately. Two lines will be constructed, for the exclusive use of the officials of the company and other employés. They will supplant a through wire leased from the Bell Telephone Company. The estimated cost is $75,000, exclusive of the poles. The wires will be strung on the new poles recently erected for the Postal Telegraph Company by the Pennsylvania. They will be of the heaviest copper, and it is said that the line will be the most expensive ever built. The Pennsylvania will maintain its own telephone wires between division points. Telephones are said to be a much cheaper method of transmitting certain messages than the telegraph, requiring fewer messages.

PORT JEFFERSON, L. I.—The North Shore Telephone Company, with a capital of $7,500, has been organized with the following directors: Frank H. Tuthill, of Rocky Point; W. A. Davis, of Mount Sinai; Postmaster C. A. Squires, of Echo; J. H. Davis, H. T. Bayles, John E. Overton, Charles V. Platt and Ralph J. Hawkins, of Port Jefferson, and Thomas N. Bayles, of Stony Brook. It is proposed to run a local line from Smithtown to Wading River, with a central at Port Jefferson, and give an unlimited service to all subscribers, except business places, at $10 a year. Business places will be charged $15. The new company anticipates starting with 200 connections, and is already securing contracts for service. The company is not yet incorporated, nor has it secured a franchise, but it has good assurance that these matters will go through all right. The new company will give an all-night service and put telephones in all public places where it will be of any advantage to the subscribers.

ELECTRIC RAILWAYS.

WATERLOO, IOWA—It is said that Des Moines parties, representing Cincinnati capitalists, have in view an electric railway running from Britt through Crystal Lake, Buffalo Center, Elmore, and terminating at Fairmont, Minn.

WILLIAMSPORT, PA.—It is proposed to connect Wellsboro, Tioga County, Pa., with Elmira, N. Y., by trolley. The proposed road will be about fifty-five miles long, and it is estimated will cost from $15,000 to $30,000 a mile. It is also proposed to build a spur connecting Covington and Blossburg with Tioga.

MANSFIELD, OHIO—The Mansfield & Eastern Traction Company, projecting a trolley line between this city and Ashland, has elected the following officers: president, David Morison, Cleveland; vice-president, Robert B. McCrory; general manager, Charles Meiley; secretary, James W. Galbraith; treasurer, James W. Maguire. All of the officers but the president are residents of this city.

ALBANY, N. Y.—The Court of Appeals has sustained the action of the State Board of Railroad Commissioners in granting permission to the New York & Port Chester Railroad Company to construct a third-rail electric road twenty-one miles long from Willis avenue and One Hundred and Thirty-second street, through Fordham, Williamsbridge, Mount Vernon and New Rochelle to Port Chester.

COLUMBUS, OHIO—The Barnesville & Woodsfield Electric Railway Company has been incorporated by George E. Hilles, E. T. Petty, J. W. Chappell, T. J. Buchanan, J. W. Laughlin and W. E. Sharps. Capital stock, $25,000. It will build an electric railway from Bethesda, in Belmont County, to Woodsfield, Monroe County, Somerton, Malaga and Miltonsburg, and will supply heat, light and power to those towns.

FREDERICK, MD.—The county commissioners have passed an order granting to the Meyersville & Catoctin Railway Company, the right to construct a railway across county roads at certain points at and above Meyersville. This privilege was asked by the company, with a view to the construction of a link connecting the

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electric railways in this and Washington counties. It is granted upon certain conditions respecting the maintenance of safe and easy crossings.

FAYETTEVILLE, W. VA.—The electric railroad up Loop creek is said to be assured, the contract for the building of the first five miles of the new line having been let. Work at Thurmond will be begun at once. The rest of the line through to Kilsythe, a distance of about twelve miles, from Thurmond will be let to contract also within a short time. The new road will be standard gauge and will be both a passenger and freight line. The part let to contract is from Glen Jean to Thurmond.

FREEPORT, ILL.—The Freeport-Dixon Electric Railroad Company has been granted a charter by the secretary of state, the capital stock of the company being given as $50,000. The company will construct a road from Freeport to South Freeport, to connect with the Great Western Railroad, and from there it will extend to Forreston and Polo, in Ogle County, and thence to Dixon, in Lee County. All preliminary work will be done this fall, and active construction will commence early in the spring.

WAPAKONETA, OHIO—The Sandusky Southwestern Railway Company, of this city, has filed a deed of trust with the company recorder to the Cleveland Trust Company, for the sum of $2,000,000, covering all its rights of way, franchises, real estate and property in Auglaize, Allen, Logan and Hardin counties. This mortgage is given to secure a bond issue of $1,000 bonds, payable twenty years from November 1, 1903, with five per cent interest. The road, as planned, is seventy miles in length, extending from this city to Kepton, and from Lima to Bellefontaine.

PIERRE, S. D.—Articles of incorporation have been filed with the secretary of state for the Black Hills & Wyoming Railway Company, with headquarters at Rapid City and a capital of $700,000. The line is to be thirty-five miles in length, and will connect with the Elkhorn Road at Rapid City, and the Burlington & Missouri River at Mystic, and will be all in Pennington County. The directors of the road are Charles D. Crouch, Francis Sieberling, Frank A. Sieberling and Fred E. Smith, of Akron, Ohio; E. F. Hurlburt and Jacob S. Gantz, of Rapid City.

YORKTOWN, VA.—The extension of the lines of the Newport News Railway and Electric Company to Yorktown is about to be made. A survey of the projected route has been completed. The idea of the company is to cross the eastern end of the peninsula, bridge Back river near its upper end, and gain access into York County, through Poquoson, thereby tapping the richest section of Tidewater, and affording transportation facilities to a country entirely devoid of anything of the kind. Both mail and express matter will be afforded much better schedules, and as the resources develop, the road will be pushed through Gloucester County to West Point, gaining the rich trade of the tier of counties lying between the York and Rappahannock.

PROVIDENCE, R. I.—The Westerly & Hopkinton Street Railway has secured a controlling interest in the Pawcatuck Valley Street Railway Company. The following board of directors has been elected by the new owners: Frank P. Sheldon, of Providence; J. O. Sweet, of Jewett City, Ct.; F. G. Jillson, of Woonsocket; Nathan D. Lewis, of West Kensington; George W. Mansfield, of Boston, and William Hoxsey and John Champlin, of Westerly. These directors have elected the following officers: president, William Hoxsey; vice-president, Frank P. Sheldon; secretary and treasurer, J. O. Sweet. The same company is said to be also negotiating for the controlling interest in the Westerly Gas and Electric Light Company. The company has opened an office in Westerly, and the management expects to build the road through from Westerly to Hopkinton.

INDIANAPOLIS, IND.—Articles of incorporation have been filed for the Indianapolis, Newcastle & Winchester Traction Company, with a capital stock of $100,000, divided into shares of $100 each. The officers of the new company are: president, Benjamin Koons, of Mooreland; vice-president, E. L. Watson, of Winchester; secretary, Charles S. Hernley, of Newcastle; treasurer, Daniel E. Storms, of La Fayette. The directors and incorporators are composed of these officers and D. S. Wiggins and J. T. Burrows, of Losantville; Union B. Hunt, of Winchester; A. N. Fisher, of this city; Robert G. Hunt, of Modoc. The work of surveying the line has already begun, under charge of A. N. Fisher, who will also have charge of obtaining right of way. The survey has begun through Brightwood, and it is announced that it will be pushed rapidly. A part of the right of way has been obtained. The line for the road as at present planned will be about seventy-five miles in length, leading from this city to Winchester, Ind., by way of Newcastle. Among other towns that it is planned to pass through are: Modoc, Cadiz, Kennard, Shirley, Wilkinson, Wilcox, Maxwell, Mount Comfort and Mohawk. In addition to the traction business it is proposed to furnish these towns with light and power. The principal place of business of the company will be at Newcastle.

ELECTRICAL SECURITIES.

Probably the most encouraging feature of last week in financial quarters was the improvement in the money market outlook. Notwithstanding this improvement, rates have held firm, with nine per cent the highest for call funds, and five and one-half and six per cent for time loans. It is prophesied that no further large drains for funds will be made upon New York for the interior. The banks gained in exchange to an amount estimated at from $1,200,000 to $1,500,000. This, following last week's gain from the same source, is accepted as an indication that the demand is practically over.

It is reported that there is a better activity in pig iron as well as in finished iron products. The concession in rates by the railroads on export business has stimulated that industry, and it is announced that the management of the steel corporation has already made large foreign contracts and expects to make even more, to offset the decreased home consumption.

It is predicted that there will be an early breaking away of the railroad list from the adverse influence of the industrials. This sentiment has been strengthened by last week's readjustment in the value of the latter securities, and the small effect this had on prices for rails. Several of the largest railroad companies have but recently made splendid annual reports and show that, notwithstanding the settling down of trade for the past six months, they have been carrying a profitable traffic; and there is every indication that this condition will continue.

ELECTRICAL SECURITIES FOR THE WEEK ENDING NOVEMBER 28.

New York:	*Closing.*
Brooklyn Rapid Transit	39¾
Consolidated Gas	178
General Electric	154½
Kings County Electric	175
Manhattan Elevated	139¼
Metropolitan Street Railway	116⅝
New York & New Jersey Telephone	145
Westinghouse Manufacturing Company	170

The Kings County Electric Company is paying its regular quarterly dividend of 2 per cent.

Boston:	*Closing.*
American Telephone and Telegraph	125
Edison Electric Illuminating	240
Massachusetts Electric	76
New England Telephone	120
Western Telephone and Telegraph preferred	80
Philadelphia:	*Closing.*
Electric Company of America	7⅜
Electric Storage Battery common	46
Electric Storage Battery preferred	46
Philadelphia Electric	5⅞
Union Traction	43⅞
United Gas Improvement	78¼
Chicago:	*Closing.*
Chicago Telephone	124
Chicago Edison	142
Metropolitan Elevated preferred	51
National Carbon common	17½
National Carbon preferred	86¼
Union Traction common	5
Union Traction preferred	29

The report of the Northwestern Elevated Railroad Company for the year ended June 30, 1903, shows gross earnings of $1,642,456, and expenses of $517,441, leaving net earnings of $1,125,015. Charges, taxes, etc., amounted to $941,605, thus leaving a surplus of $183,410, as compared with a surplus of $151,631 the previous year, an increase of $31,779.

South Side Elevated directors have declared the regular quarterly dividend of one per cent, payable December 31. Books close December 19 and reopen January 2.

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INDUSTRIAL ITEMS.

THE UNION SWITCH AND SIGNAL COMPANY, Swissvale, Pa., has ready for distribution its catalogue, illustrative and descriptive of interlocking and signaling devices, which will be sent on request.

THE BALL & WOOD COMPANY, builder of improved automatic cutoff engines, has opened a Chicago office at 1247 Marquette Building. The New York office of the company is 17 Battery place, New York city.

THE BENBOW COMPANY, New York city, N. Y., is sending out descriptive circulars showing the application of the "Benbow adjustable swinging telephone bracket," which it manufactures. These circulars will be sent on request.

ALEXANDER WRIGHT & COMPANY, Westminster, England, will send on request a descriptive circular detailing the construction and use of the Simmance-Abady patent "Flicker" photometer. This is a novel and efficient apparatus for testing the illuminating power of gas, electric or oil lights of any color or intensity.

THE CENTRAL ELECTRIC COMPANY, Chicago, Ill., reports that during the past few weeks it has done an exceptionally good business in Nernst lamps and Westinghouse wattmeters. The company is carrying a large and complete stock of both of these lines, and is in position to make immediate shipment on orders.

THE ELECTRIC VEHICLE EQUIPMENT COMPANY, Philadelphia, Pa., announces that on November 30 it will discontinue its garage at 210 North Broad street, Philadelphia, and devote its entire attention to the manufacture of commercial vehicles and tractor trucks at its factory, Twentieth street and Montgomery avenue.

THE AMERICAN CONDUIT MANUFACTURING COMPANY, 413 Grant street, Pittsburg, Pa., announces a new price list and table of discounts on "American" iron-armored conduit. The main office has been moved from New Kensington to Pittsburg, Pa., and improvements have been completed at the factory at New Kensington.

THE WIRT MANUFACTURING COMPANY, Philadelphia, Pa., is sending out several descriptive bulletins which illustrate dynamo field rheostats, battery charging apparatus, and the Wirt dynamo brush. A novel souvenir which the Wirt company is distributing to its patrons is called the "Sensitive Fish." This is a unique article and affords much amusement.

THE A. L. DYKE AUTOMOBILE SUPPLY COMPANY, St. Louis, Mo., announces that it has completed arrangements to expand its business, by acquiring new capital and employing several salesmen to cover new territory. Several St. Louis men are now associated with Mr. Dyke, the president of the company. These are Messrs. F. H. Britton, Roy F. Britton and Charles Peters, who will become directors of the new company.

THE F. BISSELL COMPANY, Toledo, Ohio, is distributing its perpetual catalogue descriptive of motor starters and controllers. This perpetual catalogue is arranged for binding into those sheets which have already been distributed to be supplemented by future editions. This catalogue lists a very extensive line of electrical apparatus and should be in the hands of any one interested in this class of machinery.

THE EWING-MERKLE ELECTRIC COMPANY, St. Louis, Mo., will carry a full line of the new "Imperial" lamps made by the Bryan-Marsh Company. The Ewing-Merkle company is preparing a booklet giving full particulars of this new lamp, which burns out at the eighty per cent line—that is, when it drops to eighty per cent of the initial candle-power. This booklet will be sent upon request to the company.

THE STANDARD STEAM SPECIALTY COMPANY, New York city, manufacturer of "Utility" steam specialties, is calling attention to the "Utility" exhaust-heating apparatus. This, the maker states, works well with all systems, is economical, durable, self-cleaning, and will give good service for an indefinitely long period. This apparatus has been installed in a number of prominent buildings throughout the United States.

THE GOULD STORAGE BATTERY COMPANY, New York city, N. Y., has recently secured a contract from the New York, New Haven & Hartford Railroad Company to install at the Bristol, Ct., and New Britain, Ct., stations, for lighting purposes, an installation of storage batteries of fifty-five cells each. The company also recently received a contract from the Narragansett Electric Lighting Company, Providence, R. I., to install positive plates with an aggregate capacity of 320,000 ampere-hours, in place of those of the original installation.

THE HESS MANUFACTURING COMPANY, Fifteenth and Chestnut streets, Philadelphia, Pa., has issued a handsome catalogue descriptive of milling machines and cutters for large output. This company makes a specialty of adapting electric motors for direct-driving, and will be pleased to receive specifications for large and small work. The company furnishes its machines with a special form of cutter for fast feeding and heavy milling. The catalogue will be sent to any one upon request, and should be of great interest to those engaged in this class of work.

THE WOODWARD GOVERNOR COMPANY, 658-660 Race street, Rockford, Ill., has published a handsome catalogue describing and illustrating its governors for water-wheels. These are of the compensating type in two models for electric light, power, and railway service, and the standard type, for factory and mill service. The illustrations are definite and well worked up and a concise description is given as to mechanism and operation. The company has doubled the floor space of its shops within the past year, and has added many new machines and special tools to ensure the exact duplication of parts.

THE BULLOCK ELECTRIC MANUFACTURING COMPANY, Cincinnati, Ohio, suffered the partial loss of its shop No. 2 by fire on Thursday evening, November 26. This shop consisted of the plant containing the punch presses, annealing ovens and forges. The loss is fully covered by insurance, and the tools were not seriously damaged. The company has already erected temporary sheds over its tools, and there will be no delay in the completion of orders it has on hand or those that it may receive. The company will at once begin the reconstruction of shop No. 2 on a scale larger than the original structure.

THE AUTOMATIC ELECTRIC COMPANY, Chicago, Ill., manufacturer of automatic telephones and automatic telephone installations under the Strowger patents, is distributing a booklet, on the front cover of which is endorsed, "In Witness Whereof We Hereto Have Set Our Hands and Seals," the cover being further illuminated by an embossed representation of the Automatic Electric Company's desk apparatus and a seal pen and bottle of ink. This booklet contains the signed testimonials of a great number of the subscribers of the Home Telephone Company, of Dayton, Ohio, which is equipped entirely with the Automatic telephone system, installed by the Automatic Electric Company.

THE AMERICAN STEEL AND WIRE COMPANY, Chicago, Ill., has issued a new catalogue on its wire rope and fittings. This is dated November, 1903, and cancels the issue of April, 1900. In this catalogue are described several types of wire rope for haulage, transmission and standing rope construction, running rigging construction, hoisting rope construction, special flexible hoisting rope and tiller rope construction, and a chapter of suggestions to users of wire rope, and instructions and working data on the foregoing types of rope is added. Directions are given for splicing wire rope, and the charges of labor for splicing endless rope. There are also illustrated and described cast-steel flat rope, and various forms of combination rope and metal auxiliaries.

THE COLUMBUS STORAGE BATTERY COMPANY, 97 North Third street, Columbus, Ohio, manufacturer of the Columbus Storage battery, has issued a new catalogue which, besides listing its various types of cells, also contains a short treatise on the use and care of storage batteries. This is the company's third annual catalogue to the electrical trade. The company has installed a number of batteries in private lighting plants during the past year, and is thus enabled to give a prospective customer detailed information in regard to his particular installation. The company states that its batteries have found a good market in the telephone trade, and it has made a number of such installations during the year. This catalogue will be sent to any one interested upon request.

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CHARLES W. PRICE . . . . . PRESIDENT AND EDITOR
STEPHEN H. GODDARD . . . . . SECRETARY AND MANAGER
WM. HAND BROWNE, JR. . . . . TECHNICAL EDITOR
AINSLIE A. GRAY . . . . . ASSISTANT EDITOR

PUBLISHING OFFICE . . . . . 13-21 Park Row, New York
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CONTENTS.

EDITORIAL:
Electricity in Siberia . . . 835
Electrical Dispersion of Fogs . . . 835
The Value of Technical Education . . . 836
Report on the Edison Storage Battery . . . 836
Meeting of the Underwriters' Electrical Committee . . . 837
Electrical Energy Direct from Coal . . . 837
Some Elements Inherent in Automatic Telephony which Make It Popular, by Joseph B. Baker . . . 838
The Money Value of Technical Training, by James M. Dodge . . . 839
Making an Integrating Wattmeter . . . 841
Worcester Polytechnic Institute . . . 845
The Electrical Committee of the Underwriters' National Electrical Association . . . 846
Water-powers on the Kennebec River . . . 846
Electrotechnical Industry of Germany . . . 846
Notes on X-Light, by William Rollins . . . 847
A New Device for Producing Electric Currents . . . 850
Telephone and Telegraph Construction for the New Republic of Panama . . . 850
Carbides, by Alex. A. Beadle . . . 851
Telephone Systems and the Fire Hazard . . . 852
The Finzi Single-Phase, Alternating-Current Traction Motor, by Enrico Bignami . . . 853
A New Process for Electrogalvanizing . . . 855
Electricity in Siberia, by An American Traveler . . . 856
Electric Convection . . . 858
Switching for Accumulator Plants . . . 858
Shop Testing of Motors and Generators for Commercial Service—VII., by Bertrand B. Abry . . . 859
Industrial Electrochemistry and Electrometallurgy, by John B. C. Kershaw . . . 861
Report on the Edison Standard Cells for Automobiles, by W. Hibbert . . . 862
The Growth of the New York Telephone Service . . . 863
Extensive Dredging Operations by the United States Government . . . 864
Electrical Patents . . . 864
A New Steam Turbine Patent . . . 866
Braking Tests of Cars and Automobiles . . . 866
Electric Light and Power Stations . . . 867
The 1821 Meeting of the American Institute of Electrical Engineers . . . 867
The Forty-eighth Annual Meeting of the American Society of Mechanical Engineers . . . 867
Water Powers on the Chippewa River, Wisconsin . . . 867
REVIEW OF CURRENT ENGINEERING AND SCIENTIFIC LITERATURE . . . 868
Convention of the Interstate Independent Telephone Association . . . 870
INDUSTRIAL SECTION:
A Synchronism Indicator . . . 872
A New Flush Receptacle . . . 872
Straight-Bridge Transmitter . . . 873
Power Plant Accidents . . . 873
Electrical Company Reorganizes . . . 874
An Automatic Time Switch . . . 874
A New Form of Reflector . . . 874
Book Reviews . . . 876
Wireless Telegraphy Notes . . . 876
CURRENT ELECTRICAL NEWS . . . 877–882

ELECTRICITY IN SIBERIA.

Few people have any knowledge of commercial opportunities in Siberia. This is a most important country, and has not begun to be worked for American electrical trade. We understand that there is not a gasworks in the breadth of the land. What a chance for the incandescent lamp. Siberia is a cold place (generally), but there is a summer time there when it is "hotter." A recent traveler has failed to find a solitary electric fan, even where there was power to run one.

ELECTRICAL DISPERSION OF FOGS.

At a recent meeting of the British Physical Society, Sir Oliver Lodge described his work upon the dispersion of fogs and dust clouds by means of electrical discharges into the atmosphere. It has been known for many years that, when a body surrounded by a cloud of dust or mist is electrified, that portion of the cloud immediately around the body is dispersed, the particles cohere, and either sink to the ground or are driven away. In the case of mist a fine rain is formed. Sir Oliver suggested, some years ago, that this effect might be put to practical use to disperse fogs, and he has endeavored to interest a number of bodies in this matter and have it put to test, but so far without success.

Successful Experiments.

Sir Oliver has, however, tried at Liverpool to disperse fogs, using for this purpose a Wimshurst influence machine which discharged by means of a bundle of points into the air. A very high potential is necessary, and to increase the surface a large gas flame was used to supplement the points. On one occasion the discharge of electricity from the flame was sufficient to keep a clear space of fifty or sixty yards radius in a dense fog. Although these experiments were promising, the Wimshurst machine did not seem suitable for every-day use, and there was no other generator which would give a sufficiently high direct voltage to do the work.

Method of Obtaining High Voltage.

To overcome this difficulty, Sir Oliver now uses the rectifying properties of the Cooper Hewitt mercury vapor lamp. To procure the necessary high potential, current from a high-frequency dynamo is carried through an induction coil and then connected to the terminals of the rectifier. The rectifier consists of twelve lamps connected in a quadrilateral having three lamps in each arm, and rectifies both sections of the alternating-current wave. This arrangement gave him unidirectional sparks two or three inches long, and was very effective in laboratory experiments.

Difficulty in the General Application.

To dispel the fog in a circle of fifty or sixty yards' radius is a noteworthy performance, but the general application of this method seems to be rather far off. The cleared area will have to be extended much more than sixty yards from the discharge station before the system can be of use in harbors or at sea, thus necessitating the use of very high voltages, such as are at present impracticable. There are, however, waterways—such as the Manchester canal or the Chicago river, in which the channel is narrow and the traffic very great—where a system of dispelling fogs only slightly better than this would be very useful. It is to be hoped that Sir Oliver will carry on his work and will be able to report much more successful experiments before long.

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THE VALUE OF TECHNICAL EDUCATION.

If any more evidence were needed to prove that the value of technical education is now well recognized, the address delivered before the American Society of Mechanical Engineers, by President James M. Dodge, would probably be conclusive. However, the growing demand for technical men, and the crowded courses at the technical schools, are alone sufficient to prove the case. It is true that there has been a great deal of discussion and even criticism of our technical courses as now laid out, but these criticisms merely indicate that there is a growing demand for men with a broader training and a wider view than that given by our present somewhat narrow engineering courses. The rapid growth of the electrical industries created a great demand for men with a special training, and it was to meet this demand that these courses were laid out. Now the employers have tested technical graduates, and they appreciate their value; but there is a new demand for men whose training has been carried further than that which can be given a college student in four years. To meet this new demand, several technical institutions are now offering graduate courses in engineering subjects.

The Money Value of the Man.

Mr. Dodge in his address takes up only the money value of technical training. He compares the earnings of young men of four classes—labor, shop-trained or apprentices, trade school and the technical school—from the time they are sixteen until they have reached the age of thirty-two. Comparison is made by capitalizing at five per cent the young man's earnings for fifty weeks, the figure thus obtained being designated as his potential value. A chart thus constructed shows that the laborer starts with $3 a week when he is sixteen, and rises to $10.20 by the time he is twenty-one; but he rises no higher. His potential value at that wage is $10,200. The apprentice or shop-trained worker starts with the same wages as the laborer at sixteen, but rises more rapidly, and is earning by the time he is twenty-four years old, $15.80. His potential value at that time is $15,800, but he makes no further rise. The trade school graduate, starting at the same point, rises still more rapidly, and is earning when he is twenty-five years of age $22 per week, his potential value at that time being $22,000. From this point his wages rise less rapidly, reaching possibly $25 a week at the age of thirty-two, and representing a potential value of $25,000.

Value of the Technical Man.

The graduate of the technical school starts at the same point at a weekly salary of $3, and is earning $4 when he enters college at eighteen. Upon graduating from college, at the age of twenty-two, he can draw a salary of $13 per week. He has then already passed the laborer, but is still a little below the shop-trained apprentice. He passes the latter, however, during his first year of employment, but is still below the trade school graduate, whom he does not overtake until his twenty-fifth year. From this point on he rapidly leaves behind the other three workers and at the age of thirty-two is drawing $43 a week, his potential value being $43,000; and the curve indicates that his value is still rising, although at a slower rate. Thus, four years' training at a technical school makes a man, by the time he is thirty-two, four times as valuable as the laborer, approximately three times as valuable as the shop-trained apprentice, and seventy-two per cent more valuable than the trade school graduate. Surely a good return for four years spent in preparation.

Other Considerations Have Influence.

Mr. Dodge's method of analysis should carry conviction to certain classes of employers. On the other hand, it does not take into consideration other phases of this problem which doubtless influence many ambitious young men. It is certainly some satisfaction to such a man to occupy a more important position than his brother workers, and to feel that he is an important factor in the development of his profession, and in the advancement of the world.

REPORT ON THE EDISON STORAGE BATTERY.

On another page of this issue is given an abstract of a paper presented at a recent meeting of the British Institution of Electrical Engineers by Mr. W. Hibbert, and which gives the results of tests made by the author on the Edison standard automobile cell. The report will, doubtless, be read with interest, as there has been a demand for information concerning this battery based upon actual results. These tests were carried out during a period of six months, and the endeavor was made to determine as far as possible in this time, the actual value of this cell. The method of conducting this test was to determine the efficiency of the cells at different rates of charge and discharge in the laboratory, and then to see whether they would give the same efficiency under running conditions, and to determine what deterioration took place.

Laboratory Tests.

The tests show that the efficiency of the cell in the laboratory is somewhat less than that of the lead cell, but, under garage conditions, it is possible that the lead cell would not make as good a showing as it does in the laboratory, while the Edison cell seems to be less affected by unfavorable conditions. Tests made to determine the effect of ill usage showed that conditions such as short-circuiting or allowing the cell to stand while charged, caused no injury by the first treatment, and that the loss in efficiency during the second was not great.

Running Tests.

To test the cell under actual operating conditions, a car equipped with an Edison battery was secured, and this was run under conditions as varied as possible. From these tests Mr. Hibbert comes to the conclusion that the cell gives practically the same efficiency when in actual use as it does in the laboratory; and at the end of his test he was not able to detect any deterioration.

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ELECTRICAL ENERGY DIRECT FROM COAL.

On another page of this issue will be found a description of an apparatus which has been devised by Mr. James H. Reid, of Newark, N. J., for the purpose of producing electrical energy direct from fuel. The elements of the apparatus are an iron containing-vessel, forming one electrode; a fused electrolyte of the oxides of sodium calcium and iron, contained in the iron vessel, and a hollow electrode of porous carbon. Combustible gas of any description, mixed with forty times its volume of air, is forced into the carbon and finds its way out through the pores, coming in contact with the electrolyte, which is kept hot by some external means. The mixture of gas and air, in rising through the electrolyte, keeps it in circulation and brings fresh portions in contact with the gas. The apparatus gives an electromotive force of 0.9 volt per couple on open circuit, and upon short-circuit will deliver heavy currents.

The Inventor's Notion of the Action.

The inventor says that his apparatus can not be compared with any other device heretofore produced. He does not think that the effect is electrochemical, nor is it thermoelectric; but he believes the action is rather to be compared with the breathing of animals, where the action of the lungs continually brings an oxidizing medium in contact with the blood.

The Action Not Electrochemical.

From the demonstration which was made, we are hardly ready to accept this view; nor does the action seem to us to be electrochemical. If the action were electrochemical, the combustible and oxidizing gases should be supplied at opposite ends of the cell, but here they are mixed before being forced into the cell. Further, the analogy offered by Mr. Reid does not seem to us to hold, for the fuel supply for animal life is certainly not taken in through the lungs with the air.

The Jacques Cell.

We, however, think that the action of the cell can be explained as thermoelectric. It will be remembered that when the Jacques cell was brought out some seven or eight years ago, Mr. C. J. Reed proved the action to be thermal. The Jacques cell consisted of an iron vessel containing a fused electrolyte and a carbon rod. Air was forced into the electrolyte below the carbon and rose about it. This had the effect of keeping the contact of carbon and electrolyte cooler than that of the electrolyte and iron. The temperature of the cell was about 400 degrees Fahrenheit. The same electromotive force was produced when the air was replaced by any negative gas. The potential was 0.9 volt, and heavy currents could be drawn off. The apparatus was not found to be an efficient generator of electricity. The electrical energy was not produced by the oxidation of the carbon rod.

Action Probably Thermoelectric.

Now, while there are several marked differences between the Jacques cell and Mr. Reid's apparatus, these do not seem to have any effect upon the result. We have in the Reid apparatus an iron vessel, a molten electrolyte and a carbon rod surrounded by the gases forced through it. The voltage developed is the same as that of the Jacques cell. If there were any other action present, should not the voltage of the cell be greater? because this thermal electromotive force must also be present—that is to say, if a thermo-couple, consisting of iron, a fused electrolyte, such as here used, and carbon, gives at about 400 degrees Fahrenheit an electromotive force of 0.9 volt, any other electromotive force set up by any other cause should either add to or subtract from this, and we would not expect to have an open-circuit voltage of 0.9 volt. This could easily be tested by forcing ordinary air through the carbons, omitting the combustible gas. Should this apparatus prove to be merely a thermoelectric generator, its efficiency will, of course, be limited by the second law of thermodynamics, and the device can hardly be expected to be of much commercial value. It might be remarked that in the demonstration, while the terminal voltage of the two cells in series was 1.8 on open circuit, it fell to about 0.1 volt when short-circuited through an ammeter and delivering about fifty-three amperes. The output of the two cells was then only 5.3 watts.

The Apparatus to Be Tested.

Mr. Reid has, however, made some tests with a cell of similar description, and he says that he obtained an efficiency of transformation of the energy contained in the gas to electrical energy of about seventy-two per cent, making an efficiency from coal to electricity of about forty-five per cent. The efficiency of the gas-producing process was about eighty per cent. He intends to have his apparatus tested by disinterested experts, and should his figures be verified, it is hardly necessary to say that they will demonstrate the success of his apparatus.

MEETING OF THE UNDERWRITERS' ELECTRICAL COMMITTEE.

The electrical committee of the Underwriters' National Electrical Association met in New York, December 2 and 3. The meetings were well attended by electricians connected with the insurance companies, by members of the national conference on electric lighting rules, by members of the code committee of the American Institute of Electrical Engineers, and by officers of the National Electrical Contractors' Association. Any proposed rules or changes were therefore considered from the standpoint of the electrical engineer and contractor, as well as from that of the insurance company. At these meetings there were but few changes proposed, the policy of the committee being to pay less attention to small details, and to lay greater weight on the general principles of the results to be obtained.

Importance of Work of the Committee.

The work of this committee is of much importance to all interested in electrical matters, as it is obviously to the advantage of all concerned that sensible and satisfactory rules be adopted, sensible because they work hardship to none and satisfactory because they protect against unsafe material and work. The membership of the committee is evidently such as to promote confidence in its rulings in all matters.

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SOME ELEMENTS INHERENT IN AUTOMATIC TELEPHONY WHICH MAKE IT POPULAR.

BY JOSEPH B. BAKER.

THE SERVICE OF THE AUTOMATIC REGARDED AS A STANDARD.

The accelerated rate of growth in the use of the automatic telephone exchange system, indicating as it does the recent enlightenment of responsible telephone managers and engineers, warrants the prediction that in a few years machine telephone operating will be "the thing," just as common battery systems of manual exchange operating have been the thing ever since the central energy idea gained a firm foothold in the art of telephone communication, because the growth of the traffic had reached a point no longer endurable by the local battery, magneto-ringing systems. This accelerated growth warrants also, in the writer's opinion, the taking of a radical point of view in explaining the merits of the automatic system. The reader is asked to look fairly at an automatic subscriber's station set and the new art of electric communication that it stands for; considering, with the writer, the service given, point by point. The best cause can be put in an unfavorable light by seeking faults in it, by destructive criticism based on false premises; and of these there has been too much in the past in discussions of the merits of the automatic telephone exchange system, even by responsible telephone engineers. The time has quite gone by, in view of the hearty and responsible support given in substantial form by the managers of so many telephone companies recently, for either ignorance or prejudice to stand in the way of proper appreciation of the automatic. Indeed, the time has gone by, in discussions of this subject, for any sort of a defensive attitude to be taken by believers in the automatic. The installations that were put in years ago and have been working ever since with varying success, but always working, have served their purpose of helping to enlighten the public, of creating a widening demand for the new art of telephone communication that they exemplified in such striking contrast with manual systems with which they competed locally. These installations served as "trial horses" in the development of the apparatus under the severe conditions of actual service, whereby the newer plants, whose inauguration of service is now attracting the careful attention of all telephone men, have been able to be equipped with apparatus that is mechanically perfected.

The telephone men in charge of the expenditures for these more recent automatic installations—men who can not afford to try experiments with the money of their stockholders—have clearly seen their best interests in the installing of automatic apparatus, after studying its practical working at Fall River and New Bedford, Mass.

CHARACTER OF THIS NEW STANDARD SERVICE.

What is the character of the service given by an automatic telephone exchange installation? The telephone set, with its numbered dial adapted to calling any number that can be expressed in Arabic numerals by a simple, time-saving method, stands for a telephone service that completely justifies its claim as an instrument in a new art of electric communication. It is a mistake to start with the thought that the automatic is a mere improvement on the manual, a last result of the evolution of the telephone switchboard. It is not an improvement, nor the product of one; it is the embodiment of a revolution begun (and begun right) as a correct idea for accomplishing a desirable end, carried through long and painful stages of laboratory development; tested and refined by the ruthless processes of actual commercial use; and reduced in the fulness of time to mechanical perfection, of an order recognizing the deepest needs of the telephone service, by the application of sufficient capital, inventive talent and skilled organization. The result of all this independent evolution in telephony is, to-day, a system of mechanical operating that works like a machine.

The many years' growth of the use of the telephone have seen many ingenious improvements in manual switchboard and operating systems that were improvements in the struggle to adopt mechanisms to a multiplied pair of hands. But these systems do not and can not give a "telephone service" in the sense that the automatic does. Under the pressure of the growth of the telephone traffic that began as a hand-operated system of communication, these manual systems provided the means and possibility of connecting any subscriber to any other subscriber in large and small communities under conditions of improvement of detail whereby the earliest and smallest exchanges could grow to give the same kind of service to large cities.

COMPARATIVE INEFFICIENCY OF THE MANUAL SYSTEM.

The operation of calling from an automatic set by partial rotation of the dial from the proper numbers, thus sending in the successive numerals of the number to be connected and causing the simultaneous selection of that number or the selection of the "busy" signal sounding in the ear of the party calling, is a simplified group of operations comparing favorably both in method and result with the old system of passing a call. It compares favorably in method, because by the automatic the giving of the order itself constitutes the execution of it, with no probability of error (mechanically speaking, and apart from sheer mistake by the party calling). The group of operations executed by the automatic compares favorably in result (from the point of view of the subscribers, which is and ought to be the traffic criterion) because the automatic presents to the party calling, after a comparatively very short interval and one never raised or extended by pressure of traffic, the actual facts of the state of his call, whether the connection is given him or denied him.

THE AUTOMATIC SERVICE SUPERIOR IN KIND AS WELL AS IN DEGREE.

Passing by several points that invite examination, but that would unduly lengthen this article, consider briefly several features of the modern service given by the automatic that appeal especially to that greater army of telephone operators—the public of telephone users—by their contrast to the old cord-and-plug hand-operated service. The strict privacy of conversation and absolute freedom from either interruption or disconnection is in refreshing contrast to the dangers that lie in wait for a manually operated call. With no operators to listen, no keyboard in which two or more lines may be crossed up, and no party lines with their opportunity for eavesdropping; with no hand-operated connections, precariously defended by a very fallible complexity of signals, the user of the automatic approaches his telephone with a sense of security and privacy that never has obtained, in the very nature of things, with the manual. This is a feature whose full importance can not be realized by any one in advance of an actual experience with the automatic service; that alone can impress upon him all that genuine privacy, security and directness in the use of the telephone means.

The disconnection, instantaneous upon the working of either subscriber's hook,

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opens vast possibilities of a quick succession of calls, useful in getting market prices, etc., and is another expression of the ever-present fact that all the time spent at an automatic telephone is live time. The hearing of the "busy signal" by the party calling means that the actual instrument of the party called is in use—not, that it has been in use at some recent time; and automatic telephone users have not been long in learning that it pays well to keep trying to get a line reported busy, since by this they can be sure of getting their party within two or three seconds of the last busy signal. The point often urged by opponents of the automatic, that the public will miss the human operator and will not put up with a machine as a substitute, is little less than absurd as a contention in view of the ample number of precedents to the contrary in American use of labor-saving machinery. But apart from this, it is a fact that in local telephone service the essential functions of the operators are the execution of mechanical movements that command and receive the wages of common labor; the additional and less elementarily mechanical functions having been added to the duties of operators in the continually more difficult struggle to help out the service under its terrible handicap of dependence on manual labor. As for the associated contention that an all-machine organization is liable to get out of order, leaving the subscriber helpless, the basis of pro-manual argument is equally shaky. The duties of the office inspectors in automatic exchanges do not call their attention to the panel and keyboard apparatus or manual switchboards, or to the relay racks connected therewith; their work, apart from care of the power plants, common to all telephone exchanges, consists largely in patroling the automatic switchboards (in which the individual switches, selectors and connectors, are arranged to be thoroughly accessible from all sides without sacrifice of compactness), ready to note and remedy troubles. These men get the usual salary of an office inspector, and by experience with the comparatively simple apparatus proposition of the automatic exchange, are able in most cases of trouble to note its existence and character by variations in the clicking sounds of the switches, and to apply the remedy before the calling subscriber has time to formulate his complaint. In the newer exchanges the switchboards are so grouped as to facilitate the tracing of a call and the prompt location of trouble.

Problems of effective insulation against leakage cross-talk; of firm rubbing contacts in circuit whereby the variation of line resistance measured from telephone to telephone of a pair connected through all the trunks compares favorably with that introduced by the best forms of plug-and-jack contacts of manual boards; of margin of safe operation of switch relays (mounted directly on the switches) for various lengths of subscribers' lines; and other problems that have come up in the course of experience in practical exchange working in competition with the Bell and under varied conditions, have been met and solved upon the high plane of an organization designed to work like a genuine machine.

The beneficiary of the service given by the automatic no longer feels the old sense of a helpless struggle with annoyances beyond his control; but, instead, the sense of being in direct control of a new art of electric communication that joins instantaneous connecting with instantaneous voice transmission to give, at last, a genuinely modern telephone service.

THE MONEY VALUE OF TECHNICAL TRAINING.[1]

BY JAMES M. DODGE.

Technical training may be self-acquired or obtained through instruction. The ability to drive a nail properly, or to design and construct the most complex and wonderful of structures or devices, is the result of technical training in but different degree. Up to a very recent date, and within the memory of most of us, the apprentice system and that of independent delving represented the sole methods of acquiring training. Research and investigation carried on in individual lines, with varying degrees of success, depending upon the mental makeup of the individual, were the means of attaining theoretical technical knowledge. The blending of these two methods developed the earlier mechanical engineers and will, even in the future, enable those sufficiently gifted by nature and habit to attain eminence. The progress of the world, however, calls for a better and more speedy means of producing trained men than could ever be developed by the methods of self-instruction. The individual, striving for manual skill, attains his desire under the old apprentice system. Individuals sufficiently gifted rise above their fellows, and become the leaders in their calling. The gratification of a mechanical appetite and the desire to earn more money than his fellows are two moving causes which impel a man toward technical education. A generation ago, the universal belief was that the sooner a young man entered upon his apprenticeship, or began practical manual work, the better and more rapid would be his progress in the mechanic arts, and book learning was derided as being purely theoretical, and of little practical value. This belief is, even at this date, all too prevalent, largely due to inherited error, and to lack of knowledge and reliable data.

Obtaining data from which incontrovertible conclusions can be drawn is now comparatively easy, but a few years ago was practically impossible. We are all prone to take extreme cases of success or failure as the basis of our opinions, and lose sight of the fact that it is the average man whose career shows the true force and direction of the current. For convenience of comparison, I will outline the actual progress made by four groups of men working in the mechanic arts—the unskilled labor group, the shop-trained or apprentice group, the trade school group, the technical school group, and give the results obtained. Each group I will refer to as an individual.

The first, the laborer, with but primitive and rudimentary training, working under the immediate and constant supervision of a boss, and earning, as the line on the chart indicates, $10.20 per week at the age of twenty-two, his line remaining horizontal through the period of his usefulness. Data are lacking as to his progress before he reaches the age of twenty-two.

The second, the apprentice or representative of the shop-trained group, of good health and habits, entering a machine shop at the age of sixteen, and earning an average wage of $3 per week for fifty weeks per year, which is about the number actually worked, is $150, or five per cent on $3,000. This, then is his potential or invested value, upon which he draws his interest on paydays.

We now note that his accumulated experience enables him to make more rapid progress, and from the age of twenty to twenty-one and one-half years we find that his pay has increased to $13.20 per week, and his potential value to $13,200. He is now approaching his goal, and his line of progress does not continue at the same angle that it followed for the past few years, but deflects toward the horizontal; and at the age of twenty-four we find him earning $15.80 per week, and his potential value $15,800. In other words, in

[1] Abstract of president's address at the New York meeting December, 1903, of the American Society of Mechanical Engineers.

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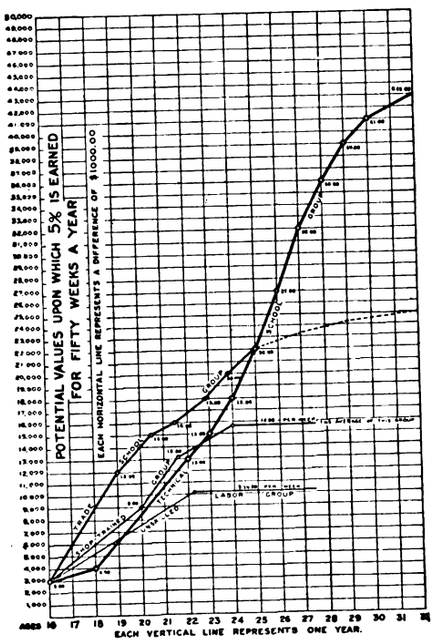
eight years he has increased his potential value $12,800. Observation shows that five per cent of the apprentices acquiring the machinist trade rise above the line made by our average man; thirty-five per cent follow the line closely, and that during the period of training twenty per cent leave of their own accord, and as near as can be ascertained, go to other shops and continue in the line originally selected; forty per cent, however, are found unworthy or incompetent, and are dismissed, probably never rising to the $15.80 line.

The third group of young men are those fortunate enough to have had the opportunity of entering a trade school, which they do at sixteen years of age, devoting the next three years of their lives, or until they are nineteen years of age, acquiring a trade under competent instruction, and at the same time adding to their store of rudimentary theoretical education. At the age of nineteen a trades' school man enters the machine shop and can command $12 per week, equal to the apprentice at twenty-one years of age, and very quickly makes his employment profitable to his employer. The three years in school have increased his potential value from $3,000 to $12,000, a gain of $9,000. Thus he has caught up with the apprentice entering the shop at sixteen, and who has been working for five years. Progress of the trades' school group now follows a line which diverges from that of the regular apprentice, and by the time $15.80 is earned by the regular apprentice, the trades' school graduate is earning $20, with a potential value of $20,000, or $4,200 greater than that of the shop-trained man. The trades' school line continues at substantially the same angle up to an earning capacity of $22 per week, and a potential value of $22,000.

The fourth group we will represent again by a boy of sixteen studying at school until his eighteenth year, and preparing himself for admission to one of our higher institutions of technical learning, such as the Stevens Institute, the Massachusetts Institute of Technology, Columbia, Cornell, and the like, where, after a four years' course, he is ready to begin practical work. The statistics upon which this chart is based show the average starting wage at $13 per week, or the same amount earned by the regular apprentice at the age of twenty-one and one-half and by the trades' school graduate at the age of nineteen and one-half. In other words, apparently a graduate of our technical schools has lost by his six years of preparatory study, having been beaten by the regular apprentices by six months and by the trades' school graduate by two and one-half years. From this time, however, there develops a most interesting and instructive line of progress. The regular apprentice, who is earning $13.50 a week at the time the technical graduate is earning $13, is overtaken in six months, and we find both earning $14 per week, and the technical graduate reaches the $15.80 line nearly one year before the regular apprentice. In other words, while it has taken the regular apprentice from his twenty-first to his twenty-fourth year, or three years, to increase his wages from $11.50 to $15.80 a week, the technical graduate has done the same in fifteen months.

Progress now continues on substantially the same line, and we find the technical


POTENTIAL VALUES UPON WHICH 5% IS EARNED
FOR FIFTY WEEKS A YEAR
EACH HORIZONTAL LINE REPRESENTS A DIFFERENCE OF $1000.00
EACH VERTICAL LINE REPRESENTS ONE YEAR.
LABOR GROUP
LABOR GROUP

POTENTIAL VALUES UPON WHICH FIVE PER CENT IS EARNED FIFTY WEEKS IN A YEAR.

graduate earning $22 per week, and crossing the line of the trades' school group in three years' time, a worthy tribute to the higher education and attainment.

The line of the technical graduate now continues divergent from that of the trades' school graduate, with earning capacity regularly increasing, and a corresponding augmentation of potential or invested value until, at the age of thirty-two, or ten years after entering upon the practical work, we find our technical graduate earning $43 per week, and his potential value at $43,000. In other words, six years of preparation have enabled him to distance the shop-trained man and the trades' school graduate overwhelmingly. Bearing in mind that this is an average line, it is of interest to say that most technical graduates with a better record than the one in the chart have devoted even more time to their preparation, either by study or by shopwork, after graduation.

Thus we see clearly that preparation pays, and that it pays in dollars and cents, and that even a long term of years spent in proper study and technical training is a good investment from every point of view.

The highest wages are paid to the man through whose ability the largest number of other men may be most profitably employed. He does his work with his brain.

A practical man performs his work within the radius of his arm, a technical man within the radius of his brain. This fact is, even to-day, realized by the few, but it is gratifying to know that the number is increasing.

The technical training of an individual makes him valuable just in proportion as his ability is manifested by good judgment and perception. Trained common sense receives the highest compensation and reaps the greatest reward.

Mental ability to receive ideas and impart them properly and wisely, rearranged and grouped, is typical of the most brilliant mentality; a dull intellect may be compared to blotting paper, fit only to absorb and inter a heterogeneous mass of impressions.

The most interesting of all graphical charts would be that properly exploiting the value of technical training to manufacturing plants and enterprises. To illustrate this more clearly, we may fairly assume that the apprentice of our chart corresponds to the old-fashioned primitive shop, having practically no overhead expense, the proprietor carrying his business "in his hat," priding himself on his non-receptive sturdiness, contempt for all improvements and personal attention to all details. For his costs he adds together the value of raw materials and labor, and then adds a few dollars for profit. The line of this establishment would parallel the $15.80 line of our shop-trained group.

The trades' school line on the chart truthfully represents establishments in which some attention has been paid to the improvement of the system, with an increased so-called non-productive force, operating possibly in some particulars with brilliancy, but with defective features in others; acknowledging the value of improvements if internally originated; moderately but unconsciously absorbent of ideas from without, but tenacious of dogma and lacking departmental symmetry. Growth, increased earning and relative immunity from disastrous failure result.

The technical graduate line of our chart represents the manufacturing establishment technically trained and "abreast of the times" in all particulars, and I predict a time not very far distant when it will be almost universally recognized that establishments should be trained as well as individuals, and that the marvelous development in scientific shop practice and management will do for the manufacturer fully as much as technical training is doing for the individual.

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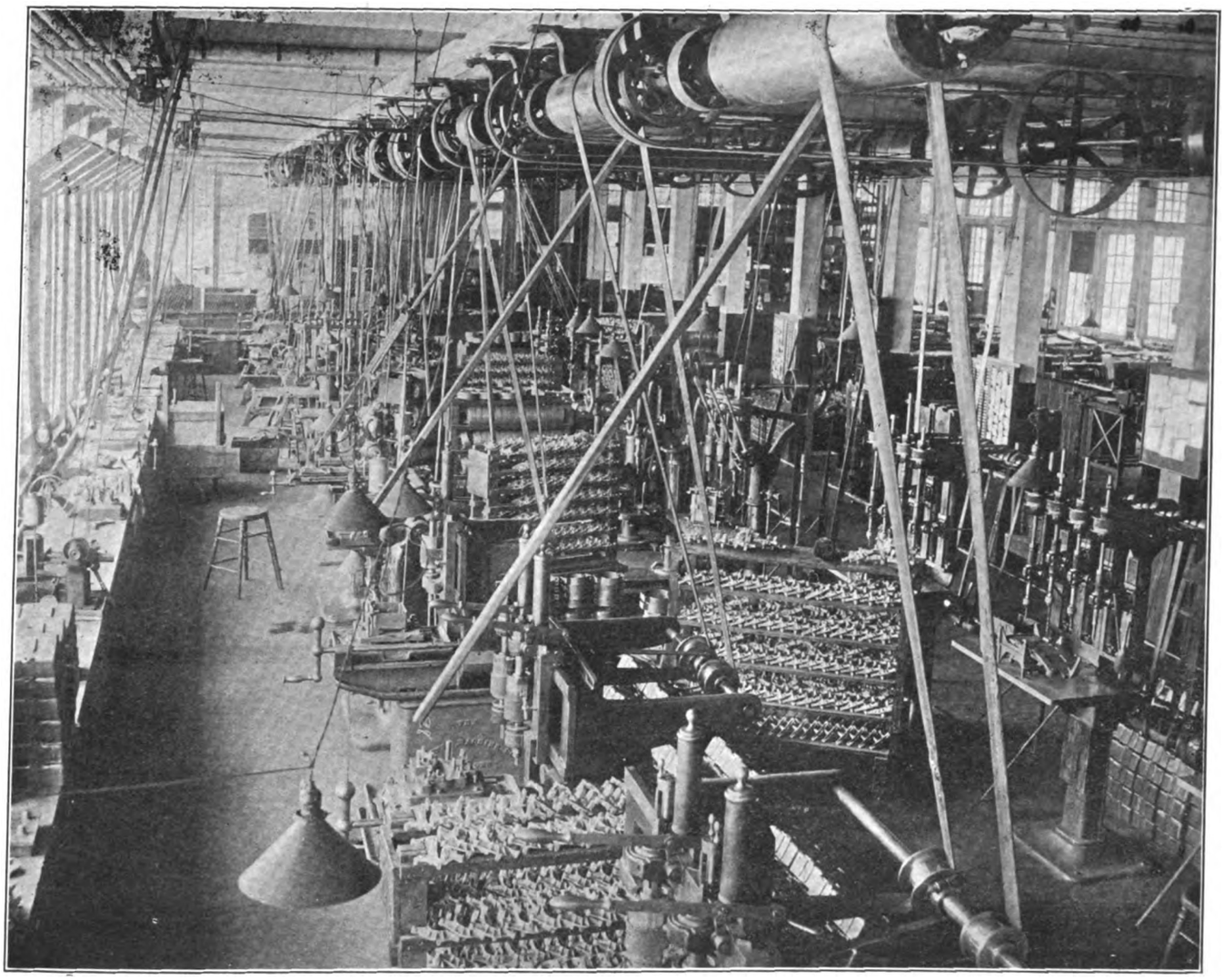
Making an Integrating Wattmeter.

Some Points in the Construction of the Stanley Wattmeters, and Some Views of the Stanley Instrument Company's Works.

THE Berkshire Hills of Massachusetts are reputed to be one of the most healthful and most beautiful spots in the New England States, and it was to this locality that William Stanley was sent some years ago, when his health had broken down and but few expected him to recover. To this incident may be attributed the location and the building up of two important industries in the electrical field. One of these with which Mr. Stanley is now identified is at Great Barrington, where are made the Stanley recording wattmeters, known all over the world for their accuracy and reliability. The construction and testing of this meter present points of considerable interest which are well worth description.

The supplying of electricity, be it for light or power, is daily becoming more and more important, and the measuring of this power is daily becoming a more essential part of the supply company's business. The old, crude system of supplying power at so much per lamp per month or per horse-power per year has given way to the more sensible and satisfactory system of paying by the meter. The wattmeter thus becomes equally important to the consumer and the supply company. Upon its operations depend the consumer's bills and the supply company's income. For this reason it is essential to have meters which are accurate and which will remain accurate, and it was to meet this need that the Stanley meter was designed.

While it is a simple matter to construct an instrument which will record, after a fashion, the power passed through it, it is not easy to make a meter which will record accurately day in and day out, under all variations of load, and which will not require attention or adjustment from time to time. A meter should record accurately the power passed through it, whether this is being supplied for one lamp or fifty, and it should not creep—that is, it should not turn when no current is being drawn from the circuit supplied through it. The meter should not be unduly large, it should require but little power to operate it, and it should retain its accuracy for a considerable time. To meet these requirements, the moving part of the meter should be as light as possible; friction should be reduced to a minimum and should remain constant—this means that all parts must be constructed with the greatest accuracy, and



MACHINE SHOP MAIN FLOOR, STANLEY INSTRUMENT COMPANY, GREAT BARRINGTON, MASS.

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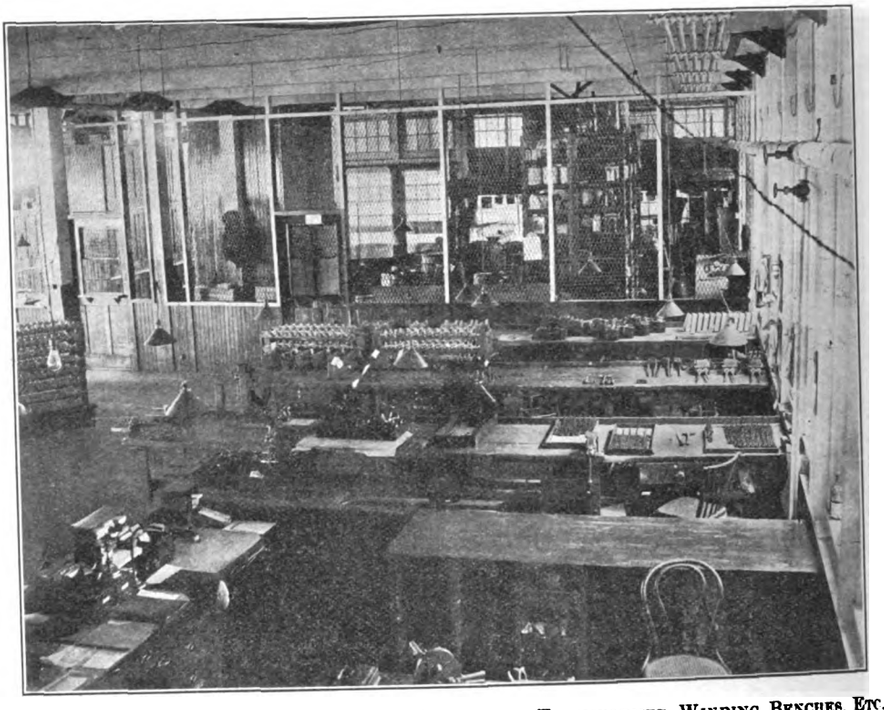
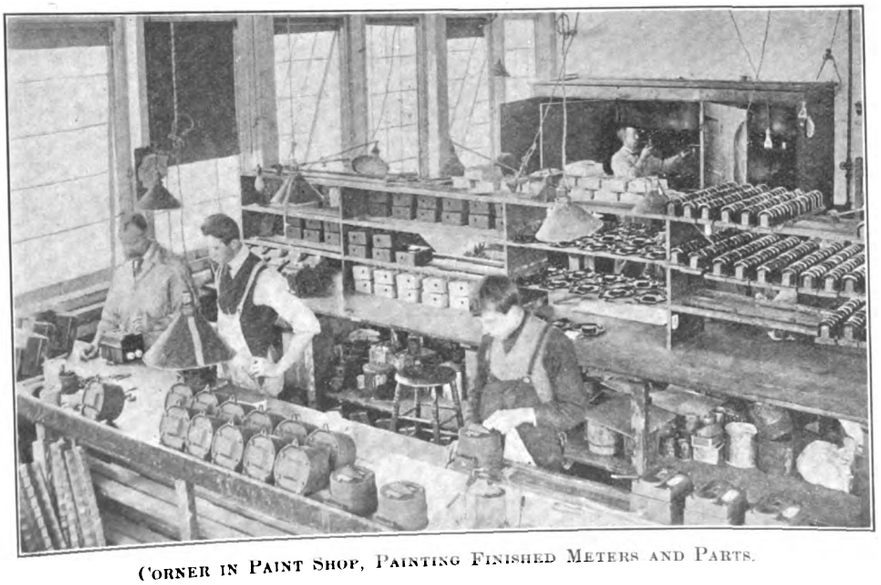
all unbalanced forces must be eliminated.

Undoubtedly the most important of these requisites is the reduction of friction, because the only mechanical work of any consequence required of a meter is to overcome its own friction. If the friction to rotation is large, compared with the power recorded, the meter not only consumes an undesirable amount of energy itself, but slight variations in this friction will cause considerable variation in the accuracy of the meter, as the meter will always be working against the frictional resistance, which does not vary with the power passed through it, it will respond less readily to slight variations in this power. For this reason it has been the aim of all meter designers to reduce the mechanical friction to the lowest possible amount.

In a meter the most important moving part is the disc, the other moving part being the recording train. The proper construction of these parts calls for the highest mechanical skill, and in this work the meter-making companies often vie with, and even surpass, the best watch manufacturers. As the disc is the largest moving piece, and as its speed is much greater than that of any part of the recording train, the friction opposing its rotation forms the most important part of the whole, and may often mask that offered by the recording train. To the problem of reducing this friction the greatest attention has been paid, and it is in this respect that the Stanley magnetic suspension meter differs most radically from other makes.



Corner of Main Floor, Showing Part of Stockroom, Transformer Winding Benches, Etc.



Corner in Paint Shop, Painting Finished Meters and Parts.

The designer of this meter was not content to use jewel bearings constructed with the greatest care, but he decided to eliminate such bearings for supporting the disc. To accomplish this he devised the so-called magnetic suspension. In the magnetic suspension the disc is not held in position by jewel bearings, but its weight is entirely supported by an ingeniously constructed permanent magnet. The disc, which is a circular disc of aluminum, stamped and pressed in one operation, is mounted upon a hollow steel core, having at its lower extremity a projecting collar. This core is turned with the utmost nicety, and must not vary in diameter more than two-ten-thousandths of an inch.

The magnet which supports the disc by attracting this core is of steel, with two steel pole bushings. The upper of these bushings is drilled to admit the upper end of the suspension core, while the lower bushing is cup-shaped, having a projecting rim which just admits the collar on the lower end of the core. The clearance between the two bushings and the two ends of the core is just sufficient to allow the core to revolve when held centrally, without rubbing. The attraction of the magnet upon the core lifts it up until the collar lies nearly in the plane of the flanged lower bushing. While in this position the core and its disc are held centrally by a very fine wire passed through guides within the two bushings and through the core.

The mechanical work just here is probably the finest done on the meter, as lateral motion of the disc must be avoided as far as possible, and yet sufficient clearance must be given the wire so that it will act as a guide for the core, and not a spindle upon which it revolves. The wire and the hole through the core must not vary more than two-ten-thousandths of an inch. This method of suspension, the engineers of the Stanley company believe, reduces the friction opposing the rotation of the disc to a minimum. But to obtain the full advantage of this construction, it is necessary that all forces acting upon the disc be carefully balanced, so that the driving force acts in the plane of the disc and at its point of application is normal to the radius. The disc is therefore carefully balanced, so that the centre of gravity lies in the centre of the core, and the

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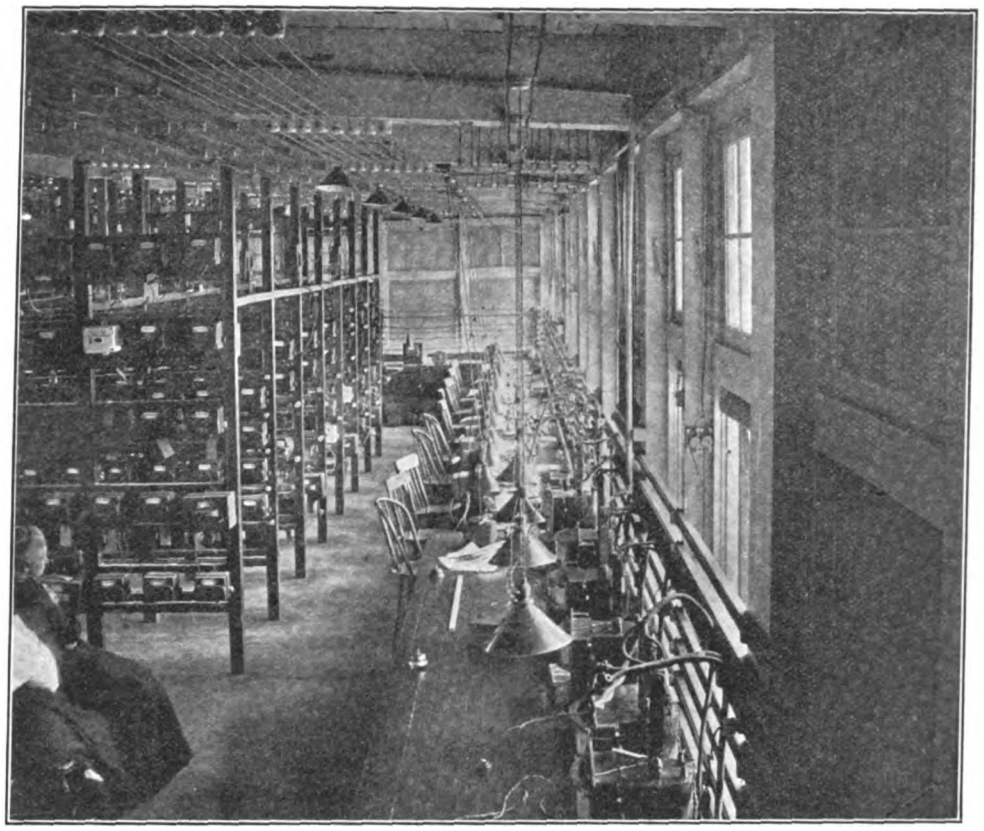
driving coils and the brake or retarding magnet are both arranged symmetically with respect to the disc.

If the shunt and series coils are not arranged symmetrically with respect to the disc, the force due to the reaction of the metrical, and since the currents induced by the alternating field are not in phase with the field, this thrust varies both in direction and amount, thus tending to throw the disc into vibration, as well as increasing its friction. Both effects, how-



CORNER IN TESTING ROOM, WITHOUT OPERATORS.

currents induced in the disc by the varying fields set up by the coils will not have a direction coincident with the plane of the disc, and there will be a downward or upward thrust acting upon the disc and tending to throw it out of line. To eliminate this undesirable feature, there are four shunt or field coils and two current or series coils in the Stanley meter, arranged symmetrically above and below the disc and placed so as to produce a uniform field.

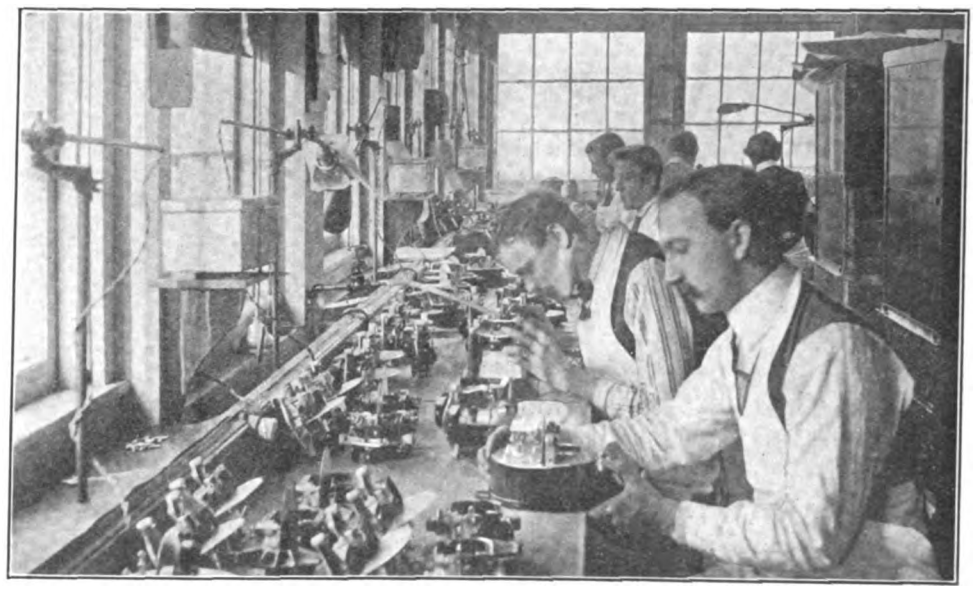
While this arrangement of coils eliminates any upward or downward thrust upon the disc, it does not do away with a side thrust caused by the direction of flow taken by the eddy currents in the disc. These currents would not normally flow across the pole along radii, and there would, in consequence, be a side thrust. This effect is prevented by closed circuited copper rings placed over the side of the shunt pole nearest to the edge of the disc, whereby a compensating force is set up which balances the side thrust.

A third undesirable reaction is also eliminated by the symmetrical arrangement of the series and shunt coils. As explained above, an upward or downward thrust exists where the field is not symever, are eliminated by the symmetrical arrangement of the driving coils adopted.

In the construction of these meters the aim has been to eliminate friction as far as possible, rather than to compensate for it. Since the moving disc is light and perfectly balanced and is not subject to disturbing forces, but a small torque is necessary to set it in rotation. No starting device is needed, as the meter will begin to revolve and will register accurately, even upon the smallest loads.

Another detail of construction in these meters which has received considerable attention is the design of the brake magnet. These magnets, as well as the supporting magnets, are of special steel, carefully magnetized and seasoned, and they are all tested for the proper degree of magnetization before being used. The brake magnet is held by the supporting frame in such a way that the expansion and contraction due to changes in temperature will not cause any variation in the length of the air-gap. This length is adjustable by means of a screw bushing in the pole, and this means is made use of to adjust the meter, so that it will rotate at the proper speed.

Having seen how the mechanical friction of the disc has been reduced to a minimum, it is well to turn to the recording train and notice the means used here for accomplishing the same purpose. The only useful work performed by the meter is that of driving the recording train, and while these gears revolve at relatively low speeds compared with the disc, it is important to reduce the friction of the train as much as possible. The ideal meter would be one in which there was no mechanical resistance whatever, as the mechanical resistance offers a constant retarding force, while the retarding force in an ideal meter should be proportional to the speed of rotation. For this reason



ASSEMBLING MAGNETIC SUSPENSION AND BALANCED THRUST METERS.

the principal retarding force in practically all recording meters is that due to the eddy currents set up by the braking magnet; and the smaller the frictional resistance compared with this force, the more sensitive the meter. In the Stanley

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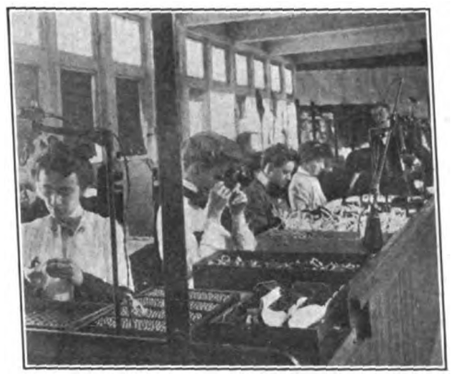
meter the friction of the recording train is reduced by careful, accurate gear cutting. These gears are cut from blanks stacked on a mandrel by involute cutters which themselves have been generated. The curves of the teeth are then as nearly perfect as it is possible to make them, and are not close approximations such as would result from designed cutters.

It would be apparent that, in constructing a meter such as the Stanley, the greatest care must be exercised at all times. Every piece must be inspected and tested before going into the meter. For the finest work—that of making the suspension core—accurate gauges are used. Where exceedingly delicate work is required, multiplying gauges are employed. In this work all that could be learned from methods used in watchmaking was available; but much of the work is even more delicate than that thought necessary in watchmaking. A gear filed out by hand or stamped out by a die can not be as accurate as one cut by machinery with a carefully prepared cutter.

The electrical parts of the meter do not require such exact mechanical work, even were it possible to use such in these parts. The meter has two series or current coils, and four shunt coils. These are wound carefully on formers, attention being paid to securing the proper insulation. The series coils are wound from a bare copper strip of a definite length, the adjacent turns being insulated from each other by paper tape. The shunt coils are formed by winding a definite number of turns of insulated wire on a spool. These are then coated with an insulating varnish and are placed upon a laminated core. Each coil is inspected several times and tested before being accepted for the stock-room.

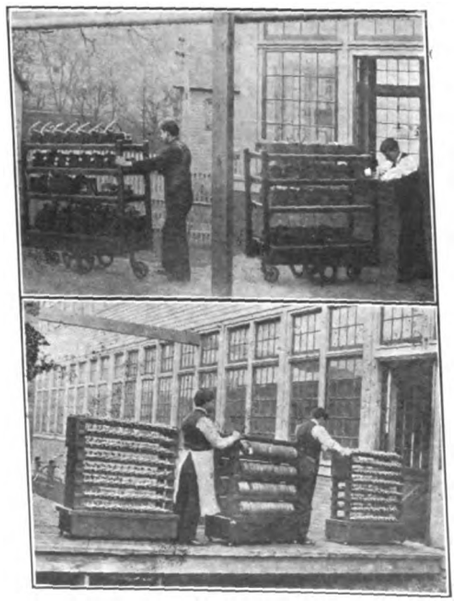
In the design of an induction meter it is important that the accuracy of the meter be not affected by the power-factor of the circuit which is drawing its supply through the meter. For a meter to be accurate on all power-factors ,the magnetic field set up in the air-gap by the shunt coils must be in quadrature with the electromotive force. If the lag on the flux is less than ninety degrees behind the electromotive force of the circuit, the meter will run slow on loads with a low power-factor or lagging current, and fast when the current leads. If it were possible to wind a shunt coil of a sufficient number of turns without any appreciable resistance, and if all losses in the iron core could be prevented, there would be no difficulty in securing this quadrature relation; but these conditions do not obtain in a meter that will be commercially practicable. This quadrature relation can, however, be obtained by modifying the shunt magnetic circuit. A magnetic bridge is arranged so as to shunt part of



CORNER IN INSPECTION DEPARTMENT WHERE ALL PRODUCT IS EXAMINED.

the flux set up by the shunt coils. This causes an additional lagging of the flux in the air-gap which is beyond the magnetic shunt, and by properly adjusting the length of the air-gap in this magnetic shunt circuit, the flux in the air-gap can be brought exactly into quadrature with the electromotive force of the circuit.

The parts of the Stanley meter are made as nearly alike as possible and are kept in stock, each piece having passed through several critical examinations before being accepted. The next stage in the construction of a meter is assembling,



TRUCK LOADS OF FINISHED METERS GOING TO SHIPPING DEPARTMENT. TRUCK LOADS OF PARTLY COMPLETED CASES AND FRAMES.

and great care must be exercised in putting together and adjusting these delicate parts, so as to get each exactly in its proper place. From the assembling rooms the meters are passed to the testing rooms. Here they are first examined and adjusted by passing through them a constant load for short intervals. When they have been adjusted as closely as possible, they are then given a test for determining the accuracy, and after that are put on the time test and run. For testing and adjusting the meter, the testing room at the Stanley shops is provided with circuits carrying different loads and different frequencies. At each table the operator can cut in the meter to be tested without disturbing any other operator. The load on each circuit is kept at a predetermined value by operators in another part of the room, so that there is no need to make any measurements at the meter. All that is necessary is to time the speed of the disc by a stop watch. Much, of course, depends upon the accuracy of the watch, and to keep a check on this each watch is tested before and after each day's work. The meters are tested at the frequency for which they are constructed at several loads and at power-factors of unity and one-half, the latter test being more severe than they are required to stand in practical operating conditions.

After adjusting and testing the meters, it is desirable that they should be sealed up to prevent any tampering. With the Stanley magnetic suspension meter this can be done, as there is no jewel to be injured by jarring or pounding of the disc during transportation. The users of these meters are not supposed to touch them after they have been put in place. The meters are shipped ready for attaching the wires, and they are guaranteed to retain their accuracy for three years without being adjusted.

The meter thus far considered is that which the Stanley company believes to be the most perfect recording wattmeter which has yet been put upon the market. There has, however, been a constant demand for a less expensive meter. Some of the electrical supply companies do not believe such extreme accuracy in measuring their product is necessary. For such cases the Stanley company is now making a meter on practically the same lines as the magnetic suspension meter, except that this suspension is omitted, and jewel bearings used. The same care is exercised in eliminating undesirable forces acting upon the disc, so as to prevent any strain on the jewels, except that due to the weight of the disc and its pinion. To prevent injury to the lower jewel, caused by vibration, this is mounted on a spring support which absorbs shocks and jars. These meters are calibrated to highest accuracy when sold; but, though the company believes they are subject to less wear than other jewel meters, it does not believe that any jewel

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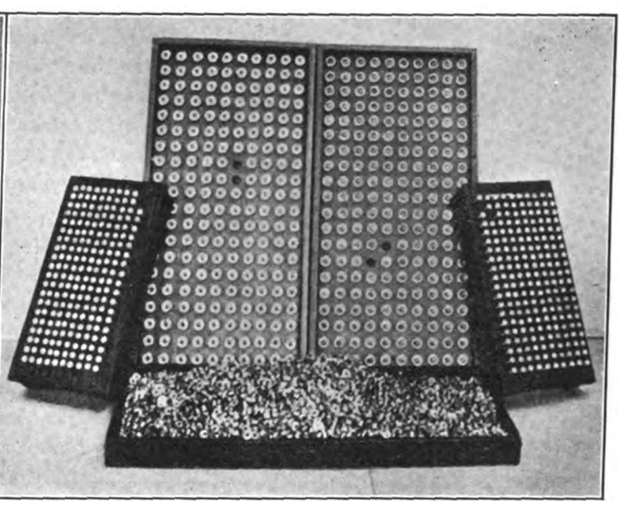
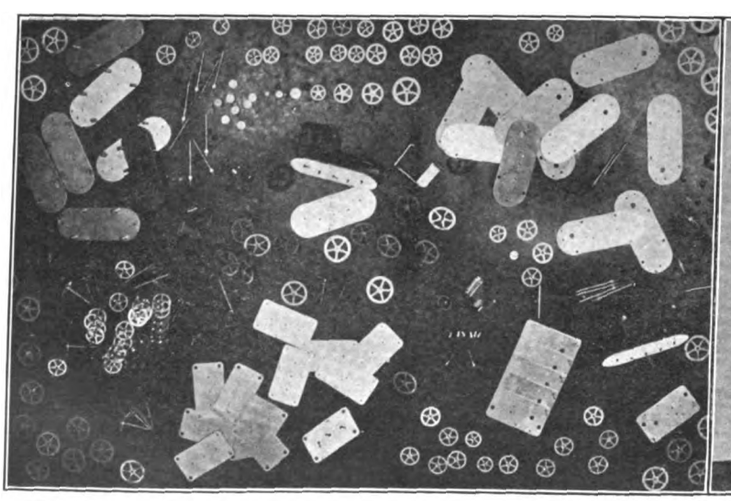
meter can maintain its accuracy for long periods as does the magnetic suspension meter.

So far attention has been directed to certain details only in the construction of the Stanley meter, but it will be appreciated that where such care and exactness are necessary in all stages of the work, the organization of the shop must be particularly well carried out. The illustrations given indicate, to some extent, how well this has been done at the shops of the Stanley Instrument Company. All the work is systematic and all the parts standard, for having secured a good design for a meter, the next step toward turning it out in quantity is standardization. This is necessary not merely for the sake of reducing the cost, but that there may be the least possible variation from the prescribed dimensions. The employment of highly skilled labor and the use of special tools whenever possible contributes much to this end. All parts of the Stanley meters are standard; they are made in quantities and kept in stock to be issued for assembling into meters as desired.

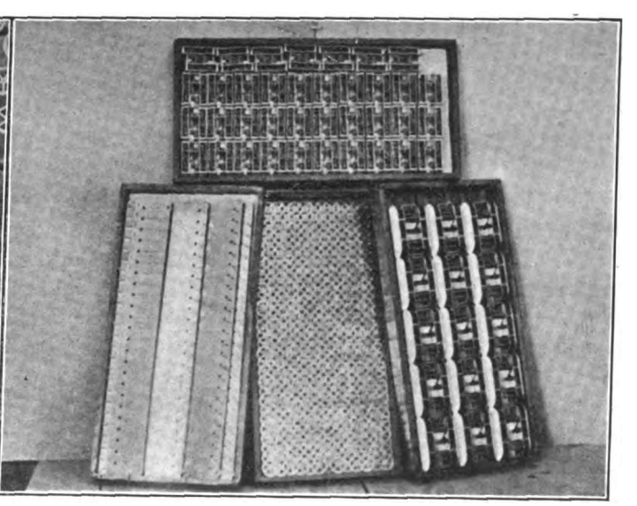
GROUP OF SPECIAL TOOLS AND GAUGES.



TRAYS CONTAINING SOME PARTS OF MAGNETIC SUSPENSION.



TRAIN PARTS.



TRAYS CONTAINING TRAIN PARTS.

Worcester Polytechnic Institute.

The high-potential transformer built by the electrical engineering department of the Worcester Polytechnic Institute in 1898 under the direction of Professor Harold B. Smith, the head of the department, has recently been sold to Mr. C. S. Knowles, of Boston, and has been sent by him to New Lexington, Ohio, for installation at that place. It will be used in connection with the high-voltage porcelain works in which Mr. Knowles is interested.

The transformer has already been installed and is now ready for testing work. The installation was performed by Messrs. J. A. Sandford and W. T. Goddard, assistants to Professor Smith in the electrical department of the institute. This transformer has, since it was built, been an object of considerable interest in electrical engineering circles, and enquiries have been received by Professor Smith respecting the details of its construction from all parts of the United States, and also from abroad. Its capacity is 150,000 volts, with a frequency of sixty, and, as is well known, this is the first transformer ever built in which so high a voltage was attained which could be successfully used for commercial purposes. The transformer was from the first entirely successful, and amply fulfilled the expectations entertained by Professor Smith when he first designed it. In searching for apparatus with which the necessary testing could be done, Mr. Knowles experienced great difficulty in obtaining satisfactory estimates from the different electrical companies; hence negotiations were opened with Professor Smith which finally resulted in the purchase of the transformer belonging to the Worcester institute.

It will be replaced immediately at the Worcester Polytechnic Institute by the construction of a new transformer which will contain a number of improvements. These have been devised during the experience of the electrical engineering department in high-potential work during the last five years. Mr. Sandford will remain at New Lexington where he will be engaged for some time conducting a series of experiments involving the use of high potentials.

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The Electrical Committee of the Underwriters' National Electrical Association.

The electrical committee of the Underwriters' National Electrical Association, which is the body which prepares the rules of electric wiring for the National Board of Fire Underwriters, held its meetings in the room of the New York Board of Fire Underwriters, 32 Nassau street, December 2 and 3, Mr. F. Elliot Cabot, chairman, and Mr. C. M. Goddard, secretary.

A large number of electricians connected with the insurance companies from all over the country were present, and also members of the national conference on electric lighting rules, the code committee of the American Institute of Electrical Engineers, and officers of the National Electrical Contractors' Association. It is the custom at these meetings to go over the rules for the purpose of making any amendments from the developments of experience or changes in applications of electricity during the past year. At this meeting the amendments were few in number and the policy of the committee governing the proceedings appears to be a deviation from the former methods of attention to details and a larger and greater weight to the general principles of results to be obtained. The principle amendments adopted were in the line of improvements in rosettes with knob and cleat work. A report was submitted by the committee on the standardization of enclosed fuses which recommended interchangeability of fuses of the same carrying capacity, and also the standardization of the fuse blocks in different sizes so that the tube containing a fuse of given capacity could only fit in a type of block made for a fuse of that capacity, in order that it would not be possible for fuses of too large capacity to be inserted in blocks for a smaller size.

In this work the committee has received the cooperation of the largest manufacturers of fuses and of electric lighting apparatus. The committee was given more time to complete a series of tests which had been laid out, and the results of which will be embodied in a later edition of the rules.

A committee on car rules presented a report of progress which states that it was in conference with a committee of the American Street Railway Association.

The proposed rules for protective car wiring contemplated making arrangements for the protection of the under side of the car above the electrical apparatus by fire-resisting material; the use of stranded conductors, and for all exposed conductors a flame-proof outer covering; the use of approved switches, cutouts, etc., with those having exposed metal parts which were connected with a circuit located in cabinets; and running of wires in metal conduit or any other methods protected by fire-resisting material; the abolition of cluster lighting and the substitution of individual lamps; electric heaters should be so placed that there will be a safe distance between the current-carrying parts and the woodwork of the car; and finally the design of terminals should be so improved that loose contacts may be avoided.

The secretary stated that the amendments to the rules of a year ago, particularly those providing against the hazard of extra high-potential circuits, had been promulgated and were thus far exceedingly satisfactory in their results.

At these meetings the proceedings are kept closely to the subject in hand, and the concentration of practical experience in electrical affairs over a wide range of the applications of electricity throughout the United States renders their deliberations very much to the point.

Water Powers on the Kennebec River, Maine.

The United States Geological Survey has recently completed a survey of the Kennebec river from tide water at Augusta to Moosehead lake. This survey shows the occurrence and location of a number of fine undeveloped water powers. In almost every place where there are plants in operation from one-half to two-thirds of the power still goes to waste.

At Augusta a seventeen-foot dam furnishes about 20,000 horse-power, of which only 4,000 horse-power is used. Eighteen miles up the river, at Waterville, two dams use only a trifling part of an available head of forty-two feet, and at Fairfield not more than one-tenth of the power of a sixteen-foot dam is employed. The same is true of the twelve-foot dam at Shawmut. At Skowhegan, where there is a fall in the river of twenty feet, only 7,000 horse-power is used.

Between Norridgewock and Madison there are sites that present fine opportunities for power development. For twenty-four miles above Solon there are a great many rapids and shoals, which have a total fall of 160 feet. Three miles above the forks, the last settlement up the river, is the first power, on Moxie stream, with a vertical drop of eighty-five feet. For four miles below Indian pond the river gorge is very narrow, with walls about 200 feet high. In this distance there is a fall of 190 feet, with several excellent sites for power development. The outlets of both Indian pond and Moosehead lake are controlled by crib dams that regulate the water for lumbering purposes.

The survey was made by Messrs. A. T. Fowler, John C. Hyer, and T. J. McMaugh during last summer. In addition to making a complete map plan of the river, showing all the islands and the position of the hills on either side, the party made accurate determinations of the height above the ocean of the top and bottom of each rapid and fall. They left permanent bench marks on which future surveys may be based. The elevation of Indian pond was found to be 933 feet and of Moosehead lake 1,029 feet.

Electrotechnical Industry of Germany.

[*From United States Deputy Consul-General Hanauer, Frankfort, Germany.*]

An essay on the electrotechnical industry of Germany, written by Dr. Brüner, the syndic of the Association for Fostering the Interests of German Electrotechnics, gives the following data: Germany's output of the electrotechnical products during the year 1898 aggregated 228,670,000 marks ($54,423,460) in value, of which 57,000,000 marks ($13,566,000) was for foreign orders. The value of the exports of electrotechnical products rose to nearly 100,000,000 marks ($23,800,000) in 1902, although the total production decreased considerably in that year.

The total amount of capital invested in German electrotechnical works and enterprises in 1900 amounted to 2,500,000,000 marks ($595,000,000). The greater part of this sum has since been wiped out by the depreciation of the share capital. Many of the enterprises inaugurated and conducted for their own account by the electric manufacturing companies proved unprofitable and had to be given up, nearly all the capital invested becoming a dead loss. Among these ventures electric railroads in mountain districts and tramways and lighting plants in the smaller towns form a large proportion of the losses.

The *Electrotechnical Journal* says that the increase of electric roads in Germany during 1902 was about 300 kilometres (186 miles), with an additional 400 kilometres (248 miles) in course of construction. The number of motor cars is estimated at 12,500, against 7,300 in 1901, and their power capacity at 30,000 kilowatts, against 25,530 kilowatts in 1901.

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NOTES ON X-LIGHT.

BY WILLIAM ROLLINS.

NOTE CLXXIV—RADIANT AREA FINDER.[1]

In earlier notes X-light tubes in which the walls were the source of X-light were recommended for therapeutic purposes; the form and position of the cathode determining the position and size of the radiant area. Before using such tubes, it is desirable to test them to see if the X-light is given off from the calculated area. For this purpose, a brass tube covered with lead and containing diaphragm plates and a fluorescent screen is useful. The tube is one metre long and twenty-five millimetres in diameter. At one end there is a diaphragm plate D with a hole five millimetres in diameter. A similar plate is placed at D2; the fluorescent screen at FS; a circular plate of heavy lead glass at LG, to protect the observer from the X-light. One eye is applied to the eyepiece EP of the tube, which is directed toward the radiant area, until a round spot of light is seen on the fluorescent screen. The other eye looking through the glass plate sees the direction in which the tube is pointed, which is the line of the ray of X-light. By moving the tube about, a mental picture is obtained of the size and position of the radiant area. In earlier notes the necessity of using the X-light tube in a non-radiable box was shown, no X-light being allowed to strike the observer. When investigating X-light tubes this box cannot always be used. In these cases, the observer must protect himself in the way already recommended by non-radiable coverings. In note xlv, a covering of this kind was described which was made by coating cloth with a flexible non-radiable paint. As one person has thought well enough of this idea to ask for the formula for the paint, it is given here:

FLEXIBLE NON-RADIABLE PAINT FOR COATING CLOTH COVERING TO PROTECT FROM X-LIGHT.

White lead paint..... 9 pounds
Soap..... 2½ ounces
Water.....12 ounces

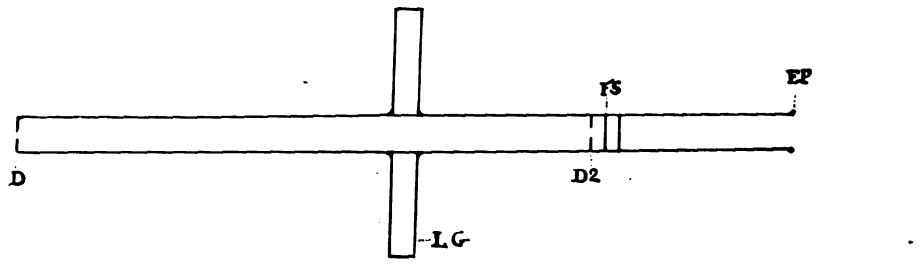
Heat the water to 212 degrees Fahrenheit, dissolving the soap in it. Pour the mixture while hot into the paint, stirring until well mixed. As this paint comes off slowly after a time, a better way is to mix dry powdered white lead with rubber dissolved in benzole, spreading the mixture between two sheets of cotton cloth, which are then pressed together. This method protects the non-radiable coating.

If lead is considered undesirable a bismuth compound can be used mixed either with a drying oil or rubber dissolved in benzole, but a greater thickness is required. November, 1903.

The idea of using paint of this kind as a protection from X-light occurred after seeing it employed by Mr. C. A. Welch on the coverings for sails, which need to be flexible and waterprof. Experimenters with X-light will find a long white duck coat, of the kind used by marketmen, a convenient garment when coated with this paint. A pair of white cotton or thin rubber gloves, recommended in earlier notes, should also be painted in the same way and used to protect the hands. They soon break up the unwise habit of employing the hands as a test of the strength of the X-light. The lower parts of the body are easily protected from the direct X-light by a non-radiable table placed below the tube which is being studied, as the shadow it casts covers them.

NOTE CLXXV—DESIGNING X-LIGHT TUBES.

The tube shown in Fig. 1 is of the type illustrated and described in note cxxxviii.



NOTE 174.—FIG. 1.

The centres from which the curves are struck and the length of the radii are given. The vacuum regulators operate on the principle first embodied in my tubes and later described in this series of notes, that of having two regulators, one a regenerator[1] to permanently lower the resistance of the tube, the other to lower the starting resistance and then automatically keep the working resistance of the tube at any desired point. The importance of being able to always regulate the light during an examination is so great that it has been much dwelt upon and made into an X-light axiom.

In the tube shown in Fig. 1, both regulators are operated by the generator used to excite the X-light tube. When the tube is to be used, the regulators are arranged as shown in Fig. 2. The current then does not go through the permanent regulator. It goes from the electric generator through the arm A to the wire B, the spark-gap S, the automatic regulator AR, the stem of the terminal C to the electric generator. The regenerate the tube, the starting resistance is reduced to any determined point, for example, 150 millimetres by the automatic regulator to prevent risk of puncture. The stem A is then lifted quickly (to the position of the dotted line A2), the regulator HR put into the circuit (by turning the arm HW down into the position shown by the dotted line HW2); the current going through the stem of the terminal T, the wire HW3, the regulator HR, the wire HW2, the wire B, the spark-gap S, the automatic regulator AR, the stem of the other terminal (C) to the electric generator, until the resistance of the tube is less than 150 millimetres, when the current will leave the regulator and regenerator circuits, passing through the X-light tube between the faces of the terminals, the regulators ceasing to operate. The arm HW2 is then raised, cutting off the current from the regulator HR. The arm A is brought in contact with the terminal disc TD, fully described in earlier notes. The current then goes through the automatic regulator; the resistance of the tube being maintained at any point less than 150 millimetres by the length of the spark-gap S which is controlled by a handle RH4 (note cxlvi, Figs 5 and 5A), and described in note cliii. The handle is within reach of the operator while making an examination or taking a photograph. The kind of X-light can therefore be varied without interrupting the examination. As the X-light tube is intended for use in a tube box (illustrated in note clvi), provision must be made to prevent the spark-gap from cutting off any of the X-light escaping through the openings of the diaphragm. In the tube illustrated in note cxxxviii this was effected by having the stem of the target arranged to allow the latter to face in several directions. If this idea is not used, the spark-gap tube should be placed at an angle. The regulator and regenerator are both somewhat alike in appearance. One contains a chemical which liberates a gas

[1] No originality is claimed for the principle of this finder.

[1] As it seemed possible that one cause for the deterioration of X-light tubes by use might be that some of the charged particles formed during the action of the tube pass out through the glass well, the tubes were kept in an enclosure with radium salts to see if the charged particles shot off from the radioactive material might not by passing into the tube supply the loss. The experiment should be repeated now with pure radium bromide which can be purchased by any rich person.

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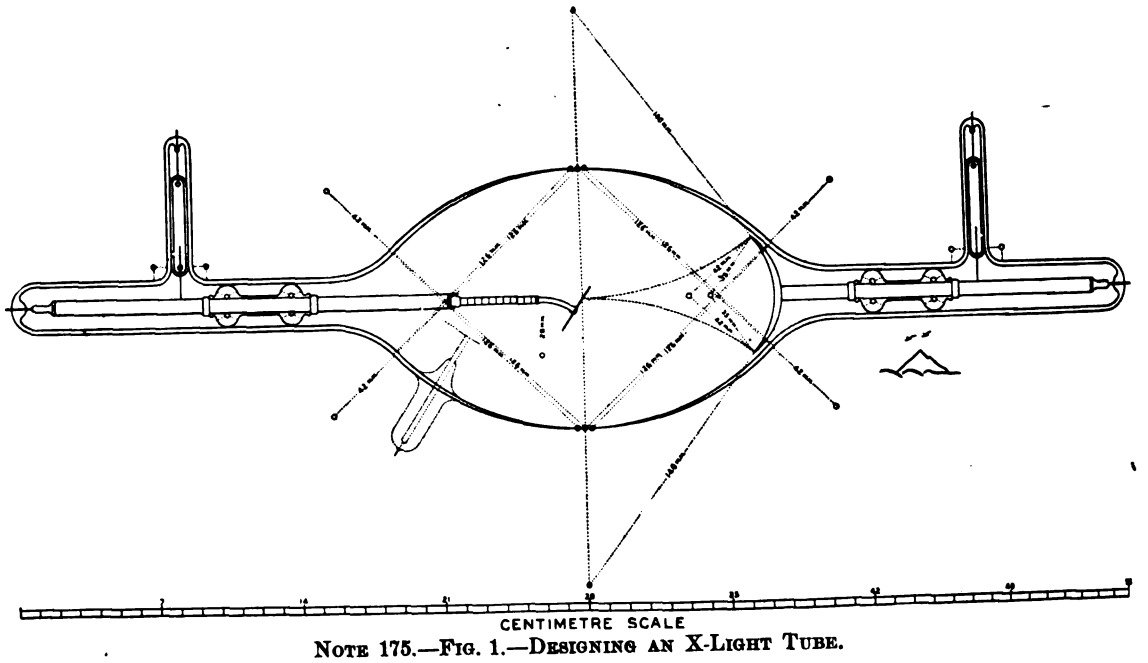
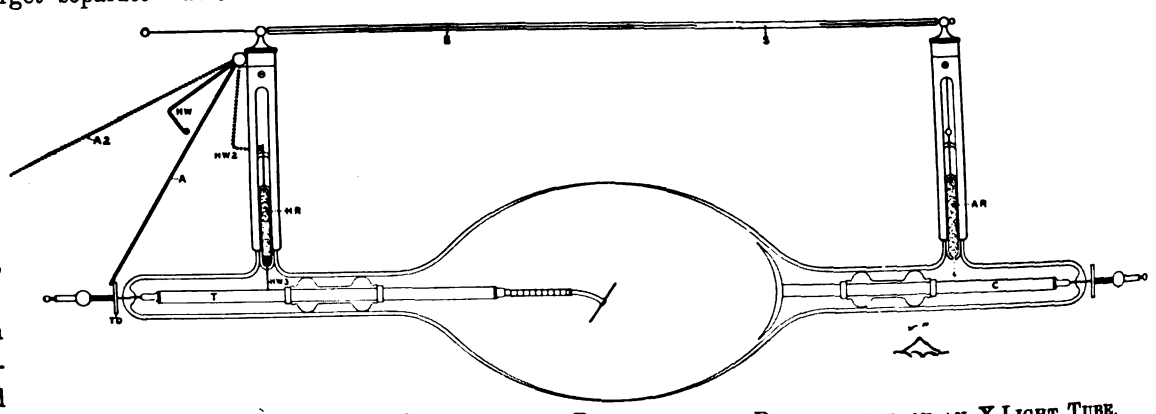
that it reabsorbs, while the other liberates a gas which it does not reabsorb. The tubes in which chemicals are placed are shown in Figs. 2 and 3. Each form has a platinum wire sealed into one end. Another wire may be sealed into the other end, or the end may be open, the openings serving for the introduction of the chemical, in a powdered state mixed with a conducting substance, gold foil, for example, as described in note cxxxix. The opening, whether in the side or end, is closed with spun glass. This construction of regulators and regenerators is useful in experimenting with gases, helium, for example, which are contained in minerals, as the high temperature produced in the interior of the powdered chemical by the current as it jumps from one bit of conducting material to another is efficient in liberating the gas. The tubes are to be heated in an oven before being used. If any material collects on the outside, it is to be removed before sealing into the X-light tube; particular attention being paid to having a free passage for the gas through the spun glass plugs.

In Fig. 3 is shown a cooled target tube constructed on the same design as the tube illustrated in Fig. 1.[1] If it is desired to construct a tube with three terminals on the principle first recognized in these experiments of having the target separate from the anode (though capable of being connected with it) and nearer the cathode, the third terminal may be placed as shown by the dotted lines in Fig. 1. For further details as to this type of tube refer to notes iv, xvi, xxxi.

This principle has been extensively adopted by several makers of tubes and such tubes are the most common forms now both in America and Germany.



NOTE 175.—FIG. 1.—DESIGNING AN X-LIGHT TUBE.



NOTE 175.—FIG. 2.—METHOD OF OPERATING THE REGULATOR AND REGENERATOR OF AN X-LIGHT TUBE.

NOTE CLXXVI—ON THE MEDICAL USE OF SOME OTHER ETHER MOTIONS BESIDES X-LIGHT.

In the Boston *Medical and Surgical Journal* for February 25, 1897, attention was called to a method of reducing pain and inflammation by sending a high-voltage current directly through the tissues by connecting the patient with both terminals of the electric generator. Since that time the method has been in constant use, thereore it will be mentioned here, though not an X-light treatment. The procedure is painless if the terminals of the generator are of proper size for the amount of current and are in direct contact with the patient while the current is passing. In the note mentioned, a simple foot switch was recommended for starting the current after contact, and stopping it before the contact was broken. This is important as the treatment often requires to be of considerable length, making it convenient to have the patient able to control the current to save the physician's time. The experiments were made because it seemed possible to electrically produce and maintain a condition of the ether which would prevent the transmission of unwise messages by the nerves, and yet allow useful ones to be sent.

In note xxx and subsequent notes it was said an X-light tube produced not only ether waves which were X-light, but longer waves down to and below those of ordinary light. Here is pointed out the value of some of these waves in the treatment of disease. The experiments have been chiefly confined to the lower animals, but a limited experience with man has shown the value of the method in skin diseases.

The waves may be produced from vacuum tubes of the type recommended in some earlier notes for therapeutics. The cathode should not bring the Varley stream to a focus, as a small area of radiant energy is not required, for definition is not sought. The cathode stream particles should strike either a broad metal target or the interior wall of the vacuum tube. The area of impact should be sufficient to prevent injurious heating, the size varying with the diseased area to be treated. The impact gives rise to ether (electromagnetic) waves longer than those of X-light, because the velocity of the impact of the cathode stream particles is less than in an X-light tube, owing to the less exhaustion of the ter-

[1] Refer to note i.

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minals and the greater density of the atmosphere of the tube. This treatment is to be distinguished from that of X-light, ultra-violet light, violet light, ordinary light, heat and high-frequency waves, as the ether motions are not the same. In treating skin diseases less care is required than with X-light to avoid injury to the tissues, as the burns which can be produced are less serious and more superficial. On the other hand, the treatment may be extended to a greater depth than with Finsen light. It requires less electrical energy, for the proportion of heat waves generated is smaller and the source of waves can be almost in contact with the skin. Tubes for producing these waves are less expensive than X-light tubes, as the prolonged electrical treatment of the terminals is not required. The resistance of the tube should be too low for X-light to be produced. The tubes should be given forms suited for the areas to be treated. The area from which the waves arise will be determined by the form of the cathode which should be constructed in accordance with the results of the experiments mentioned in earlier notes. Precautions should be taken to protect the patient from other radiations, charged bodies and electrons, when these are not wanted.

NOTE CLXXVII—A GROUPING OF SOME OF THE AXIOMS MENTIONED.

In an X-light tube the space enclosed by the glass walls should vary directly with the rate of using electrical energy in the tube.

In an X-light tube the size of the cathode should vary directly with the rate of discharging electricity from its face, and with the size of the surges.

In an X-light tube the target should be cooled when it is struck by a powerful cathode discharge.

In an X-light tube the target should be placed at the focus of the cathode discharge.

In an X-light tube the distance between the cathode and the target should be capable of variation, or there should be an automatic regulator.

In pumping X-light tubes the X-light should not strike the observer.

In pumping X-light tubes they should be enclosed in a non-radiable oven.

In pumping X-light tubes water vapor should be excluded from the pump.

In pumping X-light tubes mercury should be kept out of the tube.

In pumping X-light tubes the removal of the gases is but a part of the work, the value of the tube depending also on the electrical treatment of the terminals.

In pumping X-light tubes they should be hot, and the pump should be warm.

In pumping X-light tubes the necessary amount of gas should be removed from the glass and the interior of the tube before they are electrically taken from the terminals.

In pumping X-light tubes the absence of leaks should be ensured before the electrical treatment of the terminals begins.

In pumping X-light tubes the amount of electrical energy to be afterward used with the tube should be known, the terminals being treated to bear that amount.

In using X-light the source should be in a non-radiable tube box from which no X-light can escape except the smallest beam which will serve the purpose.

In using X-light it should not strike the observer.

In using X-light selective filters should be employed to strain out undesirable radiations.

In using X-light, the fluorescent screen should be covered on the side toward the observer with a plate of heavy lead glass as a protection from the X-light.

In using X-light with a cryptoscope, the walls of the instrument should be non-radiable to prevent the entrance of X-light except in the direct beam.

In using X-light with a fluorescent screen, whether open or enclosed in a cryptoscope, the surface of the screen should be held normal to the central ray of X-light employed.

In making photographs by X-light, only the beam arising from the radiant area of the target should be allowed to strike the photographic plate.

In making photographs by X-light, the central ray of the beam of X-light employed should strike the photographic plate normal to its surface.

In making photographs by X-light, the place where the central ray of the beam employed strikes the plate should be automatically recorded on the negative.

In making photographs by X-light, the position and distance of the source of X-light should be automatically recorded on the negative.

In making photographs by X-light, the object being photographed should be enveloped in a non-radiable covering which will admit only the X-light in the direct beam employed.

In using X-light in medicine, the examination room should be fumigated every night.

In using X-light in medicine, the apparatus should be sterile.

In using X-light in medicine, none should strike the patient except the smallest beam which will cover the area to be examined, photographed or treated.

In using X-light in diagnosis, to avoid undue exposure of the patient, the X-light should be produced in surges, each of the shortest possible duration, with as long periods between as are compatible with a light apparently steady, advantage being taken of the persistence of vision and of luminescence. The more luminescent the salt of the fluorescent screen the shorter the surges may and should be, with moving organs like the heart and lungs.

In using X-light in medicine, the physician should be able to make all the adjustments of the light without removing his eyes from the images on the fluorescent screen.

In using X-light in medicine, the physician should be able to orient himself in relation to the patient and the source of X-light at all times during an examination without removing his eyes from the image on the fluorescent screen.

In using X-light in therapeutics, its waves should be such as are most absorbed by the diseased tissues.

In using X-light in therapeutics, the waves should be as long as can be employed without injury to the overlying tissues.

In using X-light in therapeutics, the distance of its source from the surface of the body through which the X-light enters should vary directly with the distances of the diseased tissue below that of the surface.

In using X-light in therapeutics, the distance of the diseased tissues below the surface of the body through which the X-light enters should determine the form of vacuum tube to be employed.

In using X-light in therapeutics, the nearer the diseased tissue is to the surface of the body through which the X-light enters, the nearer the source of X-light should be to the nearest wall of the vacuum tube.

In using X-light in treating diseases of the outer surface of the body, the X-light tube should be in a portable non-radiable case from which no X-light can escape except toward the diseased tissues, the tube box being provided with a handle to allow the tube to be moved over the diseased area.

In using X-light in treating diseases of the outer surface of the body, the source of X-light should be at the wall of the vacuum tube.

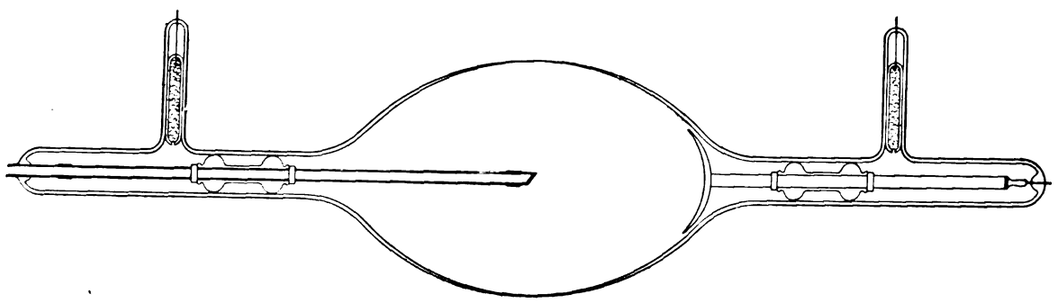
In using X-light in treating diseases of the outer surface of the body, the area to be treated should determine the area of the tube wall from which X-light should originate.

In using X-light in treating diseases of the outer surface of the body where the vacuum tube is brought in contact with the skin, the area of the wall of the tube from which X-light arises should be cooled. In using radioactivity, the source of the energy should be in a case from which no radioactivity can escape except in the required direction.

In using radioactivity, the investigator should be protected from the energy.

In using radioactivity in medicine, the beam of energy striking the patient should be the smallest which will cover the area to be examined, photographed or treated.

In using radioactivity in medicine, the distance of the source of energy from the surface of the body through which the energy must pass should vary directly with the distance of the diseased tissue below that surface; the nearer the disease to the surface the nearer the source of energy should be to the surface.



NOTE 175.—FIG. 8.—COOLED TARGET TUBE.

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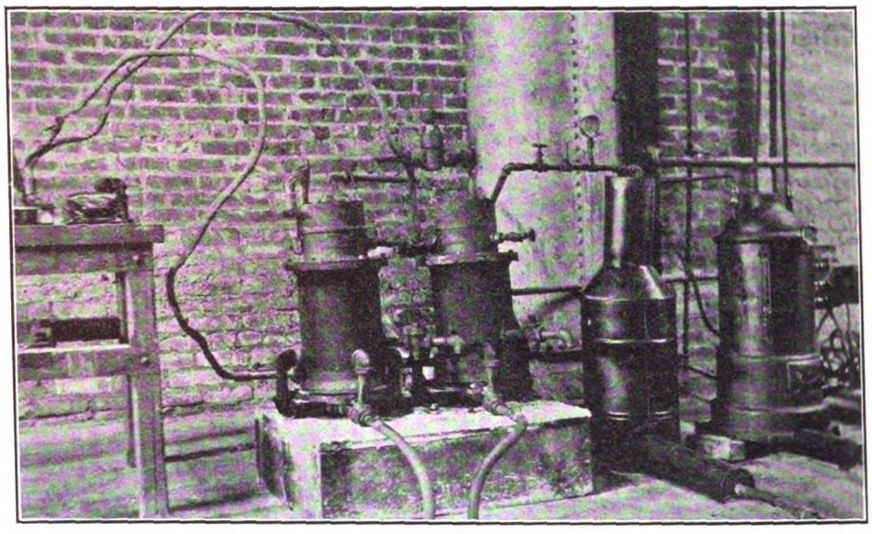
A New Device for Producing Electrical Currents.

On Wednesday, December 2, a demonstration was given at 352 Mulberry street, Newark, N. J., of the "Dynelectron," an apparatus designed by Mr. James H. Reid and his son, Mr. Allen E. Reid, for the direct production of electrical energy from fuel. A gas retort was charged with culm mixed with street sweepings and oil, and heated externally, steam being passed through the retort. The gas thus produced was mixed with air, in the proportion of one volume of gas to forty of air, and was then forced through two cells consisting of cast-iron shells, containing a molten electrolyte and carbon rods. The two cells were connected in series, and upon open circuit gave 1.8 volts; and upon short-circuit through an ammeter, from fifty to sixty amperes flowed. The electrolyte was kept hot by burning gas under the cells.

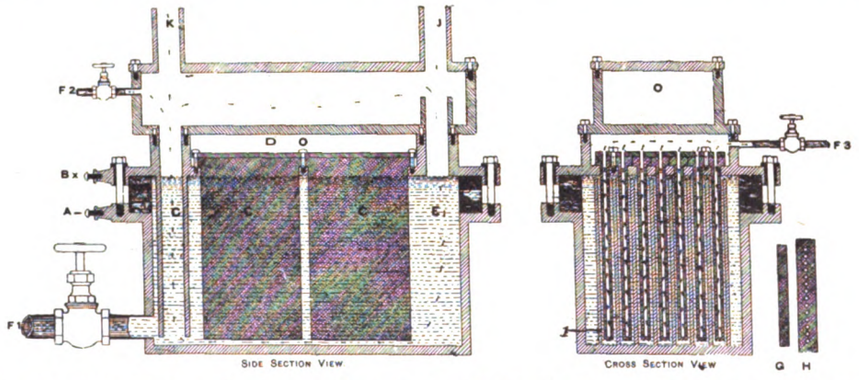
The construction of the cell will be understood from the following diagram, although the apparatus used in the demonstration differed in certain mechanical details from this. The containing-vessel is of iron, with an insulated cover. From this cover are suspended the carbon electrodes C. These are hollow and porous, and their method of formation is such that the inventor believes they will not disintegrate. Certain of these electrolytes, he says, have been used for about a month, day and night, and show no change whatever, either upon microscopic or chemical examination. Around these electrolytes, and projecting up from the containing-vessel, are perforated iron plates. The cell is filled with an electrolyte consisting of an oxide of calcium, sodium and iron, designated as E in the drawing. The vessel is heated by any means to a temperature of about 390 degrees Fahrenheit, which maintains the electrolyte in a molten condition.

Through the hollow carbons is forced the mixture of combustible gas and air, prepared in any manner whatever. This percolates through the pores of the carbon out into the electrolyte, passes up through this, and escapes through the pipes K J. In its passage through the electrolyte this foams over into the chamber above the cell, and then runs back through the pipe C. It is thus kept constantly in circulation. The electrolyte, it is said, is not affected by the reactions in the cell, and that which was used in the demonstration has been in constant use for experimental purposes for three years.

The demonstration was not intended to prove the efficiency of this process, but merely to show that considerable current could be drawn from these cells. Mr. Reid, however, says that the efficiency of this process is about forty-five per cent. Any fuel can be used, and the flow of gas will be regulated automatically in the completed machines. Mr. Reid is now preparing to build machines for 100 horsepower. These will be eight feet by eight feet by ten feet high, and will generate about ten volts. The cost of a generator of this kind, he says, will not be more than twenty-five per cent of that of an equivalent steam plant. One of the experimental types which was constructed was rated at sixty horse-power. It contained seven cells and gave 6.3 volts. From tests upon this apparatus Mr. Reid was convinced that he was obtaining as electrical energy seventy-two per cent of the energy contained in the gas. This was of poor quality, running about 650 B. T. U. to the cubic foot, and five feet were used per horse-power. This apparatus failed, however, because the carbon electrodes went to pieces quickly, and it required eighteen months of hard work to produce an electrode which would not disintegrate.



A New Apparatus for Producing Electrical Currents.



Side-Section and Cross-Section of New Apparatus for Producing Electrical Currents.

In the completed design it is intended to return the gases given off from the cell under the cell, and use them for heating it and to assist in producing the gas. When a cell is once put into operation it can be worked continuously for an indefinite length of time, as there is not thought to be any corrosion of the iron vessel or disintegration of the carbon, and no change in the electrolyte.

Telephone and Telegraph Construction for the New Republic of Panama.

The director-general of the national telegraph and telephone systems of the republic of Panama is in the market for telegraphic and telephonic material. He would be pleased to receive catalogues descriptive of this material, as the national government is reconstructing the systems throughout the whole country, and would prefer to buy American material. One of the essential elements of the construction in this country is cheap iron poles to carry one or two telegraphic wires. The director would be glad to receive ideas as to costs, weights, etc. Iron poles must be used, because, when the big plains are burned during the summer, the bases of wooden poles burn through. Prices are also asked on telephone cables. The address is: E. T. Leferve, director-general, post office box 290, Panama, Republica de Panama.

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CARBIDES.

BY ALEX. A. BEADLE.

The production of metallic carbides in the electric furnace has received much study of late, notably in Germany, where those of all the more ordinary and many of the rarer metals have been produced and their properties studied.

On account of the very high temperature which is required to produce most of the less fusible carbides, the electric furnace has been almost exclusively used for their production, but it would be interesting first to see if any of them has been made by the aid of the ordinary or regenerative combustion furnace.

The regenerative furnace places at our disposal a temperature of about 1,700 degrees to 1,800 degrees centigrade, which for several reasons is not at all likely to be increased by this principle. The oxy-hydrogen regenerating furnace gives us, however, at least another 200 degrees centigrade to make use of on account of the absence of the diluting action of the nitrogen which is here eliminated and for several other reasons. According to Hall, calcium carbide can be produced at a temperature of 1,500 degrees centigrade, which is well within the limits of the regenerative furnace. Bergmann also produces it by means of an ordinary blast furnace, for which purpose he uses a charge of coke and lime, but in the place of air he uses oxygen which, of course, greatly increases the available temperature.

It does not appear that any other carbides can be thus produced, but for this purpose the electric furnace is called into requisition. This, however, places at our disposal probably another 1,500 degrees centigrade, which makes all the difference.

The reactions which take place in the electric furnace when the oxide of a metal is heated with carbon are somewhat more complicated than it would at first appear. It is manifest that the reactions and the final result are to a very large extent influenced by the proportion of the carbon to the oxide in the charge. If, for instance, a charge is introduced into the electric furnace in which there is just sufficient carbon to combine with the oxygen of the metallic oxide to form an equivalent of carbon monoxide and there is no appreciable excess, we should expect a metal as the final product. If, however, we introduce with the charge a large excess of carbon, sufficient to form a carbide, we should expect to find the whole of the metal converted from the form of oxide to that of carbide. This is to a large extent true; thus if manganic oxide be mixed with about eighteen per cent of carbon the metal is reduced, but if the proportion in the body of the charge much exceeds twenty per cent a large proportion of carbide of manganese is produced.

It is not really essential to introduce in the first instance a charge containing the metal to be reduced, or converted into carbide, in the form of oxide, but it may be used as a salt which is itself capable of forming an oxide upon calcination. In this way metallic chromium may be reduced from calcium chromite or chromate or sodium bichromate, titanium from titanite and manganese or molybdenum from a manganate or molybdate.

Almost all the commoner metals and many of the rarer ones are capable of forming carbides in the electric furnace, and although the composition of some of these is somewhat doubtful, many present but little difficulty.

Among the industrial metals the most important carbides are those of aluminum (Al_4C_3), iron (FeC_3), magnesium (MgC_2), manganese (Mn_3C), and tungsten (W_2C). Among the alkali metals are caesium (Cs_2C_2), sodium (Na_2C_2), and potassium (K_2C_2). Among those of the alkali earths, barium (BaC_2), calcium (CaC_2) and strontium (SrC_2). Among the rarer metals and metalloids, boron (BC (Wahl and Green) and BC (Moisson)), cerium (CeC_2), lanthanum (LaC_2), molybdenum (Mo_2C_3), selenium (SeC_2), silicon (SiC "carborundum"), thorium (ThC_2), titanium (TiC), uranium (U_2C_3), and zirconium (ZrC).

There are but few of the properties of metallic carbides which interest the chemist besides the power to decompose water or to withstand oxidation, and in one or two instances, the conducting power and hardness.

Two carbides possess the property of hardness in an extreme degree, carbide of silicon, now called carborundum, the hardness of which lies between 9 and 10, nearer in fact to 10, and also boron carbide (B_6C) which, if anything, is even slightly harder than carborundum. But the latter carbide is obviously the cheaper of the two and, as it is nearly as hard, it is of more commercial value.

With regard to the oxidizing action of water or damp air, five at least can be said to be quite inert at or near the ordinary temperature, namely, those of boron, silicon, titanium and zirconium. Six are strongly acted upon, namely, those of barium, caesium, calcium, lanthanum, thorium and uranium. The rest lie midway between these two classes, being slowly decomposed.

The kind of reaction which takes place when these carbides are decomposed by water or moist air is somewhat complicated, depending upon the valency of the metal, etc. The following examples of reactions may, however, give some idea as to what generally takes place.

Manganese carbide evolves a mixture of methane and hydrogen, according to the equation—

$$MnC + 6H_2O = 3MnOH_2 + CH_4 + H_2$$

Those of the cerium group evolve a mixture of methane and acetylene, thus—

$$3CeC_2 + 6H_2O = 3CeOH_2 + CH_4 + C_2H_2.$$

Thorium and uranium carbides yield in addition to this some hydrogen, while the carbides of calcium, barium and strontium evolve acetylene.

Calcium carbide is used for the production of acetylene in preference to the other carbides on account of the more general occurrence and consequent cheapness of lime, but it appears that barium and strontium would work as well.

A new compound called "siloxicon," very much akin to a carbide but apparently containing some combined oxygen and which has lately been discovered by Mr. E. G. Acheson, may here be mentioned. Its composition is apparently Si_2C_2O. According to Mr. Acheson this body, when heated to about 5,000 degrees Fahrenheit, splits up into carborundum, silicon and carbon monoxide, the vapors of the two latter being driven off. If oxygen is admitted at this temperature or considerably below it the siloxicon simply decomposes or burns into silica and carbonic acid. He also states that under similar conditions carborundum has been found to be oxidizable. This body seems to be a sort of basic or acid carbide, and it will be interesting to see if other metalloids are capable of forming corresponding compounds.

One of the greatest enemies and causes of trouble to any first-class packing is water in cylinders, which, when it occurs, demoralizes the packing. Strange to say, no metallic packing has been designed which will give first-class results as a water packing—the water rods of pumps, for instance. When first applied they usually work with fair success, but soon commence to leak and continue doing so. Also no thoroughly satisfactory packing has been invented and used for expansion joints. There is quite a large field for investigation in this direction.—*Scientific American.*

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Telephone Systems and the Fire Hazard.

The Insurance Society of New York held a meeting at the rooms of the Underwriters' Club on Tuesday evening, November 24, at which Mr. C. J. H. Woodbury, of the American Telephone and Telegraph Company, spoke on "The Telephone System."

As would be expected of a paper before that society, the speaker directed the main portion of his theme toward the conditions of the telephone system pertaining to the interests of underwriters. He explained the extent of the telephone plant and the methods of operation, but largely the methods of construction of the buildings and the extreme care which is taken in the management of telephone companies to guarantee the continuity of the service, and these measures were largely those of the prevention of the occurrence of fire which would be one of the more serious damages to such property. On the equipment of the telephone lines with protectors to defend against the whole range of foreign currents, he said that telephone protectors used by the Bell companies, which are especially careful in this regard, are threefold in their nature, the first element consisting of a fuse made of an alloy which is contained in a tube of vulcanized fibre and these fuses will deflagrate when exposed to currents of seven to ten amperes, the capacity of the fuse being varied according to the type of the apparatus.

The next element consists of a pair of small carbon blocks whose larger surface measures about one by one and one-half inches, one of which is connected to the telephone circuit and the corresponding block to the earth and separated by a sheet of mica, a portion of which is cut away so that the surfaces are exposed to each other. A small cavity in one of the opposite faces of the carbon is filled with a button of solder such as is used in automatic sprinklers and which melts at 165 Fahrenheit. The distance between the carbons is such that electricity at over 350 volts will pass from the carbon connected with the telephone circuit across this space to the opposite carbons and thence to earth, thereby relieving the telephonic apparatus of electric tension exceeding 350 volts; thus, if the foreign current exceeds the carrying capacity of the tubular fuse its deflagration opens the circuit at that point. If, however, it is less in volume than the carrying capacity of the fuse and over 350 volts tension, it leaps across the thin space separating the carbons and thence passes to earth. The resistance of the tiny arc in the space between the carbons is sufficient to warm them and cause the fusible metal to flow from its recess and fill the space between the carbons and thus establish a conductor of low resistance to earth. This diminished resistance generally causes a sufficient increase in the foreign current imposed upon a line to cause the tubular fuse to deflagrate and open the circuit if it did not do so on the first occurrence of the contact which imposed the foreign circuit on the telephone circuit.

In order to protect the fine wires of the telephone apparatus from injury by currents which are too small to operate the tubular fuse and of too low tension to pass to earth through the carbon cutouts a third element, known as the heat coil, is employed which is a fine German silver wire and which forms a part of the telephone circuit and is heated by a current of one-sixth of an ampere to a temperature sufficient to release a conductor ordinarily secured by fusible solder and pass the current to earth. This latter element of the device is not used at the subscriber's end of the line in these modern types of telephone apparatus in which the circuit is normally open except when the telephone is in use. The result of this protective apparatus has been so successful as to establish conditions of immunity in the Bell system of telephony against mishaps to the apparatus resulting from foreign currents and lighting throughout an experience of many years.

Every possible precaution must be taken to avoid contact between high-tension and signaling lines and prevent the occurrence rather than to rely upon protective devices to defend the plant against physical injury, because the operation of a protector suspends the service over that line for the time being. At crossovers it is preferable that the high-tension line should be above, as its wires are of larger diameter and generally fewer in number. The simplest method to prevent contact in such positions is to make the upper span so short that the radial distance from the lowest wire of the upper span to the nearest wire in the lower span is less than the width of the upper span and then to dead end wires to prevent overhauling in case of breakage occurring on adjacent spans. In many instances this method of line construction is unfeasible because the poles for such a short upper span would interfere with the requirements of travel in the highway and other methods of preventing contact in case of breakage must be adopted, usually by guard wires which in some instances are connected by slats secured transversely across them. When different lines are parallel to each other the distance between them should be so great that the highway lines could not touch the wire of the lower line if it fell toward it. In all cases when high-tension and signaling wires approach each other every precaution should be taken to prevent against possible contact by the use of heavy material in construction and guys and braces to the poles as may be needed to assure their stability.

Placing wires underground appears to have eliminated all of the hazards, if the ordinary principles of construction of refraining from placing high-tension and signaling wires in adjacent conduits are observed.

He corrected the general opinion of the damagability of the switchboard by water stating that although the switchboard was sensitive to water and must be absolutely dry for successful operation, yet they have been dried out after being wet and that in such respects are no exception to many other classes of contents of buildings, and that the facts are far different from the newspaper item which was quoted to the effect that a tumbler of water would cause a thousand dollars damage on a switchboard.

Of the advantages to the underwriters of the private branch exchange system, now generally in vogue in large establishments, was mentioned the fundamental difference being that whatever fire hazard existed to a telephone without considering the question of protectors was proportionate to the exposure of the line wires to the wires of other currents, and if these wires could be reduced in number, as is the case with a private branch exchange, the fundamental hazard is diminished in like ratio; furthermore, it is an advantage to have the wires under skilled supervision as they are in such instances, especially in case of emergency calls and especially in cases of fire, because if one circuit is out of order another one can be used. The buildings erected by the telephone companies are of fireproof construction, especially designed for the purpose, with a view to obtaining stability under heavy loads and to afford resistance by fire. They are equipped with subsidiary fire apparatus, and windows opening toward exposures are provided with fire shutters. In smaller towns, where special telephone buildings are not warranted, every endeavor is made to obtain quarters in the best building possible in order that the permanency of the station may not be interfered with by the general fire hazard. The telephone property is under constant supervision of the most systematic manner, in addition to the constant occupancy by the operators who can reach the fire department at any time.

Many details were given by the speaker of elements of the telephone system in order to set before the audience the wide scope of its applications to every-day life and the absolute necessity of taking every possible precaution for the permanency of the service.

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The Finzi Single-Phase, Alternating-Current Traction Motor.

By Enrico Bignami.

THE single-phase alternating-current traction motor recently designed and tested at Milan, Italy, by Dr. G. Finzi, is the natural adaptation of the marine type of continuous-current motor made by the Brioschi-Finzi Company. This motor has been the standard type for auxiliary uses on board of the Italian men-of-war, and its characteristics are laminated multipolar field core, with longitudinally divided poles, a small air-gap and low speed, and, lastly, a set of resistances connecting the inductor windings through the commutator sections.

The longitudinal division of the poles, as often suggested and sometimes used, is fully as important as the laminating of the field, and stands as the simplest means of killing the reaction flux of the armature.

The single-phase traction motor designed by Dr. Georgi Finzi was first of all accurately tested in the testing room of the Gadda Brioschi-Finzi shop. Out of the results, the characteristic curves of the motor were drawn (Figs. 1 and 2). Fig. 1 shows for each voltage applied, the amperes in function of the angular speed (full lines) and of the torque (dotted lines).

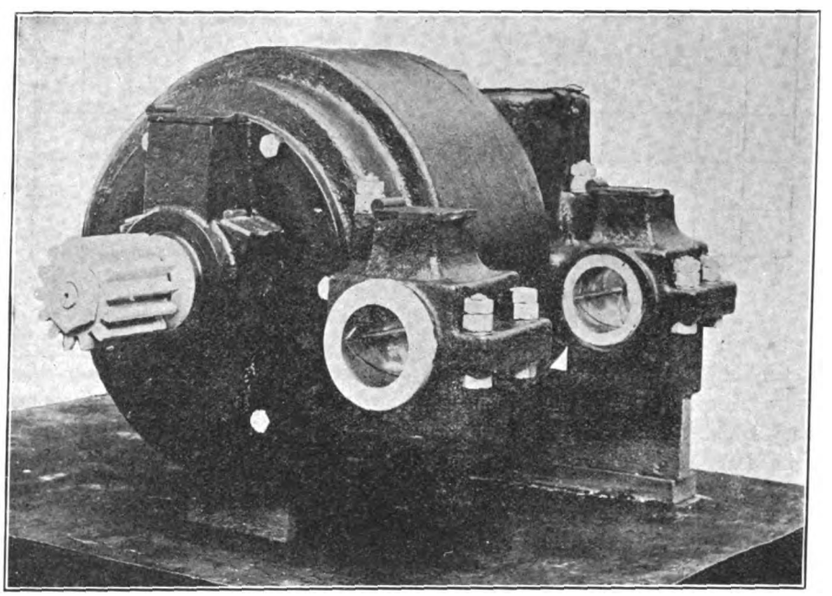
In this case the curves allow the clear statement that for a given torque the current is slightly higher with a higher voltage, and this more clearly when the torque be greater. Thus there are a number of slightly divergent torque-current curves.

Fig. 2 gives the efficiency and the power-factor for this particular motor for various voltages in function of the speed. It is interesting to note that in the efficiency curves the higher segment corresponds to lower speeds when the voltage is lower, so that even though the efficiencies be not particularly high, the motor always works in favorable conditions, its speed being generally lower when the voltage is kept lower. Attention is called to the high level of the power-factor whenever the speed be above the lowest figures.

This motor was geared to one of the ordinary cars that the Edison company uses for city service; there were taken off the continuous-current motor (0.7) ton, one controller (0.072 ton), the rheostats (0.08 ton). Given 6.7 tons for the fully equipped car, the stripped car remains at 5.85 tons. There were then put in place the single-phase motor (0.8 ton) and the controlling transformer (6.5 ton), bringing the weight up to 7.15 tons. To save time a standard forty-kilowatt transformer was used for controlling, while a fourteen-kilowatt one is sufficient with a weight of 0.25 ton, giving a total weight of 6.85 tons for the equipped car.

The circuits on the car are shown in Fig. 3. The line from the trolley has a switch I_1 on one platform; then it passes to the other where the controller is placed, and passes an ammeter A_1, a snap-fuse V and another switch I″, then the autotransformer; the other end of this is earthed, and so is one brush of the motor. The other brush goes to the field E″ and then to the handle of a controller, which takes current from different points of the transformer winding. These points go to five sections, corresponding to 80-100-120-140 volts, giving a 500-volt supply and the passing of the five points was successfully made, absolutely non-sparking. It is seen that the five points were running points. For stopping either of the two switches I_1 or I_2 was opened. This was only for simplicity's sake, because generally use was made of already existing pieces of apparatus. Of course, the controller as designed for practice has a dead section for stopping. Through a commutator C the fields were inverted to run in the opposite direction; an ammeter A″ showed the current in the motor, and a voltmeter V the voltage. All testing instruments in the cars were of the hot-wire pattern. A special circuit, wired as usual from trolley to earth, carried the incandescent lamps of the car.

The usual way of gearing the motor was adopted. A standard pinion (fourteen teeth) geared to a sixty-seven-tooth wheel (4.78 ratio). The diameter of the car wheels was seventy-seven centimetres. A Kapp accelerimeter was fastened to the car; while for measuring the speed several methods were used, the ultimate and most exact one being to get it indirectly from current and voltage through the well attested curves of the motor itself.



FINZI ALTERNATING-CURRENT, SINGLE-PHASE TRACTION MOTOR.

The generating station had its place near the laboratory of the Edison company, in its works at Porta Volta, and contained a sixty-horse-power, 3,600-volt, three-phase induction motor, belted to an old eight-pole alternator with rotating armature that gave a frequency of eighteen at 270 revolutions. The exciter was one of the very old curious Edison dynamos with thin upright fields.

The voltage from the alternator was raised from ninety to about 550 by an autotransformer, feeding the trolley line through the laboratory, the other wire being connected to the rails. The instruments were: a hot-wire ammeter, a Thomson integrating wattmeter and a Siemens wattmeter, which was replaced after some nights by one of the excellent recording wattmeters of Olivetti's, specially ar-

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ranged for these experiments. Another voltmeter showed the line voltage; this varied from 575 at open circuit to about 520 when the car was running.

The greatest number of runs was made during the night on the municipal line connecting the Monumental Cemetery to the new Musocco Cemetery; when the ordinary traffic was stopped the Musocco and the Cagnola sections were disconnected from the continuous-current system and the alternating current was fed in. The track had Vignole rails for its whole length—about five kilometres—with a considerable number of switches and several curves of a small radius; the crossing with the ordinary circle railway has an average twenty-five per cent grade for 225 metres on each side. Besides, the whole line has an average grade of two per cent from Musocco to the Monumental Cemetery.

The test runs began on June 29, 1903, continuing for ten nights; the two last nights' runs were made through the whole town of Milan, running on the tram-car lines (Phœnix rails) with a trailer, through Bramante-Principe Umberto Vincenzo Monti-Monforte and nearly the outer circle complete. The total mileage of the car was about 200 kilometres. Not the slightest difficulty was found from such new electric equipment, and it is remarkable that even the grade and curve of the Central Railway station was managed, though not very easily, by the car with full load and one trailer, while, owing to the drop of voltage of the generator, the motor received only ninety-five instead of 160 volts.

The first tests showed very smooth speeding up, and the same absence from sparking that the laboratory tests had shown; this satisfactory commutation being chiefly apparent in starting, when the motor by all means behaves better than the corresponding continuous-current traction motor. Some little sparking occurs from time to time, only when the full voltage is fed; not more, however, than usually observed in a good standard traction motor. The infrequent sparks did not show the color or the light of an arc, resembling rather carbon particles worn away from the brushes. As a matter of fact the 200 kilometres left the commutator perfectly clean and smooth, with the same appearance it showed before, and the brushes suffered no measurable wear.

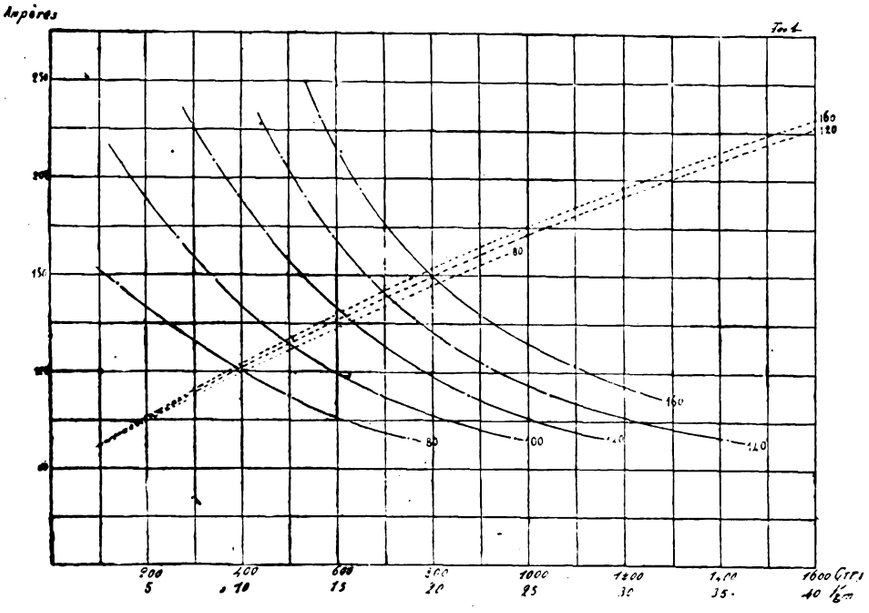

FIG. 1.—CHARACTERISTIC CURVES OF THE FINZI SINGLE-PHASE MOTOR.

The car was lighted with the same lamps that were on the ordinary 500-volt circuit; six incandescent lamps in series. The slightly higher alternating voltages made them burn more brightly than usual and the fluctuations of the current were not much felt; they would disappear altogether by the use of standard lamps of fifty volts or less, instead of the 100 volt ones.

The object of the test was, on one side, to determine the general working of the motor in regard to its specific qualities for traction use; on the other, to measure how much power the runs and the startings absorb, in comparison with standard continuous-current equipments. With these objects the runs have been of two different classes; some were occupied with instantaneous readings of the instruments and together with the diagrams from the Olivetti wattmeter gave the power necessary to keep up the various speeds when once attained; these runs had very few startings, in fact only those that were necessary.

Other runs were full of successive speeding up and stopping; thus there was gathered an exact idea of what a standard starting was, while the figure from the integrating wattmeter at the end of the run showed the difference due to a given number of startings in comparison with the energy absorbed by a run without startings.

The result does not claim a very high degree of accuracy; in fact no traction experiments can, owing to the difficulty of getting exact readings at the same moment, and to the complex elements of the experiment; they are, however, trustworthy so far as they go, and some results

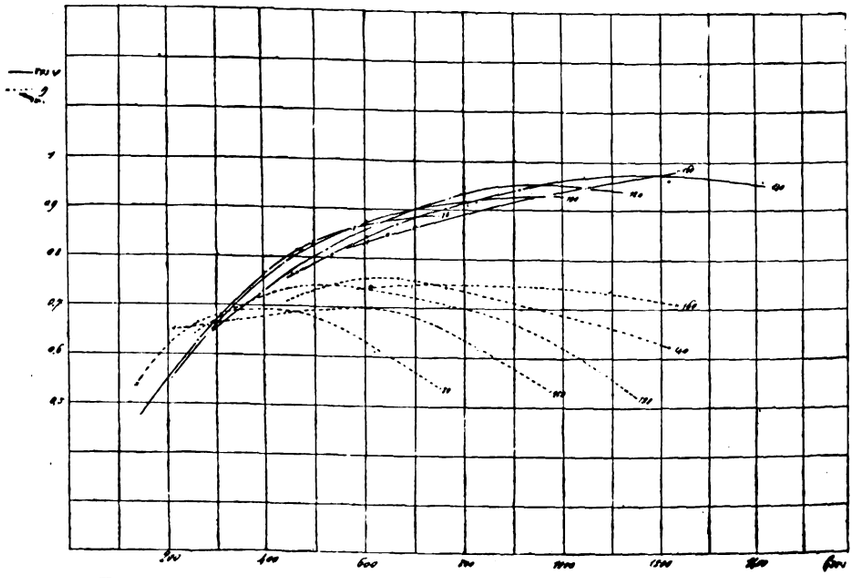

FIG. 2.—CHARACTERISTIC CURVES OF THE FINZI SINGLE-PHASE MOTOR.

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when arrived at through different paths show satisfactory concordance.

In Fig. 4 the line A shows the power at the generating station that is necessary for a ten-ton mono-phase car, on a level straight track, at speeds between twenty-five and forty kilometres per hour. This curve is average from all our experiments, and it is the collective result of the Siemens wattmeter readings at measured speeds and of the Olivetti diagrams. The experimental points are rather dispersed, but not more than we anticipated from having a track with many grades and with short straight segments where a speed could only be kept up a short time.

The B line shows the power given by the motor, and it is obtained from A, taking account of the line loss, the transformer loss, and the efficiency of the motor giving the voltage and the speed.

The line C gives the energy in watt-hours per ten-ton car-kilometre given by the motor; line D gives the energy dissipated per car-kilometre in mechanical friction, that is after subtracting the air resistance. This last was computed, considering the shape of the car and taking advantage of the coefficients found in the latest experiments (Finzi and Soldati on air resistance). Thus we find that mechanical friction absorbs ten watthours per ton-kilometre, of which about 0.5 is gear friction; this leads to a traction coefficient of 3.48 kilogrammes per ton, a very normal figure for a level straight track and for Vignole rails.

A comparison has been made between a single-phase motor acceleration and a continuous-current motor acceleration. A number of runs were made to secure accurate data for acceleration and energy output. These were made, some in one and some in the opposite direction, to eliminate the influence of the average two per cent grade on the line over which the runs were made.

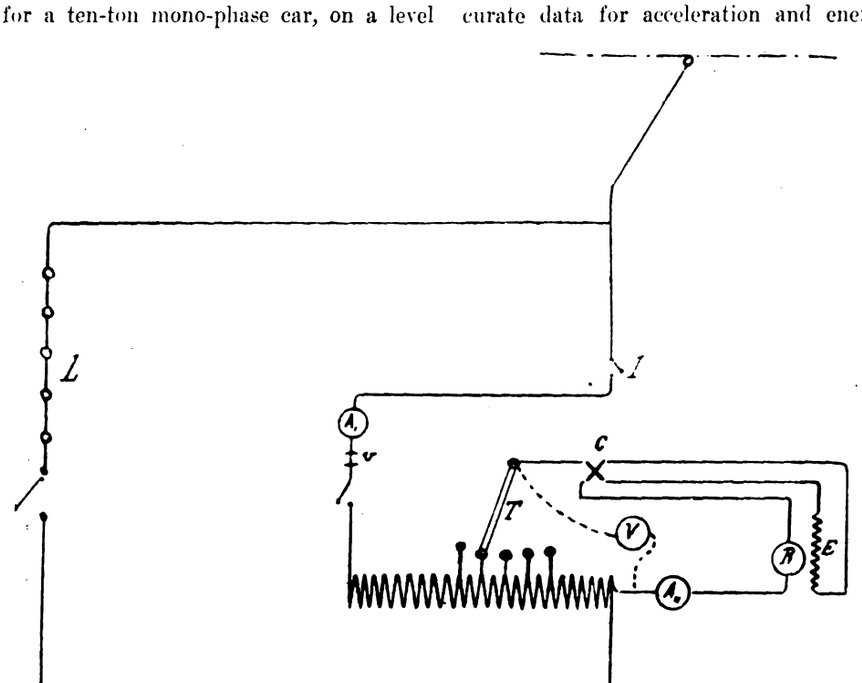

FIG. 3.—CIRCUITS ON CAR USED IN TESTING FINZI SINGLE-PHASE MOTOR.

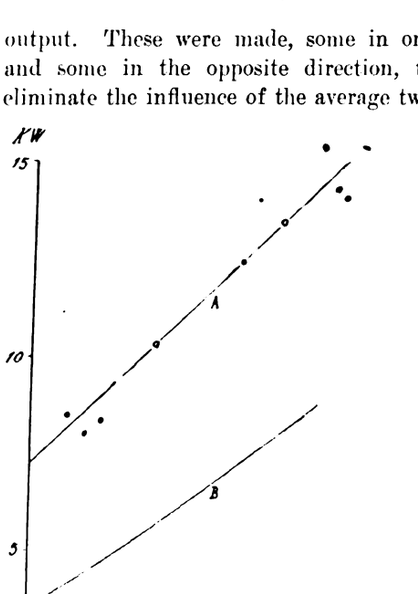

FIG. 4.—TEST OF FINZI SINGLE-PHASE MOTOR.

On a town tram-car system a maximum speed of twenty-two kilometres per hour was necessary between successive stops, to get an average speed of seventeen kilometres per hour. There was thus attained a speed of twenty-two kilometres per hour on an average acceleration of 0.25 metre per second with a single-phase motor. Even at starting, a low absorbed power was found, though the efficiency of the motor is a trifle lower than it should be, on account of the resistances which the motor still had in series with it. Integrating the power curves of the motor to twenty-two kilometres speed, this was found to be 9.4 watthours per ton. Integrating to a 23.5-kilometre speed, the single-phase motor showed 10.6 watthours per ton.

The theoretical amount of energy for starting to the twenty-two-kilometre speed would be 6.6 watthours per ton.

The experiments showed that the mono-phase motor would allow a wide range of velocities without lowering the efficiency at normal speed. The power-factor varies between rather wide limits, according to the speed and voltage, as the characteristic curves of the motor (Fig. 2) show. Making a comparison of the wattmeter diagrams with the instantaneous current and voltage figures at the station during the run, it was found that the average power-factor (for line transformer motor) was 0.8, varying between limits of 0.6 and 0.95.

A New Process for Electrogalvanizing.

A new process for electrogalvanizing has just been discovered by Ignaz Szirmay, of Budapest, Austria, consisting essentially of adding grape sugar (dextrose) to a bath, and he says that a pure, glossy deposit of zinc is obtained, free from blisters and adhering so tenaciously that the object may be bent without the coating peeling off.

His method is as follows, *viz.*, twenty-eight pounds of sulphate of zinc are dissolved in twenty-five gallons of water, preferably warm. Next dissolve separately in boiling water, one and one-half pounds of sulphate of aluminum, twelve ounces of sulphate of magnesium (Epsom salts) and six and one-half pounds of grape sugar. These solutions are then added to the sulphate of zinc solution. The resulting solution should be clear and have a feeble acid reaction. An anode of pure rolled zinc is recommended. The deposition is carried out at about sixty-five degrees Fahrenheit, with a current of ten amperes per square foot, and a voltage of four volts. In order to prevent bubbles of hydrogen gas from adhering to the work it is kept in motion. This also serves to stir up the solution and keep it uniform.—*Metal Industry.*

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Electricity in Siberia.

By an American Traveler.

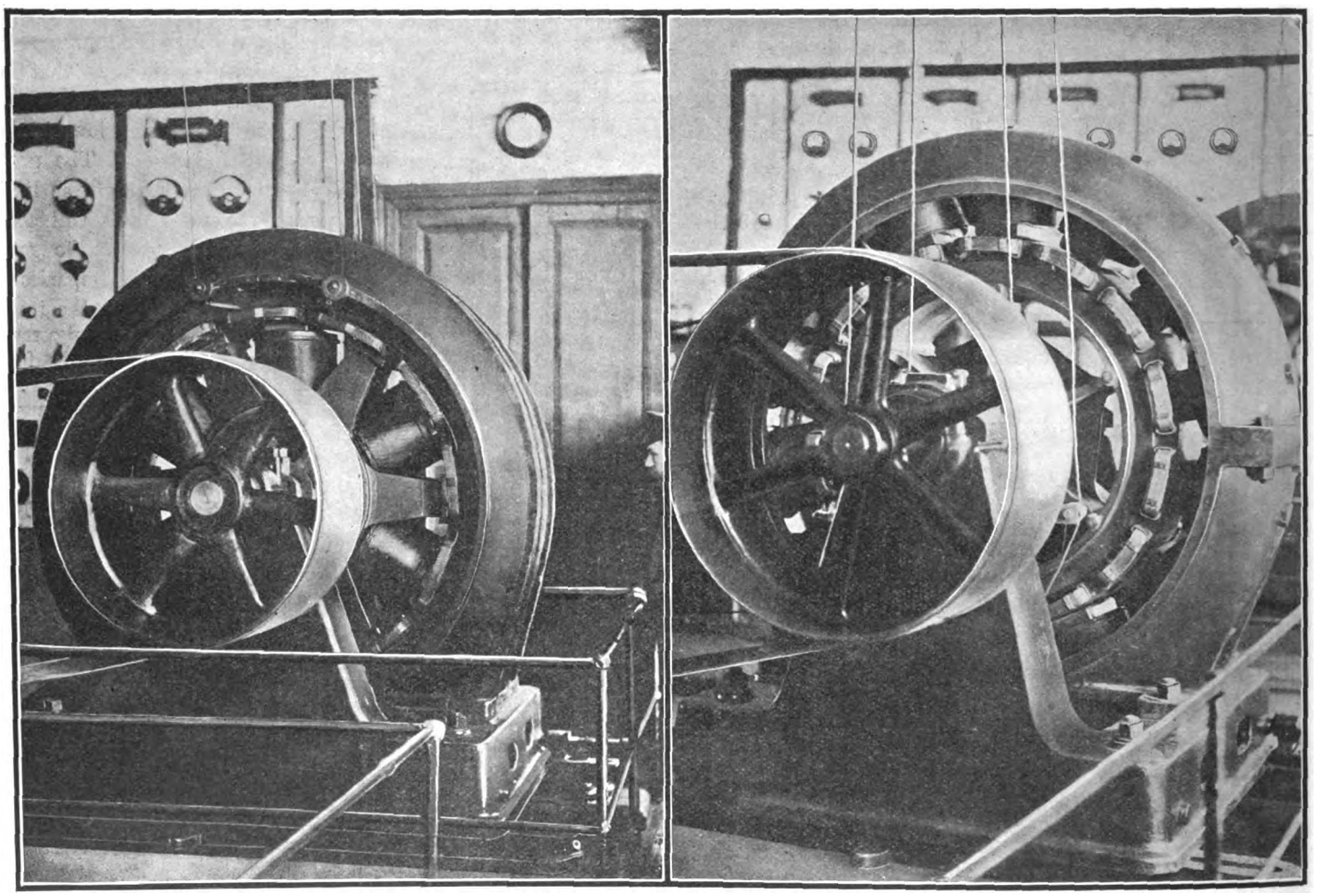
THE subject of electricity in Siberia, it is believed, has never been reviewed in any journal at length. During two years' travel over Siberia and Russia, taking the westward route from the Pacific Ocean overland to Europe, the writer saw practically all of what was to be seen of an electrical nature in the far north. Hence the authority for the present article.

Central stations are located at Omsk, Tomsk, Krasnoiarsk, Irkutsk, Blagovechensk and Vladivostok. This last is on the Pacific. The first town is hundreds of miles beyond the Asiatic versant of the Ural range.

The central station at Tomsk is the best equipped, and was entirely installed by Brown, Boveri Company, Baden, Helvetia. This station is owned by the municipality, and is like any other installation in Europe equipped by the same company—affording very little novelty, save in the fuel, which was all wood. The great forests of Siberia made the fuel problem safe for a few years, until the advent of the trans-Asiatic railroad, when fuel for the locomotives and for the millions of ties which were used for the permanent way, began to make a serious drain on the adjacent country. At Tomsk at the present time, liquid fuel is brought from the Baku-Batym district in meridional Russia, *via* the Volga and the central Ural, and stored at the Tomsk central station.

Over a year ago the writer made three efforts to secure views of this station, together with relative data on the working cost and output. These resulted in failure, however—even the chief who pointed out the features of the station failing to reply to questions of this nature. The accompanying photographs have been secured since the writer's return to the United States. Siberia is the hardest country in the world from which to get a reply.

The steam engines at the Tomsk central station were constructed by Bromli & Company, of Moskba, Central Russia. The flywheel diameter is three metres, normal running 140 revolutions per minute, and the nominal horse-power is 125, with a maximum of 150. These engines are belt-connected with three dynamos. The dynamos were built by Brown, Boveri & Company, of Baden, Switzerland. These are rated at 400 revolutions per minute, 2,000 volts. The four boilers were built by Bari, of Moskba, following the system of the Russian engineer Chyxof. Three of these boilers have 740 square feet of heating surface, and the other 1,145 square feet, and they work at a pressure of 150 pounds. The vertical compound engines are on Wolf's system, developing 225 horse-power at 225 revolutions per minute. The cylinders are sixteen and twenty-six by fourteen inches, and are all provided with condensers. The maximum electrical output is 2,500 kilowatt-hours per day.



VIEWS IN THE DYNAMO ROOM, TOMSK CENTRAL STATION, SIBERIAN RUSSIA.

While there is nothing to learn from Siberian electrical engineering, there is something Americans can learn as to Siberian electrical needs. Their trade is worth having.

The status of the electrician in Siberia is not enviable. A central station employé (a practical mechanic) will work eleven hours a day and receive abouty eighty rubles monthly. This is equal to $40 in United States coin, but its purchasing power will only be what $30 would be in

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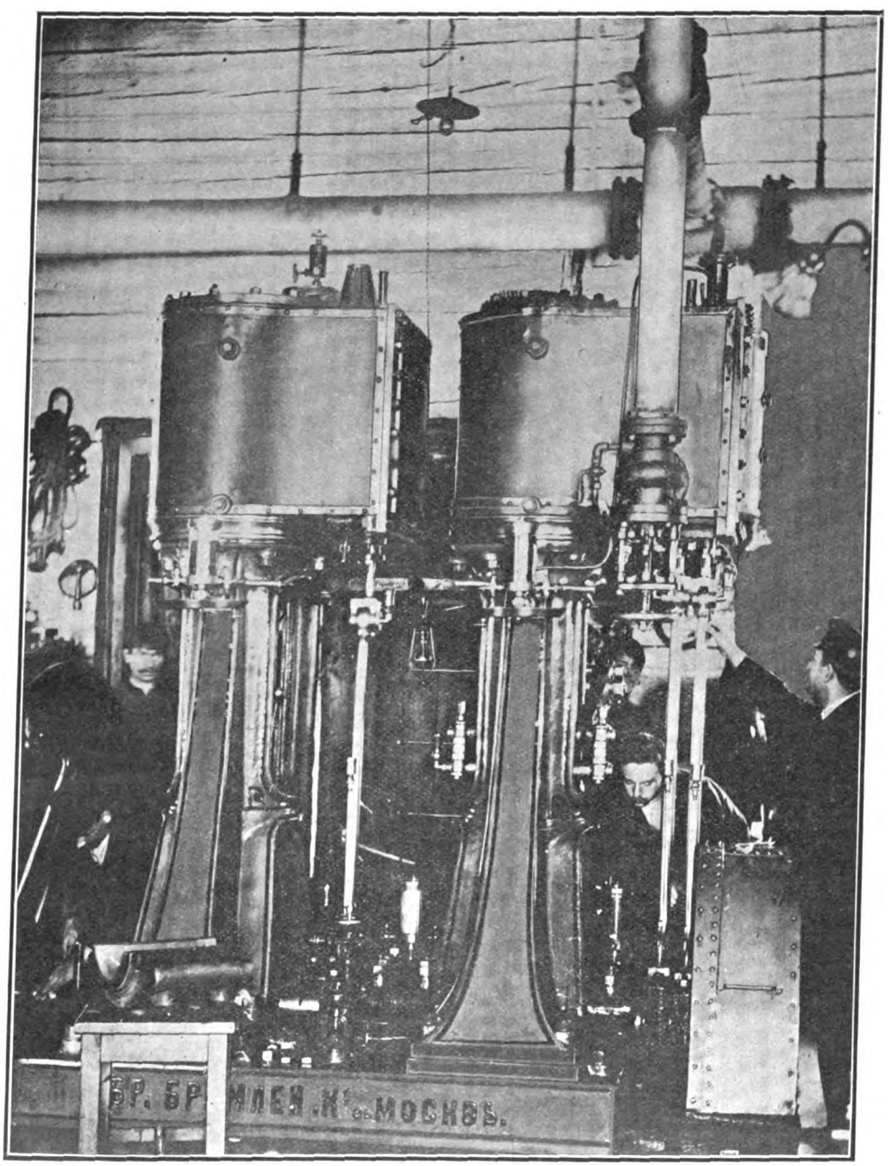
America. In this way he just exists. The pay of a station chief is little better—about 100 to 120 rubles per month. It is true that free lodging is thrown in with the above wages, but still this is not calculated to induce many to seek occupation in Siberia. Telegraph operators receive about sixty rubles per month, and have to find everything from housing to uniforms. They work in twenty-four-hour shifts, then forty-eight hours off.



One of the Vertical Engines, Tomsk Central Station, Siberia.

The periodical electrical literature received by Siberian central station employés is largely German. Some of the chiefs subscribe to three or four Paris journals of their profession. The writer never saw a single current British electrical journal in the whole of the land, and only at Vladivostok a couple of stray copies of a long-since-defunct London monthly called *Electrical Plant*. Of American journals a few copies were seen here and there of the *Telegraph Age* (received by employés of the overland telegraph) and the Electrical Review. This latter paper was all the writer had to remind him of electrical engineering in the United States during a couple of years wandering hither and thither over Russian Asia, with, in some instances, its villages three and four hundred miles apart.

The only product of an electrical nature made in the United States that he saw throughout the whole of Siberia was some insulating hard-fibre sheeting coming from a firm at Wilmington, Del. A quantity had been imported *via* San Francisco and Vladivostok. The report on it was excellent under normal conditions of temperature, but under prolonged freezing at minus thirty-five to minus forty degrees during the winter months, it became as brittle as slate. The writer saw the effect of a shock on a piece of this insulation as it lay in the yard in the Arctic cold. When struck, it shivered with a perfectly clear fracture into three or four pieces, just like a piece of slate; but the fracture was confined to the region where struck. In normal weather the same material was almost as non-liable to fracture as leather.

Although passing a couple of winters in the far north, and often out late at night on the steppes, the writer never had the opportunity of witnessing the electrical phenomenon of aurora borealis, in spite of always being on the lookout for it. The route of the Trans-Siberian Railroad, which was under construction at the time the writer was in Siberia, and which he followed, is a couple of thousand miles too far south for the observation of this phenomenon. Engineers along the line informed him it was to be seen occasionally, however, even on that parallel, during intensely cold, dry spells.

Some fifty private concerns in the different Siberian towns have small electric lighting plants of their own. They were mostly put in before the central station of municipal plants were in being. The best private plant noticed was that of the importing firm of Kunst & Albers, at Vladivostok. This company started in a comparatively small way, and has grown to considerable dimensions. Being a Dutch concern, of course all of its imports are from German quarters. Its dynamo room is fitted up very nicely, and operated at a good efficiency. All of the material, and also the personnel, are Dutch. Commercial concerns in Kabarofsk, Blagovechensk, Chita, Ctretensk, Verçni-Udinsk, Irkutsk, Krasnoiarsk, Tomsk, Omsk and Ekaterinbypr also have their own private lighting plants, as well as a couple of the opera houses.

There is quite a number of mines worked in Siberia, and a few of these have electric lighting plants. The mines, however, to the extent of about ninety-seven per cent, do not pay, and are being abandoned, as foreign investors are slowly coming to realize that these are not a profitable proposition. Many large factories—as, for instances, cement works, woodworking plants, iron founderies, etc.—have installed plants and are using considerable electricity.

All of this betokens that affairs electrical are looking up in Siberia. This is a fact, and so far the Germans, Austrians, Belgians and French have had this market entirely to themselves. Even commercial England has not secured a foothold in electrical Siberia—or what there is of it. The writer saw nothing moving

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that was a British electrical equipment anywhere between the Pacific Ocean and the Ural range. Notwithstanding this, the British have a special agent in the heart of Siberia, at Krasnoiarsk. This agent carries a representative British hardware line, but little or no electrical apparatus.

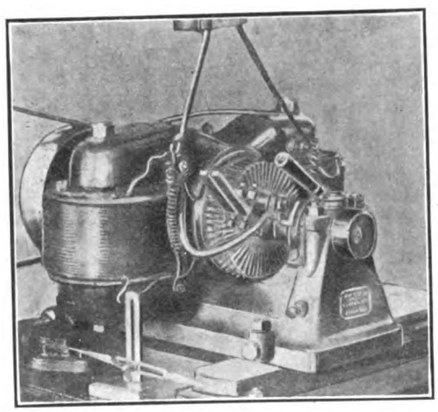
It is evident, contrary to the general belief, that electricity is already a permanent factor in Siberia. The reason for its development in Siberia is easy to see. Illumination better than that given by the kerosene lamp is wanted by the large concerns in the towns and in the country. Gas is out of the question, as there is not a gasworks in the whole of Siberian Asia, so the advantage of the gas mantle could not be used by them. Therefore it has been resolved that if any improved lighting were to be introduced, recourse must be had to electricity.

In order to capture Siberian trade, the ordinary illustrated catalogues should be sent there, and will be understood by all. Illustrations are especially necessary. These catalogues may be sent by post to applicants or to leading electrical people and importing hardware firms throughout Siberia. Price lists should go with the catalogues, or the advantage will be lost. "Prices on application" will hardly do with a far-away country like Siberia. These catalogues are carefully preserved throughout that country. There is no need of going to the great expense of having catalogues printed in the Russian language.

One important condition to which the writer would call the American manufacturer's attention, is business on an absolutely cash basis. The Continental electrical firms give long credit—sometimes as much as two, three or five years—and most of them have a hard time trying to collect at that. A poor-paying customer is not worth having. However, there are, in Siberia, a number of cash-paying concerns whose liberal orders are worth the booking.

The Siberians have electric lighting, and very little else of an electrical nature. True, the telephone is found in all of the towns, and for most of the distance along the Trans-Siberian Railroad, but the luxuries—for instance, electric heaters, cooking conveniences, stoves, curling irons, portable lamps, and a host of other articles—have never been seen there. The writer did not see a dry battery throughout the land. Even the medical practitioners use the wet battery for their tiny examination lamps and apparatus. The physicians know through the journals of the X-rays, but it is doubtful if there is a Crookes tube in the country. It is possible, however, that in recent months one of the Siberian colleges has installed a static machine or a radiographic apparatus.

The short Siberian summer is of tropical warmth, and officials and civilians take to white clothing to minimize the discomfort caused by heat. During this period it is comfortable to sleep out of doors at nights to escape the heat of the rooms. In spite of the great heat, in not one of the towns provided with a central station—and consequently having the proper power at hand—was there observed



A Much-Used Siberian Dynamo, Tomsk Central Station.

a solitary electric fan. It is the writer's opinion, however, that a few well-distributed American catalogues and the advertisements of the Electrical Review will have changed this before long.

L.

New York, December 5.

Electric Convection.

It follows from the views of Faraday and Maxwell that a charge of electricity, when in motion, produces a magnetic field in its neighborhood. This is the effect on which the modern electron theory rests, and its experimental verification is vital to this theory and to the whole of the recent views on the origin of electric and magnetic forces. A method of testing this was suggested by Maxwell, it first being put to test by Rowland in 1876. This proved to the satisfaction of Helmholtz and of Maxwell that the effect existed. Lecher attempted to repeat these experiments, but with negative results, though they were repeated by Rowland and Hutchinson with results which appeared to verify Rowland's original work. In 1897 Crémieu began some very careful experiments, but in all cases with negative results. Several ingenious modifications of his apparatus gave the same results. Pender, working under Rowland, adopted Crémieu's method, and again verified Rowland's result. Pender was then invited to Paris to repeat the experiment in conjunction with Crémieu, and their conclusions are given in this article. Pender verified Maxwell's theory, and Crémieu disproved it. Repeating the experiment by Rowland's method convinced Crémieu, but did not account for his previous failures. However, in all cases he had covered the charged conducting surface with a thin layer of some dielectric other than air, usually india-rubber or mica, and his failure was attributed to this; for, upon removing the dielectric coating, the convection effect was observed, while on coating the discs used by Pender, the convection effect was reduced ninety per cent. This work seems to close the discussion satisfactorily, but the action of the dielectric coating remains to be explained.—*Nature, November* 12.

Switching for Accumulator Plants.

In small installations making use of storage batteries, it is often desirable to be able to charge a battery with the generator at normal voltage, and the usual method is to divide the battery into two sections, connecting them in parallel, and absorb the excess voltage of the generator by means of a rheostat. This rheostat absorbs about thirty-five per cent of the energy supplied by the dynamo to charge the batteries. To reduce this loss, Herr Ernst Pöhler splits the battery into three sections and charges, by throwing two sections in parallel, the two being in series with the third section, the loss being only thirteen per cent. This arrangement may be carried out by means of one single-pole double-throw and one double-pole double-throw switch, or by means of a three-armed nine-contact rotating switch, which he has devised for this purpose. While charging the arrangement of one section in series with two sections in parallel is maintained until the single section is fully charged. It is then cut out and the other two sections, which have received half charge, are thrown in series, and the charge completed.

A Device for Preventing the Derailment of Cars.

A device for preventing a derailed car from leaving the roadbed has been devised by Mr. Ernst Schott. This consists of a beam, properly supported from the truck and extending beyond the wheels. This is provided with two projections on its lower surface. Should the wheels leave the rail, the car drops down until this beam rests upon the rails. The projections engage with the rail head and prevent the beam from leaving the rail. The car then slips along this beam until it is brought to rest.

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SHOP TESTING OF MOTORS AND GENERATORS FOR COMMERCIAL SERVICE—VII.

BY BERTRAND B. ABRY.

VI—ROTARY CONVERTERS.

The previous article on alternating-current generator tests covers those tests which apply in general to rotary converters, but there are some points in connection with the application of certain of these tests to rotaries which we wish to refer to here. It is desired to call attention to the following:

1. Iron loss and saturation test.
2. Short-circuit test.
3. Starting motor test.
4. Temperature test.

Before making any of the above tests it is usually customary to run the rotary with normal field charge for a few minutes to discover, if present, any errors in the assembly of the machine; and further, to test the ratio of the alternating-current and direct-current voltages, which if not correct will indicate, in all probability, wrong connections.

1. Iron Loss and Saturation Test—As in the case of iron loss and saturation tests on direct-current machines, the rotary is driven empty, at a constant speed, by means of a shunt motor. The connections and wiring of such a test have already been explained. In making this test there is a point of difference that should be noted as compared with a similar test on a direct-current generator or an alternating-current generator, and that is that both the alternating-current and direct-current voltages are observed for each change in the field current. When the results are plotted, we have at once then the relation between the saturation and the direct-current and alternating-current voltages at the normal speed of the machine. Care should be taken in making this test to see that the direct-current brushes are set on the no-load neutral point, otherwise local currents will be generated in the brushes, which will have the effect of increasing the iron loss. During the test the following observations are made:

Motor.			Rotary.			
Volts.	Amperes.	Field Amperes.	Speed.	Direct-current Volts.	Alternating-current Volts.	Field Amperes.

In the article on direct-current generators it was explained how we calculate, from the motor input, the iron loss and the friction and windage losses. In the case of rotary converters it is necessary to determine both the alternating-current and direct-current brush friction loss as well as the bearing friction and windage and iron losses.

Let us assume that we have made an

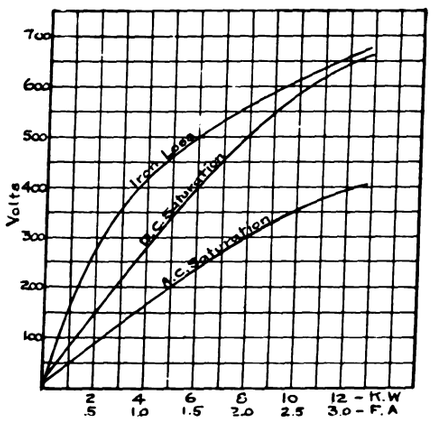

FIG. 20.—IRON LOSS AND SATURATION CURVES, THREE-PHASE ROTARY.

iron loss and saturation test on a rotary converter, and have recorded our observations in some such manner as indicated in the above table. From the motor volts and amperes, we may calculate the motor input, or, as we will call it, motor watts. Knowing the watts input required to operate the rotary with zero field charge and any positive field charge, we may at once determine the iron loss, which loss has been referred to before in previous articles as the "watts lost." Below are given some figures calculated from an iron loss and saturation test which will illustrate this, and also show how the friction and windage losses are determined.

Rotary.				
Motor Watts.	Watts Lost.	Direct-Current Volts.	Alternating-Current Volts.	Field Amperes.
11830	.....	.....	.....	0
12250	420	51	30	3.96
12600	770	92	55	7.32
13600	1770	119	73	9.90
11830	.....	.....	.....	0
14100	2570	160	96	12.75
15800	3970	199	120	19.00
17500	5670	242	145	20.00
11830	.....	.....	.....	0
20180	8350	284	170	24.35
21300	9470	301	180	26.40
23100	11270	320	191	28.90
25200	13370	342	204	32.00
11830	.....	.....	.....	0
8516	3314	} Direct-current brushes up. } Direct-current brush friction loss.		
7963	553	} Direct-current and alternating-current brushes up. } Alternating-current brush friction loss.		
2577	5386	} Driving belt off. } Bearing friction and windage loss.		

After making the last check-reading to obtain the motor watts with zero field charge on the rotary, which is done ever so often throughout the test in order to determine whether the conditions started with are remaining the same or not, the direct-current brushes are raised free from the commutator. Then, still keeping the speed of the rotary constant and the field charge zero, the motor input is again measured. We will assume that this is equal to 8,516 watts, as given above. The difference between the check-reading of 11,830 watts and 8,516 watts, or 3,314 watts, is therefore equivalent to the direct-current brush friction loss.

Next the alternating-current brushes are raised free from the collector rings, and the motor volts and amperes noted, the motor input being 7,963 watts under these conditions. The alternating-current brush friction loss is equivalent then to the difference between 8,516 watts as previously noted, and 7,963 watts, or 553 watts.

After obtaining the brush friction, we may determine the bearing friction and windage by removing the driving belt, and noting the motor input running without load, which is given in this case as 2,577 watts. The bearing friction and windage losses are equivalent then to the difference between the motor input of 7,963 watts and 2,577 watts, or 5,386 watts.

From the result of such a test, the iron loss and saturation curves for the rotary are plotted as shown in Fig. 20. These are given as typical curves of a three-phase rotary.

2. Short-Circuit Test—The short-circuit test on a rotary converter is made on the alternating-current end and is conducted in the same manner as the corresponding test for alternating-current generators. The rotary is driven at a constant speed by the shunt motor employed in the iron loss test, and after the speed is adjusted three sets of readings are taken; first, with zero field charge; second, with a field current giving approximately one-half full load current; and third, with a field charge

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giving short-circuit current equivalent to normal full load output. As in the case of the generator test this gives three points on the copper loss curve, which is of the same general shape as shown in Fig. 16.

3. Starting-Motor Test—Some rotary converters as manufactured to-day are provided with a polyphase starting motor, the secondary of which is pressed on the shaft of the rotary itself, and the primary is supported on a bracket projecting from the side of the rotary frame. Before throwing the machine on the line, it is well to have some method of bringing the rotary up to speed, or properly synchronizing the same. This can be done by means of a polyphase induction motor. If such a motor is used it must be capable of synchronizing the rotary, and also overcoming the rotary iron and friction losses when the rotary field strength is sufficient to give approximately normal direct-current voltage at synchronous speed. The purpose of the so-called starting motor test is to determine whether the motor is properly adjusted to meet these conditions.

The field charge necessary to give normal direct-current voltage at synchronous speed can be found from the results of the iron loss and saturation test. Now if the resistance of the starting-motor secondary could be properly adjusted beforehand, so that with a certain impressed alternating-current voltage on the motor the right speed would be obtained, we could at once synchronize the rotary under the normal conditions of just sufficient field current to give approximately normal direct-current voltage. It is not possible, however, to always meet these conditions on first test, and hence it becomes a matter of adjustment, as far as the motor secondary is concerned, to obtain synchronizing speed.

To effect this adjustment necessitates a change in the resistance of the motor secondary, and this is accomplished by first making the secondary short-circuiting rings of a little greater cross-section, *i. e.*, of a little less resistance than that which will give the desired speed. This greater cross-section permits of the rings being cut away after a first test, thereby gradually increasing the resistance of the secondary until upon further testing same the proper speed for the best synchronizing results is obtained.

In making a test of this kind, one of the points to be noted is the voltage at which the motor starts. By starting low enough and gradually increasing the impressed voltage on the motor, this may be determined. If the normal voltage on the alternating-current side of the rotary is 390 volts, and the motor refuses to start on less than 410 volts, it indicates that some change in the design must be effected. In another case the motor might start with an impressed voltage as low as 300 or 325 volts, and rapidly speed up the rotary beyond synchronism to such a point that we might find we have a voltage on the direct-current side of 700 or 750 volts.

Hence in making the first test on the motor under these latter conditions, it is very often necessary to put a small external load on the direct-current side of the rotary, in addition to the normal field charge, in order to pull the starting-motor speed down to somewhere near synchronous speed. This indicates that the starting-motor speed must be cut down by increasing the resistance of the secondary. Doing this decreases the slip, and upon second test we will probably be able to get the results desired. If not, the resistance of the rings must be further increased.

In the first case, with a three-phase rotary, 650 volts direct-current, let us assume that we get the following results:

Motor.	Rotary.			
Impressed Alternating-current Volts.	Direct-current Volts.	Kilowatt Losses.	Direct-current Amperes.	Field Amperes.
395	652	7.35	25	2.20

That is, the motor may have started with an impressed voltage of say 395 volts and carried the rotary up to such a point above synchronous speed as would give 700 volts direct-current, and in order not to exceed synchronous speed and get approximately normal direct-current voltage, it was found that an external load of about twenty-five amperes was required.

After altering the resistance of the motor secondary as explained above, and making a second test, we may find that now no external load is necessary to bring the speed down, and the following results are obtained:

Motor.	Rotary.			
Impressed Alternating-current Volts.	Direct-current Volts.	Kilowatt Losses.	Direct-current Amperes.	Field Amperes.
385	647	7.30	0	2.20

To obtain these results, corresponding as nearly as possible to the normal operation of the rotary, means the proper adjustment therefore of the starting motor, and is the object of the test.

In actual service it will be found that the brush tension on rotaries varies all the way from two or three pounds per brush to ten pounds per brush. In order to make sure that the starting motor will operate under all such conditions, it is customary to make a starting-motor test after the rings have been adjusted, first with about two and one-half pounds tension per brush, and second with say ten pounds tension per brush. In the latter case it will be necessary to reduce the field current, thereby cutting down the iron loss an amount corresponding to the increased brush friction loss, in order to obtain the desired starting-motor conditions. The field having been weakened, the direct-current voltage will, of course, be below normal at synchronous speed. This test will indicate what the decrease in the direct-current voltage is, and how the motor acts under these abnormal conditions.

4. Temperature Test—The usual temperature test on a rotary converter is made with the direct-current side short-circuited. The chief object of the run is to "season" the commutator. The length of the run varies from about six to eight hours. This is, however, more a matter of judgment and observation of the condition of the commutator after a few hours run with such a load.

The Present Position of the Theory of Electrolysis.

A recent number of the *Electro-Chemist and Metallurgist* contains an able article by Mr. W. C. D. Whetham on the present position of the theory of electrolysis. The investigations which led up to the theory of electrolytic dissociation and the modern convective views of electrolysis are traced, and it is clearly shown that a vast number of important observations are easily explained by the modern views. As the author points out, experiments on the comparison of the electrical and the osmotic values of ionization are of little use from the point of view of the controversialist seeking arguments for or against the ionic dissociation theory. The deviations between the two values are, however, in most cases easily explainable by a consideration of the interionic forces, which probably exert an effect even at dilutions at which the intermolecular forces are negligible, and, further, of the complex ions which are so often formed in solution,

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INDUSTRIAL ELECTROCHEMISTRY AND ELECTROMETALLURGY.[1]

NOTES ON PROGRESS IN EUROPE AND AMERICA.

BY JOHN B. C. KERSHAW.

Electrolytic Copper by the Elmore Process.

The Elmore companies for production of tube and sheet copper by electrolysis (see first series of notes, January 24, 1903), according to the last reports, have not yet surmounted the financial troubles due to the unsettled state of the copper market in 1900 to 1901. At the annual meeting of the shareholders in the German & Austro-Hungarian Metal Company held in May, the chairman stated that during the last ten years $250,000 had been paid by the company as interest upon debentures and loans, and that nearly $150,000 had been charged to repairs and depreciation. The profit of the past year's trading are insufficient to clear off the debit balance in the company's accounts, and there was consequently no dividend for the ordinary shareholders. A modification of the original Elmore process for producing small tubes of electrolytic copper, is to be introduced at the Schladern works, and the machinery for this is being constructed in America. The company's water power plant at Schladern has not proved very reliable in times of drought; and a full steam power plant has therefore been installed as reserve.

The report presented to the shareholders meeting at the Leeds copper works (the English Elmore company) in the same month was less satisfactory than that of the German company. There was a loss on the year's working, which was only wiped out by the rise in the value of the stocks of copper held by the company. There was also an overdraft at the bank amounting to $230,000. Up to May, 1902, this works had been turning out only two and one-half tons of tubes per week, but since that month the manager had been gradually increasing the output, and by December, 1902, it had risen to thirty-four tons per week. In order to increase the revenue of this company, the surplus land and power at the Leeds works are to be sublet to suitable customers. More capital is required to enable this company to carry on its manufacturing operations satisfactorily; and at present it is employing the resources of the bank for the provision of the necessary working capital.

The Position of the Calcium Carbide Industry in Europe.

Under the new duty regulations affecting the import of carbide into Germany, it is hoped that the German carbide works will be enabled to resume their full working activity, and to supply the whole of the home demand for this product. The duty upon imported carbide has been fixed at six francs per 100 kilogrammes (equal to $11.80 per ton), and it is especially aimed at the imports from Norway and Switzerland.

In view of this improvement in the outlook for the German carbide industry, it is interesting to note that a new carbide works is being erected at Zwickau in Bavaria, where 2,000 horse-power has been developed upon the river Ohe. The Nuremberg Syndicate, which practically controls the prices of carbide in central Europe, has fixed the following prices for districts under its control: South Germany, 24.50 marks per 100 kilogrammes; Berlin, 25.50 marks per 100 kilogrammes; Cologne, 25.95 marks per 100 kilogrammes. The price for export is considerably higher on account of the greatly increased charge for freight to the seaboard; and the amount of German carbide exported is therefore small.

The following figures for the weight and value of the calcium carbide exported from Switzerland in recent years show how dependent the industry in that country is upon its export trade.

	Weight. Meters.	Value. Francs.
1900.....	44,157	1,548,000
1901.....	42,865	1,287,000
1902.....	55,844	1,708,000

The large total of 24,000 horse-power has been developed for the manufacture in Switzerland, but a large portion of this is still unutilized.

In Italy the carbide industry is being rapidly developed, and whereas in 1897 only 250 tons were produced in 1900 the home production had risen to 1,400 tons, and in 1902 to 4,800 tons. The value of the output was estimated to be 950,000 lire in 1900, and 2,880,000 lire in 1901.

As regards the use of acetylene for village lighting in Germany, Vogel in a recent report has stated that in the early part of 1902 twenty-five German village communities had been provided with central installations for generating the gas from carbide. The average price of carbide was twenty-eight marks per 100 kilogrammes; and at this price the gas could be profitably sold at 1.80 marks per cubic metre. A complete village installation for a village of 4,500 inhabitants cost 70,000 marks in Germany.

Electricity for Iron and Steel Production.

Since the publication of the special illustrated article by the writer upon this use of electricity in the ELECTRICAL REVIEW (see issues of June 6 and 13, 1903) a large amount of information relating to this subject has found its way into the columns of the technical papers and journals. The opinion of the writer that these electrothermal processes will be chiefly useful for producing special brands of steel and alloys of the same, finds confirmation from these more recently published facts and figures; and it would now seem to be generally accepted, that the electrical processes will not compete with the ordinary blast-furnace procedure in the reduction of normal iron ores. Keller in a recent paper has stated that such competition is only possible where the cost of the kilowatt year does not exceed $7.12. As there are few places where electrical energy can be generated for this sum, the owners of blast furnaces may remain calm and content.

According to recent statements by the inventors and exploiters of these new processes, scrap iron or scrap steel is most generally used as raw material. The electric process is really one of refining; the impurities being driven out of the scrap iron or steel by the high temperature attained between the electric arcs used for heating the furnaces.

One of the most important developments of this branch of metallurgy is the production of ferro-silicon; the works of Keller, Leleux & Cie in France being one of the first to produce this alloy in large quantity by the electrical method. Details of this new manufacture and of its development in France were recently given in these columns. (See ELECTRICAL REVIEW, August 15, 1903.)

Chrome steel is another alloy which is being produced on a large scale in the electric furnace by the Heroult process, at Le Praz in Savoy. 14,000 horse-power is available at this locality and the works of the Compagnie Electro-metallurgique Française produce aluminum, steel and chrome steel by the Heroult methods.

Ruthenberg in a recent paper upon his own process (see ELECTRICAL REVIEW, September 26) has given further information which proves that the Ruthenberg process differs in essential details from the electrothermal processes now being tried upon an industrial scale in Europe. Only magnetic ores are suited for treatment by the Ruthenberg process, and the effect of the passage through the magnetic rolls is to obtain an "agglomerated" mass of ore, which still requires smelting and reduction. It is not clear from the author's paper, whether ordinary metallurgical methods are employed for this after reduction.

The expenditure of power has now been reduced to 250 kilowatt-hours per ton of ore.

[1] This is the second chapter of a new series of notes. The first series appeared from January to April, 1903.

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REPORT ON THE EDISON STANDARD CELL FOR AUTOMOBILES.[1]

BY W. HIBBERT.

Description of Cell—The Edison standard automobile cell is of rectangular shape. It stands thirteen inches high (over all) and measures 5.1 by 3.5 inches horizontally. It weighs 17.8 pounds. It contains fourteen positive and fourteen negative plates. Both positive and negative plates are alike, except in respect of the active materials. The pockets on the negative plate contain finely divided iron, those on the positive contain peroxide of nickel. The liquid is a twenty per cent solution of potash. This suffers no change during the action of the cell, except the loss of a small quantity of water which is decomposed while the cell is being charged.

Electrical Qualities—The electromotive force is 1.33 volts. The internal resistance is 0.0013 ohm.

Output—The output at sixty amperes is 210 watthours, or at the rate of 11.8 watthours per pound of cell. When the cell is examined as to discharging values its excellence becomes most pronounced. At high rates of discharge rising to many times the normal, it suffers no appreciable polarization, and therefore recovers its normal voltage almost instantaneously when the current returns to an ordinary value.

In relation to the weight of the cell, the output is high. It amounts to 11.8 watthours per pound of cell. If we compare the specific output of the Edison cell with that of the better lead cells made for traction, we find that the watthours are twenty-five to fifty per cent greater.

In making the experiments on output at different discharge rates, one set happened to be taken on very hot days. The temperature of the cell rose to something like fifty-three degrees centigrade. At this high temperature the output was increased, but not more than would result from the consequent fall in the internal resistance of the liquid, as these high-temperature discharges occurred at the beginning of the tests, and I found the cells were not at all worse for being exposed to such heating.

Short-Circuit—One of the smaller cells was short-circuited for forty-eight hours. After a subsequent long charge, it gave a discharge somewhat less than normal. But after a second charge, it had recovered so well that the discharge could only just be distinguished from the normal.

Flexibility of the Cell—In order to ascertain the readiness with which the cell recovered from an excessive transient discharge, the current was made to alternate from sixty to 230 amperes, a careful watch being kept on the voltmeter to see how it responded to the variation in current. Recovery was practically instantaneous.

High Rate of Charging—The cell can evidently give a high discharge rate, and tests to prove the charging rates made so far have been:

1. One hour's charge at 177 amperes. Discharge 124 ampere-hours seventy per cent of charge.

2. One hour's charge at 150 amperes. Discharge 107 ampere-hours seventy-one per cent of charge.

3. One hour's charge at about 205 amperes. Discharge 142 ampere-hours seventy per cent of charge.

These figures show that the cell is able to absorb the charge at these high rates and to discharge a very large fraction of that which has been thus absorbed.

Continued Discharge at Low Voltage—Experiments on excessive discharge indicate that when the potential difference reaches the value 0.9 volt, it falls very rapidly indeed with all ordinary currents. If the discharge be kept up, the fall is arrested when the voltage reaches a value of about 0.5 and the current flows steadily for some time at this lower pressure.

There is thus an addition to the watthours which the cell can supply. So far I have not been able to detect any injurious effect as a result of this low-voltage discharge. But here, as in the case of the short-circuited cell, there is need for subsequent excessive charging.

Effect of Rest—Many experiments have been made on the effect of rest on a discharged cell, all resulting in evidence that such a trial does not injure it.

The effect of rest on a charged Edison cell was tested in the following way. A cell was discharged at sixty amperes immediately after charging and gave 170 ampere-hours. It was again discharged, after allowing two days' rest to intervene between charging and discharging. The result was 155 ampere-hours, or ninety-one per cent of the full discharge. Part of the deficiency (nine per cent) was attributed to the loss of current due to the gases which help to fill the pockets at the end of a charging operation. The cell was again charged and put aside for twenty-six days. It then yielded 124 ampere-hours.

If this be compared with the full discharge (taken immediately after charging) it equals seventy-three per cent, a loss of twenty-seven per cent.

But this is hardly representatively true. Some of the apparent loss is due to the gas effect, and we get a better notion of the loss due to resting if the figure be compared with that observed after two days' rest.

Compared in this way, the cell gives eighty per cent of the charge, after an additional rest of twenty-four days.

Efficiency—The efficiency varies with the charging and discharging currents, as might be expected.

At thirty amperes, the watthour efficiency is about sixty-six per cent.

At sixty amperes, it is about sixty per cent.

Charged at 100 amperes and discharged at sixty, the efficiency fell to about fifty-six per cent.

Charged at the high rate of 177 amperes and discharged at sixty, the efficiency was almost exactly fifty per cent.

OBSERVATIONS ON THE ROAD.

It seemed desirable to seek an opportunity of watching the cells on the road, and Mr. Dick placed a car at my disposal. The car was driven by a Westinghouse motor, actuated by thirty-eight "Standard" Edison cells, exactly like that on which my laboratory tests were made.

The total weight of the car with two people was 1,950 pounds, the battery with its case weighing 700 pounds exactly. Unfortunately the motor chosen was too low a rating and was therefore overloaded all the time. There was a consequent lowering of its efficiency, which makes the tractive effort appear somewhat high. But this in no way affects the test as far as the battery is concerned. To get at definite data for the cells, I traveled with notebook in hand and kept a record of the voltmeter and ammeter readings, leaving my driver to attend to the car. The programme of work with the car was arranged not so much with the object of running a long distance as to finding answers to certain questions.

The following table exhibits the actual and relative output at varying discharge rates:

Discharge Rate in Amperes.	Time of Discharge.	Output in Ampere-Hours.	Per Cent of the Thirty-Ampere Output.
30	5 hrs. 46 min.	173	100
60	2 " 51 "	171	99
90	1 " 51 "	167	96.5
120	1 " 21 "	162	93.6
150	1 " 2 "	154.5	89
200	42 minutes.	142	82

[1] Abstract.

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IS THE CAPACITY ON THE ROAD EQUAL TO THAT FOUND IN THE LABORATORY?

To ascertain this, a standing discharge of the thirty-eight cells was taken before starting on my journey. It equaled 159 ampere-hours. The figure, however, was required not for comparison with any previous experience, but in order to discover if it could be equaled while running on the road.

This proved to be the case. Several discharges justified this assertion. For example, on September 9, during a run of three and one-half hours, eighty observations of the ammeter were taken. From these, I calculate that 150 ampere-hours were delivered. As the cell was not quite discharged—the volts being above 0.80 per cell—it is evident that we were getting quite as much while running as was yielded on the laboratory table.

WILL THE BATTERY STAND EXCESSIVE DISCHARGE RATES ON THE ROAD?

A thirty-two-mile run from Leicester to Northampton, England, was made with wind generally dead ahead and very strong, the rain also falling in great quantities. No record could be taken, but the current on the level was about fifty-five to sixty amperes instead of forty. On the slopes it was frequently ninety to 120, and on one hill the ammeter index passed beyond the stops and must have indicated a current over 150 amperes.

As my mind was very keenly observing the ammeter during the journey, I estimated the output immediately we got to Northampton (four hours run against 2.5 hours on a fine day) and made it at least 190 ampere-hours. This high-discharge capacity was due to the low-voltage discharge already alluded to.

The important point, however, is that the discharge current mounted up to 150 or 160 amperes and that currents not quite so high were often called for, without injuring the cells.

The battery was charged without difficulty at Northampton, and ran next day in a very efficient manner.

WILL THE BATTERY TAKE A RAPID CHARGE (SAY ONE HOUR) AND UTILIZE IT IN DISCHARGE ON THE ROAD?

At Leicester, the car was run down till the voltmeter showed 0.75 volt per cell. It was then charged for one hour at 150 amperes—the maximum current then obtainable. The subsequent discharge on the road gave 107 ampere-hours, which is seventy-one per cent of the charge. Distance run thirty-two miles. It is evident, therefore, that a rapid charge is effectively absorbed. The figures for efficiency on the road are, for rapid charging, exactly what I found in the laboratory.

WILL THE BATTERY RECOVER AFTER STANDING IDLE IN A DISCHARGED STATE?

On returning to London, the car was run about till the speed and also the voltmeter showed that the cells were run down very low. The car was then put aside for ten days so as to stand idle in a discharged state.

At the end of that time it was charged, and to make the test more severe it was charged as follows:

	Ampere-Hours.
40 minutes at about 200 amperes..	156
16 " " 120 " ..	30
Total.....	186

given in one hour. The car was then run about London and covered thirty-one miles, yielding 134 ampere-hours. The efficiency was seventy-two per cent, the same figure as obtained in laboratory. From this behavior it is evident that the thirty-eight cells were not hurt by the harsh treatment they had received.

DOES THE CAPACITY CHANGE DURING WORK ON THE ROAD?

The final runs were as good as the initial, taking corresponding days. But by taking a standing discharge very accurately at the commencement of the trials and repeating it when the trials were over, I hoped to discover if the capacity had changed by as much as one or two per cent.

At Paris the capacity was 159 ampere-hours. At London, after all the road running, the capacity was 158 ampere-hours and the curves of discharge could not be distinguished from each other. In other words, both the quantity and the pressure were unchanged.

Life—The question of life is to be decided in a positive way by nothing short of a continuance in working order. But the evidence advanced in many other points has a very cogent, though indirect, bearing on the question of life. When it is shown that the capacity has not changed by one per cent after a 500-mile run, there is a definite ground for thinking that the life will certainly not be short. This can now be confirmed by the fact that practically the same figure was obtained after an additional 900-mile run.

Other points which tell in the same sense, are the regularity of the charge and discharge values in separate trials under all circumstances—proving that the original conditions are reproduced again and again.

My conclusions may be summarized thus: the Edison cell shows

(*a*) Greater work output per unit of weight.

(*b*) Greater flexibility of working.

(*c*) Greater working range of current.

(*d*) Greater ease and safety on handling.

(*e*) Greater stability, both mechanical and electrical.

The Growth of New York Telephone Service.

Only a short time ago the telephone was looked upon as a queer invention, more a plaything than a new-born factor bound to become the great factor it has become in commercial and social life. After the first central office was opened in New York city, telephones were slowly installed until at the beginning of 1890 there were about 8,000 in service, the ratio of telephones to population being about one to one hundred and sixty. During the four following years there was an increase of about 2,500, an average of 625 a year. Up to this time the telephone was the unit of charge. The rate paid was for a telephone without regard to the number of times the telephone was used. It was referred to as the "annual rental." Not quite ten years have elapsed since the message became the charge unit and the number of stations has increased to 120,000. The subscriber is not paying a "rental" for a telephone, but he is paying for a service and his rate of payment is based on the amount of service furnished. That the message is the proper charge basis is proven by the great increase in the number of telephone subscribers.

Notwithstanding this rapid growth, the New York Telephone Company has, in the face of great difficulties, extended its plant to care for these additional subscribers without serious delay.

Though the telephone established itself permanently in the business world long ago, it has but recently become an important element in residence appointments. Conservative residents of Manhattan were not sure that the service would be of value, and a great many thought it would be a source of annoyance. All this is changed, however, and the number of residence stations now being installed in Manhattan is even greater than the number of business stations.

The value of residence telephone service is appreciated by those who are enjoying it, the cost is reasonable and the service is good. Besides affording a prompt communication with those who cater to the family wants, it brings relatives and friends within ready touch at all times. In emergencies its value can not be calculated.

The number of telephone stations in Manhattan and the Bronx—at present, 120,000—is increasing at the rate of 2,500 a month. The ratio of telephones to population is about one to nineteen.

The telephone is making a peaceful invasion of every residence in Manhattan and the Bronx. As long as the present efficient service is maintained this invasion will be marked by a still greater increase in the number of subscribers and a decrease in the ratio of telephones to population.

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Extensive Dredging Operations by the United States Government.

An indication of the large amount of river and harbor improvement work now under way or contemplated by the United States Government is given by the fact that at present ten suction dredges are being built, two of which will be sent to Great Lakes, two to New York harbor, two to the Mississippi river, two to Charleston, S. C., one to Galveston and one to Savannah, Ga. The contracts for building these vessels have been distributed to a large number of builders, possibly for the purpose of hastening their completion. Five are being constructed by the Maryland Steel Company, two by the Jas. Reilly Repair and Supply Company, and one each by the W. R. Trigg Company, the Petersburg Iron Works Company and the New York Ship Building Company.

The mechanical equipment of the dredges for salt-water service will include surface condenser outfits with Blake air pumps, feed pump, fire pumps, etc. The dredges for the Great Lakes are provided with very large Blake cross-compound, double-acting, air pumps and jet condensers with the usual complement of Blake vertical duplex feed pumps, fire pumps, etc. The air pumps are of a very novel arrangement, inasmuch at it is possible by the manipulation of valves and cocks provided for the purpose to cut each pump in half and run one side entirely independent of the other side. This practically provides a spare pump in each installation without the necessity of being overweighted with two duplicate machines, and at the same time secure the advantages of compound steam cylinders.

The operation of these machines is very interesting. A long flexible tube twelve to fifteen inches in diameter drops down from the side of the vessel twenty to thirty feet or more to the bottom of the river or harbor upon which the dredging operation is being performed. The upper end of this tube is connected to an immense rotative centrifugal pump revolving at several hundred revolutions per minute and capable of handling many hundreds of tons of water per hour. The lower end of the tube is manipulated from the vessel against the sand bars and mud banks, and as the water is sucked upward by the centrifugal pumps a very large proportion of sand and mud goes with it. The centrifugal pump discharges this water with its suspended material into the tanks on board the vessel or into scows, where the heavy matter quickly settles to the bottom, the water flowing back into the sea.

Electrical Patents.

The General Electric Company has purchased the entire interest in a patent granted to Charles H. Ingalls, of Danvers, Mass., on a commutator. This invention relates to a process of treating metal in order to regulate the friction between moving surfaces. It has especial reference to the commutators of electrical apparatus, such as rotating meters. Moving surfaces between which frictional contact is maintained are liable to alter with respect to the coefficient of friction. In the case of a recording wattmeter this change in the friction between the commutator and the brushes is a serious matter, since it necessitates readjustment of the starting coil to properly compensate for this frictional load. An electric power company is therefore put to considerable expense for the services of employés required to look after the meters, besides the annoyance of having its customers doubt the accuracy of the meter readings. It is found, however, that with the lapse of time the necessity for readjusting disappears. The surfaces of the commutator and the brushes seem to reach a condition of stability with a permanent and unchanging degree of friction. At this point of time the light load accuracy has decreased all that it is likely to from commutator causes, so that a motor corrected after this critical point has been reached retains its accuracy so long as the jewel bearing remains good. It is inferred from this that the surfaces of the commutator and brushes undergo some chemical change from gases in the atmosphere, especially corroding gases, such as contain sulphur. Mr. Ingalls has discovered that by applying to the surfaces in question a solution of sulphide or polysulphide the surfaces will be chemically altered by the union of the sulphide and the metal of the surfaces treated and that the surfaces so treated will not thereafter be further changed by the action of the atmosphere. Furthermore, so far as the commutator and the brushes enter into the proper running of the meter their condition will remain stable, and the accuracy of the meter, particularly on small loads of five per cent and over of the rated capacity of the meter, will be very reliable. The process invented may be carried out as follows: A saturated solution is made of any soluble sulphide, preferably potassium polysulphide. The vehicle is alcohol, and to this is added considerably more commercial "liver of sulphur" than will be dissolved by the quantity taken. This solution is applied to the surface to be treated, such as the commutator and brushes of a meter, by any suitable means, such as a camel's hair brush, which is preferably only moistened with the solution and held lightly against the commutator while the latter is being rotated. This application of the solution is repeated several times until the commutator shows no further change. The surface of the commutator is then polished with linen tape or the like. The solution can be applied to the meter brushes, either by using the camel's hair brush or moistening a piece of absorbent material and placing it on the brush, or by dipping the meter brush tips in the solution itself. The brush contact surfaces are also polished with linen tape. The result of this process is to quickly produce on the surfaces treated a thin coating of the sulphide of the metal of which said surfaces are composed. Copper or silver is generally used for the commutator bars of recording meters, so that the coating formed thereon will be a sulphide of one of these metals. Alcohol or ether is preferred to water as a solvent because it aids in cleaning the surface to be treated and enables the sulphide to act more efficiently. The coating is not only a protection against the corroding effect of gases in the atmosphere, but it may slightly reduce the conductivity of the commutator, since it is not so good a conductor as the pure metal. This, however, is easily allowed for in the adjustment of the starting coil, so that a meter thus treated requires no subsequent correction on account of the commutator and brushes. Greater accuracy is thus attained, and all the annoyances of frequent readjustment are obviated.

Arthur C. Eastwood, of Cleveland, Ohio, has invented a new system for the control of electric motors. The invention relates to a new combination of apparatus particularly designed for the transformation of electric into mechanical energy, having for its object the provision of means whereby the torque which may be transmitted by an electric motor will be limited to a certain predetermined extent, so that the receiving apparatus or structure to which the motor is operatively connected can not be strained by the exertion of an excessive torque thereupon. The invention also has for its object the provision of means whereby it is possible to arrest the motion of a load operated upon—as, for example, increasing it beyond the predetermined amount—and yet permit the armature of the driving

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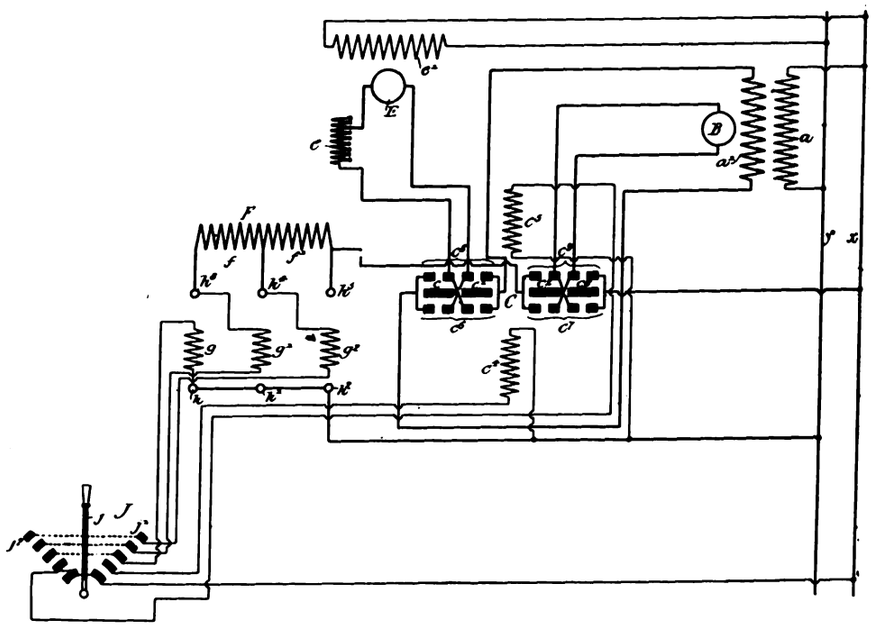
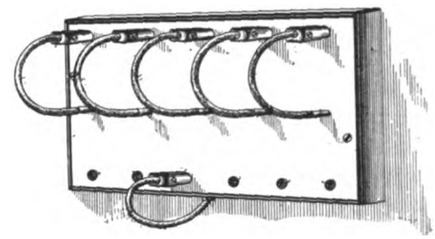
motor to continue to rotate so as to continuously transmit to said load the predetermined maximum torque. The object of the device is thus to protect both the driving motor and the receiving device, to which it is connected, from the injurious effects of overloads. There are a number of applications to which electric motors in the past have been found to be poorly adapted, owing to the fact that an ordinary motor can not permit of its armature being brought to a standstill without injurious results either to the armature itself or to the machine to which it is attached. When the armature of a direct-current motor is brought to rest under load, the current which will flow through it is limited only by the ohmic resistance of the armature and its connections, the current being in general many



System for Control of Electric Motors.

times the full load running current of the motor, so that the windings of the armature will be in danger. Further, the excessive torque which will be delivered by the motor under such conditions endangers the gearing or other parts of the machinery to which the armature is connected. An electric motor in this respect is radically different from a steam, hydraulic or compressed-air motor, the action of which may be arrested by an increase of load without danger either to itself or to the device to which it is connected. One application of the invention is to the opening and closing of the bucket on machines ordinarily used in unloading ore, coal and other raw material from the holds of vessels. In the operation of such machines the bucket in closing will frequently bury itself too deeply in the material which it is to handle, so as to arrest the closing thereof, and if the material contains large lumps the jaws of the bucket will frequently have a large piece wedged between them before they reach their fully closed position, thus bringing to a standstill the closing mechanism. While it has been feasible to employ electric motors for the operation of the majority of movable elements of unloading machines, it has sometimes been found necessary to operate the bucket-opening and closing mechanism by means of fluid-actuated pistons acting in suitable cylinders. As will be understood by those skilled in the art, it has therefore been necessary to generate upon the unloading machine itself the pressure for the operation of the closing mechanism, thus making it necessary to equip each unit with a hydraulic pressure pump driven by an electric motor, an accumulator, and an elaborate system of piping, in addition to which means must be provided for frequently replenishing the liquid of the hydraulic system, particularly if water be employed. It will therefore be understood that if an electric motor could be employed for operating the bucket mechanism a large amount of complicated machinery could be dispensed with, and the operation of unloading the machine would thereby be made simpler and more reliable.

A novel telephone exchange particularly useful in small systems has been patented by Mr. Charles S. Exley, of Clarke County, Iowa. Broadly stated, each line is provided with an independent signal connected with its line by a switch. A plurality of independent exchange contact devices are employed, each having a number of spring jacks that are adapted to be connected with the different lines by the switch employed for connecting the lines with the signals. The usual exchange in-



Telephone Exchange.

strument is adapted to be connected with any of these exchange contact devices by means of a switch comprising a flexible cord and plug. Under normal conditions the line wires are connected with their respective signals, so that, should a subscriber call up central, his signal will indicate the call at the exchange, thereupon the operator connects his instrument with one of the exchange contact devices, and at the same time disconnects the line wire from the signal and connects it with the same contact device. This throws the subscriber and operator of the switch in communication and upon ascertaining the number the caller desires, the plug from that number is removed from its signal contact and attached to the exchange contact device. This places the two parties in communication and at the same time the operator can ascertain when the subscribers have finished.

Some time ago a patent was obtained on sharpening razors and other implements having keen edges by means of magnetism, the inventor of the original idea placing a bar magnet in line with and spaced from the edge. He claimed that this would tend to align the minute ragged teeth, which an examination under a microscope has shown to be the makeup of the cutting edges. Further experiment has shown a tendency of the magnet to draw toward the poles, and consequently the tendency is to improve only parts of the edge. On the other hand, Mr. Theron Davis, of New York, N. Y., has found that by magnetizing the edged tool, and

Sharpener for Edged Tools.

then holding a bar of soft iron or other attractive metal opposite the edge, the magnetic attraction is exerted the entire length of the same and a uniform sharpening is obtained. This improvement, which is practically a reversal of the original idea, has recently been patented by Mr. Davis.

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A New Steam Turbine Patent.

A recent British patent granted to the British Thomson-Houston Company, Limited, London, and Robert Wilson relates to improvements in steam turbines, and has for its object to provide a slow-speed machine in which the expansion of the steam may be effected in a smaller bulk of appliance than hitherto employed for this purpose. The following description is from the London *Mechanical Engineer*:

The turbine, which is illustrated in Figs. 1 and 2, comprises a wheel A on which is provided a number of buckets D. These buckets are formed of a number of inverted V-shaped blades projecting radially from the periphery of the wheel, and are held in position between flanges E bolted to the opposite sides of the wheel. The peripheries of these flanges revolve in working engagement with the

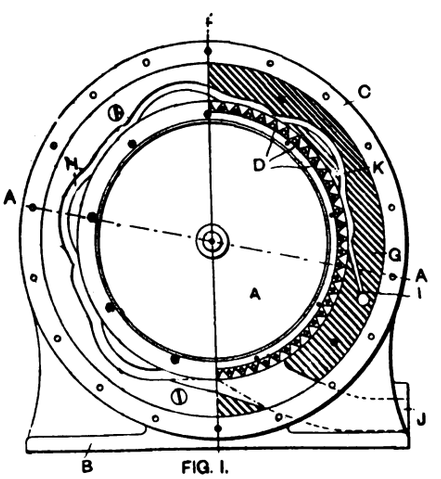
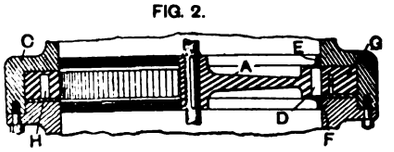


FIG. 1.

FIG. 2.



FIGS. 1 TO 5.—NEW TYPE TURBINE.

interior of the surrounding casing, and the joints between them are formed by a number of small grooves F in the peripheries of the flanges, in which steam condenses and forms a water joint. Suitable working clearance is left between the tops of the vanes and the surrounding casing.

On the interior of the casing C is a ring G in which is formed a sinuous passage H extending around the ring and gradually increasing in area from the inlet I to the exhaust J. This passage at the inlet end is constructed as a pressure-reducing nozzle, so as to wholly or partially convert the pressure energy of the steam into kinetic energy by increasing its velocity. Steam entering the casing through the inlet nozzle I (see Fig. 5) impinges on the buckets opposite, and is deflected from them into a succeeding part K of the sinuous passage H, which is of greater area than the inlet passage I so as to accommodate the increased volume of the steam due to the drop in pressure resulting from the transference of energy to the wheel. The steam as it emerges from this second part of the passage again impinges upon the wheel buckets, and is deflected from them into a third portion of the sinuous passage of still greater area than the second. This operation is repeated until the exhaust is reached, the number of parts of the wheel to which steam is supplied being proportioned according to the range of expansion with which it is desired that the wheel shall operate.

Where the whole range of expansion

FIG. 3.

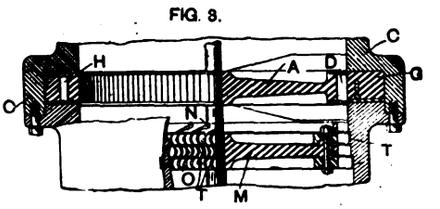


FIG. 4

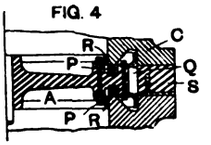
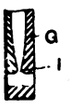


FIG. 5.



can not be conveniently obtained on a single wheel, two or more similar wheels may be employed, the steam being exhausted from one wheel into the other. This compounding may also be effected upon a single wheel, one method of doing which is illustrated in Fig. 4. In this case the wheel A is provided with three sets of vanes P, P_1 and Q, the sets P and P_1 being identical, and both receiving the steam at boiler pressure through the sinuous passages R and R_1, the combined exhaust being led into a sinuous passage S, and operating on the set of vanes Q, the area of inlet to passage S being equal to or slightly larger than the combined areas of the exhaust ends of the passages R and R_1.

Another method of compounding is shown in Fig. 3, where the steam is exhausted from the wheel A into a small turbine M of the parallel-flow type mounted upon the same shaft, and which may be enclosed in the same casing. The steam after passing through the turbine wheel A, which is constructed as above described, is exhausted through the nozzles N of the parallel-flow turbine M, and completes its expansion in passing through the fixed and movable blades O and T in a manner now well known. Instead of a parallel-flow turbine a radial-flow turbine might be used.

The operation of the turbine is as follows: Steam at a high temperature and pressure is admitted into the expanding nozzle inlet I, in which it increases in volume with a proportional increase of temperature, and acquires projectile velocity and kinetic energy, with which it impinges upon the vanes D attached to the wheel A, to which it imparts some of its kinetic energy, thereby causing it to rotate. The steam is deflected from the vanes into the part K of the sinuous passage H, from whence it emerges and again impinges on the vanes, imparting to them a still further velocity, and from which it is again deflected into the sinuous passage H. This cycle of operations is repeated until its kinetic energy is exhausted and its velocity is practically the same as the wheel.

Braking Tests of Cars and Automobiles.

The French extra Parliamentary Commission on Automobilism has held a series of comparative tests of the braking power of cabs and automobiles, the results of which are described in the English *Mechanic and World of Science*. A trial was made on the Bois de Boulogne. The macadam of the road was very greasy, and the shoes of the horses were able to obtain a better grip than the tires of the cars, which nevertheless scored a triumph. Two single-horse cabs, one two-horse coupé, a six-horse-power light car, and a forty-horse-power car, weighing nearly thirty hundredweight, competed. At seven and one-half miles an hour an ordinary cab stopped in thirty feet. Both the motor cars stopped in ten feet. At ten miles an hour the best of several attempts showed that the single-horse cab came to a standstill in forty feet, and the cars in thirteen feet. At twelve miles an hour the two-horse coupé covered forty-three feet before stopping, while the cars pulled up in seventeen feet. Following this, one of the horses, in endeavoring to stop, was severely strained, and was not able to take part in tests at higher speeds. At sixteen miles the cars pulled up in thirty-four feet, and at twenty-four miles an hour, in sixty feet. On a dry road the results would be still further in favor of the automobiles. The conclusion is reached that horses are very inefficiently braked.

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The Forty-eighth Annual Meeting of the American Society of Mechanical Engineers.

The forty-eighth meeting of the American Society of Mechanical Engineers held its opening session in the society's parlors 12 West Thirty-first street, New York city, on Tuesday evening, December 1. Mr. James M. Dodge, president of the society, delivered the annual address. His subject was "The Money Value of Technical Training." The reading of the presidential address was followed by a "smoker."

The second session was held December 2, in the hall of the Mendelssohn Union, 113 West Fortieth street. This was the annual business session for the report of the council, tellers, and of committees standing and special.

The officers elected were: President—Mr. Ambrose Swasey, of Cleveland, Ohio. Vice-presidents—Mr. O. S. Jacobs, of Hoboken, N. J.; Mr. M. L. Holman, of St. Louis, Mo.; Mr. A. Mattice, of Pittsburg, Pa. Treasurer—Mr. William H. Wiley, New York. Secretary—Fredrick R. Hutton, New York. Members of council—Mr. George J. Rockwood, of Worcester, Mass.; Mr. John W. Lieb, of New York, and Mr. W. J. Keep, of Detroit, Mich.

The papers read were: "Is Anything the Matter With Piece Work?" by Mr. Frank Richards. Mr. Richards contrasted the piece-work system of paying workmen with various other schemes, among them the so-called "premium plans," and concluded that the piece-work system was "advancing on its merits as the most honest way of paying for repetitive work in the machine trade as in all others." "Modifying Systems of Management," by Mr. N. L. Gantt; "Slide Rules for the Machine Shop as a Part of the Taylor System of Management," by Mr. C. G. Barth; "What Are the New Machine Tools to Be?" by Mr. J. E. Sweet; "Suggestions for Shop Construction," by Mr. F. A. Scheffler.

In the afternoon the members of the society were guests of the Edison Illuminating Company, of New York, and of the Interborough Rapid Transit Company on a tour of inspection of the east side power-house.

A theatre party was formed in the evening which concluded the day's programme.

The third session was held Thursday morning, December 3, in the auditorium in the main building of Stevens Institute of Technology, Hoboken, N. J. The professional papers read and discussed at this session were: "The Pitot Tube," by Mr. W. B. Gregory; "Methods of Determining Rates and Prices for Electric Power," by Mr. F. B. Perry; "Three and Four-Wire Multiple Voltage Systems," by Mr. R. A. Gillet; "Test of a Compound Engine Using Superheated Steam," by Mr. D. S. Jacobus; "The Pressure Temperature Curve of Sulphurous Anhydride (SO_2);" by Mr. E. F. Miller, and "Construction and Efficiency of a Fleming Four-Valve Engine," by Mr. B. T. Allen.

Professor Hans Goldschmidt of Essen, Germany, also described and demonstrated the powers of thermit in an illustrated lecture on alumino-thermics and their application to engineering and metallurgy.

In the afternoon luncheon was served in the Carnegie Laboratory of Engineering of the institute. The members of the society then inspected the laboratory, shops and draughting-rooms of the institute.

The evening was devoted to a reception of members and guests by the president and president-elect at Sherry's, New York city. The reception was followed by dancing and continued through the evening. The closing session was held at the society's parlors. The professional papers read were: "A Compact Gas Engine, Beam Type;" by Mr. C. H. Morgan; "Standard Unit of Refrigeration," by Mr. J. C. Bertsch; "Series Distilling Apparatus of High Efficiency," by Mr. W. F. M. Goss; "Air Motors and Air Hammers, Apparatus and Methods for Testing," by Max H. Wickhorst; "Valve Motion of Duplex Air Compressors," by Mr. S. H. Bunnell.

Water Powers on the Chippewa River, Wisconsin.

The United States Geological Survey has just completed an investigation of available water powers along the Chippewa river between Chippewa Falls and Flambeau, Wis., and finds that in this distance of about forty-two miles there is a total fall of 243 feet. Only a small part of this is used.

The Chippewa Falls Lumber and Boom Company has a plant at the Falls which develops about one-third of the available 7,000 horse-power. It also has a flooding dam at Holcombe, with a head of eighteen feet. Another company is now at work developing the power at Jim Falls, where there is a head of thirty-three feet. Points at which there are excellent chances for development are Eagle Rapids, with a thirty-foot drop; Brunne Falls, a fine site for a dam, with about the same head, and Point Creek Rapids, Coltons Rapids, and Chevally Rapids, each with five-foot fall.

The field work of the Survey was done by Mr. F. T. Fitch, who made a complete map of the river showing all the islands, rapids and falls, noting at the same time the exact height of the water at the top and the bottom of each fall. Reference marks are left at frequent intervals, by means of which other surveys may be connected to this at any time. The levels upon which the work is based were brought from the gulf of Mexico up the Mississippi river to Reeds Landing, Minn., and thence across to Chippewa Falls.

Electric Light and Power Stations.

The Census Bureau in an elaborate bulletin gives much detailed information in respect to electric light and power stations in the United States at the date of the last census:

At the time of the enumeration there were 3,620 central electric stations in operation. The cost of their construction and equipment amounted to $504,740,352. The gross income for the year was reported at $85,700,605, and the total expenses at $68,081,375. These stations furnished employment to 23,330 wage-earners, who received $14,983,112 as wages during the year.

The power plant equipment consisted of 5,930 steam engines with 1,379,941 indicated horse-power, and 1,390 water-wheels with a stated horse-power of 438,472. The generating plants consisted of 12,484 dynamos of every description with a stated horse-power of 1,624,980. A noteworthy feature of the development of this industry has been the installation of plants operated under the control of municipalities. There were 815 of these plants in operation. The cost of their construction and equipment was reported at $22,020,473. They gave employment to 2,467 wage-earners and paid $1,422,341 in wages.

The 182d Meeting of the American Institute of Electrical Engineers.

The 182d meeting of the American Institute of Electrical Engineers will be held at the Chapter Rooms, Carnegie Hall, 154 West Fifty-seventh street, New York, at 8.15 P. M., Friday, December 18. The following papers will be presented:

"Automatic Apparatus for Regulating Generator and Feeder Potential," by E. J. Bechtel.

"Safeguards and Regulations in the Operation of Overhead Distributing Systems," by W. C. L. Eglin.

"Overhead High-Tension Distributing Systems in Suburban Districts," by George H. Lukes.

"Gas Engines," by J. R. Bibbins.

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Reviews of Current Engineering and Scientific Literature.

The Influence of a Magnetic Field Upon the Pitch of Tuning Forks.

In 1885 the Vienna conference decided to use a tuning fork upon a sounding board, and actuated by an electromagnet, in order to obtain a longer period. At the time, attention was called to the fact that the magnetic field might change the pitch of the fork, and some attempts were made by various investigators to detect such an effect. Herr O. Kirstein has made a careful study of this matter, and by using two forks in tune when vibrating freely, he found that they were no longer in tune if one of the forks was actuated by an electromagnet. By selecting two forks not exactly in tune, and observing the beats, and then by changing the period of either one, he was able to determine the effect of the magnetic field. The following are his conclusions. If a tuning fork vibrates in a magnetic field in such a way that the lines of force are perpendicular to the plane of vibration, the pitch of the fork is raised. On the other hand, if the lines of force are parallel to the plane of vibration, the pitch is lowered. The change in pitch is directly proportional to the field strength. The effect of the magnetic field is only temporary. For a given field strength the decrease in the pitch is greater than the increase. If the plane of vibration of the fork lies at forty-five degrees to the lines of force, there is no change in the pitch.—*Translated and abstracted from Physikalische Zeitschrift (Leipsic), November* 15.

Recent Developments in Niagara Power.

In this article Mr. H. W. Buck describes the equipment of the two plants operated by the Niagara Falls Power Company. The old plant, which contains ten 5,000-horse-power units, has reached the limit of its output, and the second plant—which, when completed, will have eleven units of a similar output—is well along toward its limit. This station will be completed by January 1, 1904. The equipment of this station is very similar to that of the first, except that the latest five generators have internal revolving fields, instead of the external fields of the other machines. An allied company is also erecting on the Canadian side a plant very similar in its plans to the American plants, and which will have an output of 110,000 horse-power. The water here is taken from the river through a short canal and forebay, and discharged through penstocks into turbines near the bottom of the wheel-pit. It is carried away to the lower river through a tunnel 1,700 feet long. The size of the units selected for the Canadian power-house is 10,000 horse-power. The dimensions of these machines will not be much greater than those of the 5,000-horse-power machines, so that a considerable saving in the length of the power-house will be effected. Five of these machines will be installed at first. They are wound for three-phase current at 10,000 volts, twenty-five cycles. Power will be transmitted, according to the distance, at 22,000, 40,000 and 60,000 volts. A list of the customers of the company is given, showing the location, the power taken by each, and the distance from the power-house. The author thinks that the Niagara power system will be vastly increased within the next ten years. As these three power-houses will be connected together electrically, there will be almost no danger of interruption to the service. —*Abstracted from Cassier's Magazine (New York), December.*

The Brown-Boveri Parsons Turbo-Generators.

This article gives some data of the Parsons steam turbine sets constructed by Brown, Boveri & Company. These sets are built for outputs varying from 100 kilowatts to 5,000. For a machine of 500 kilowatts or less, the speed is 3,000 revolutions per minute; for 750 and 1,000 kilowatts, the speed is 1,500 revolutions per minute; and for all sizes above these, 1,000 revolutions. The pressure of the steam employed is ten kilogrammes per square centimetre for units rated at 300 kilowatts and under, and twelve kilogrammes per square centimetre for all sizes above this. The temperature of the steam is 250 degrees centigrade and 300 degrees centigrade, respectively. The consumption of steam varies, of course, with the size of the units, but is given at 12.7 kilogrammes per kilowatt-hour at full load, and 15.2 kilogrammes per kilowatt-hour at half load for the 100-kilowatt set. For the 500-kilowatt set the respective figures are 9.1 kilogrammes per kilowatt-hour, and 11.2 kilogrammes per kilowatt-hour. For the 1,500-kilowatt set, the figures are 8 and 9.8 kilogrammes per kilowatt-hour. For the 5,000-kilowatt set, they are 6.6 and 8.35 kilogrammes per kilowatt-hour. The length of the 100-kilowatt machine is 5.6 metres, and the breadth is 0.95 metre. For the 1,000-kilowatt set the length is ten metres, and the breadth is 1.8 metres. The 5,000-kilowatt set is fifteen metres long and 3.5 metres broad. The generator is directly coupled to the turbine without any reducing gear. The frequency of the generator is fifty cycles per second, and they therefore have two, four or six poles, according to the speed. The height of the machines is about equal to the breadth. The weight of a generator set of average speed, including the generator, is about twenty-five to thirty kilogrammes per horse-power.—*Translated and abstracted from L'Électricien (Paris), November* 21.

Cost of Water Power.

It has been estimated by Mr. J. C. Hawkshaw that France uses water power to the extent of 500,000 horse-power. According to Dr. Louis Bell, the total development of improved water power in the United States is 1,500,000 horse-power. Unwin estimates that Norway can supply 236,000 horse-power from large rivers, and that with regulation the quantity could be increased four times. For electrochemical stations alone it is estimated that in 1890 a total of 27,000 horse-power was being used. In addition to this Canada, Africa, India and South America have vast amounts of water power stored for the future. According to Janet, the cost of water power development in France varies from $21.40 to $150 per horse-power, depending upon the head of water, the lowest expenditure being with a fall of 140 metres in Haute-Savoie. At Geneva the first turbines cost $300 per effective horse-power. The subsequent units erected cost but $95 per horse-power, and the completed works will cost but $135 per horse-power. At Vonvray, on the Rhone, the total cost of the first 2,000 horse-power, including water rights, was $160 per horse-power. The second 2,000 horse-power cost only $55 per horse-power. At Lyons the highest capital expenditure amounted to $420 per horse-power developed. In the claret works at Vallorbe, the capital expenditure for a development of 3,000 horse-power amounted to $19.45. The charges for power in Europe vary considerably. In Lyons the yearly rental is $90 per horse-power, and in Switzerland the average rate is only $30 per horse-power per year. At Niagara the charge for electrical energy varies from

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two cents per kilowatt-hour for 1,000 kilowatt hours per month or less, to 0.64 cent where the monthly consumption is from 80,000 to 200,000 kilowatt-hours. At Columbus, Ga., electrical power is sold to consumers requiring 1,000 horse-power and over at $15 per horse-power-year, delivered at the secondaries of the transformers, the transformers being furnished by the power company. This energy can be used under contract for sixty-six hours a week.—*Abstracted from the Mechanical Engineer (London), November 21.*

London Underground Electric Railways Power Station at Chelsea.

The present condition of this large power station, which will operate the London Underground Electric Railway Company's systems, and which is located at Lots Road, Chelsea, is here described. The total length of the system is sixty-three miles. The building is 453 feet by 175 feet, and will be 140 feet high. There will be four stacks each nineteen feet internal diameter and 275 feet high. On account of the poor character of the ground, it was necessary to sink the foundations thirty-five feet, and all machinery will be installed upon tall concrete piers. The capacity of the building at normal load is 57,000 kilowatts, being 139 feet per kilowatt, including the office building, and 1.36 square feet per kilowatt. The building is a steel-frame structure sheathed with brick and terra-cotta. The boiler room will contain eighty water-tube boilers arranged two stories high, each having 672 square feet of superheating surface and 5,212 feet of heating surface. The boilers will be piped in groups of eight, each group supplying steam for one electric generating set. There will therefore be ten sets entirely independent. They will be fitted with economizers. The main generating sets will be ten in number, and consist of a horizontal steam turbine running at 1,000 revolutions per minute and driving a three-phase generator at 11,000 volts, thirty-three and one-third cycles. The normal rating for each generator is 5,500 kilowatts, and they will carry an overload of fifty per cent for two hours with practically the same steam consumption. The building is fairly well advanced, as the steel work on October 15 was in place for about half its length up to the roof of the engine room, and to the top of the coal bunkers over the boiler room. Two of the four stacks have reached a height of 150 feet, the other two being only fifty feet up. All the foundations are complete, and the feeder ducts for carrying the cables from the power-house to Earls Court, whence they will diverge to the various substations, are nearly finished.—*Abstracted from the Tramway and Railway World (London), November 12.*

Behavior of a Red Colloidal Gold Solution Toward an Electric Current.

It is generally said that colloidal gold solutions, as well as the permanent suspensions, are coagulated and precipitated by the passage of electric current, red colloidal gold solutions being simultaneously turned blue. Mr. J. C. Blake has investigated the behavior of completely reduced red solution of colloidal gold, formed by the action of an ethereal solution of gold chloride dried at 170 degrees, on acetylene water containing ether. If such a solution is contained in an ordinary beaker, there is no effect apparent upon passing an electric current for hours. This apparent inactivity is attributed to conditions favorable for uniform diffusion. On the other hand, if the solution is contained in an ordinary U-tube, with an electrode in each arm barely entering the liquid in order to avoid the diffusing effect of escaping gases, electrical migration and concentration of the gold may be observed. When contact is made, the gold immediately begins to settle around the cathode with a clear surface of demarcation, leaving a colorless liquid, but never passing the bend of the U-tube. The gold solution around the anode grows deeper in color for about half an hour, and then grows lighter in color, until, after twelve hours, only a faint pink tint remains, all the gold being now concentrated in a red cloud at the bend of the U-tube, except for a slight deposit of dark-colored slime on the anode. When the U-tube is so constructed as to have a long, horizontal portion between the two arms, the phenomena were unchanged, the cloud forming midway between the poles. The red cloud may be diffused by gentle agitation or warming, and diffuses simultaneously when the current is broken. The explanation given is that the gold particles are originally negatively electrified, and hence start toward the anode; but, upon concentrating around the anode, they give up their charges and, receiving a positive charge, are repelled. These positively charged particles meet negatively charged particles migrating from the cathode, and some sort of union is formed, which produces the red cloud at the bottom of the tube.—*Abstracted from the American Journal of Science (New Haven), December.*

Recent Developments in the London Metropolitan Electric Supply Company's Installations.

In this section of this series of articles describing the Metropolitan Supply Company's installations, two of the substations are taken up. The first of these forms part of the Manchester square generating station, and receives power from the Willisden station at 10,000 volts, reducing it to 1,000 volts for working in parallel with the Manchester square plant. The transformers are rated at 100 kilowatts each. The original installation included eight of these. The new additions consist of 2,800 kilowatts in similar transformers and 3,255 kilowatts in motor-generators. This is probably the largest substation in England. The motor-generators are rated at 500 kilowatts each, and the motors are two-phase synchronous machines designed for 1,100 volts, sixty cycles. The generators deliver direct current at from 200 to 230 volts. The machines are built on separate bed-plates, connected together through flexible couplings. A seventy-kilowatt starter set consists of a two-phase induction motor driving direct through a flanged coupling a direct-current generator. The alternating-current switchboard is of the Ferranti standard type, and the board is practically in duplicate, there being two sets of bus-bars, two sets of synchronizing gears, and two pairs of voltmeters. Oil-break switches and fuses are used. The other substation is situated in Tower street, near Seven Dials, and is a motor-generator station from which only direct current is distributed, though alternating current is transmitted thence to the Sardinia street station at times. The transformers used here are of the Berry type, are sixteen in number, and of 100 kilowatts each. They are arranged in groups of three, two and three on each side of the two phases. These transformers have annular horizontal primary and secondary coils, interspersed with one another and interlinked with a number of radially disposed laminated iron systems, leaving abundant surface for cooling by radiation and convection. These transformers supply power to four 500-kilowatt motor-generators—two installed at this station and two at North street. In addition to the motor field regulators, there are two Cowan regulating transformers for the feeders running to the Sardinia street station. Each gives a variation of 120 volts. It is intended to install at this station a storage battery rated at 400 amperes for three hours. These will be supplied with boosters and balancers. The business of the company has increased rapidly, both in supplying lights and power. It leases motors and is encouraging the use of its power for heating and cooking. It will be necessary to install additional machinery to provide for the increased output of the system by next year. —*Abstracted from the Electrical Review (London), November 20.*

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The Interstate Independent Telephone Association.

The Third General Meeting, Held at Chicago, Ill., December 8, 9 and 10.

[*Special Telegrams to the Electrical Review.*]

CHICAGO, TUESDAY, DECEMBER 8—The third general meeting of the Interstate Independent Telephone Association was opened at 2 P. M., Tuesday, December 8, at the Auditorium Hotel, Chicago, Ill. A large number of delegates were in attendance, representing telephone men from all of the nine states included in the organization.

President Charles E. Hull called the meeting to order, and introduced Mr. David Levy, who welcomed the delegates on behalf of Mayor Harrison.

A committee was appointed to draft resolutions on the death of Mr. Henry C. Raney, the first president of the association.

President Hull in his address declared that the independent telephone business originated in the needs of those people who were not supplied with telephone communication, and consequently the movement possessed the moral and financial support of the public. This was the secret of past success, and, he thought, the guarantee of future greatness. He suggested, that in order that the organization be successfully maintained, a revision of the constitution was essential, with the object of broadening the field of the organization and placing it on a sound financial basis. He urged the securing of a well-equipped, permanent headquarters, and made a plea for the solidity of the membership and for a general free-will spirit of assistance one with the other. A committee should be appointed to mature plans and to create and foster aggressive sentiment in favor of the independent telephone movement. The question of a distinctive national emblem was raised, and the necessity for this pointed out. Mr. Hull strongly advocated the immediate adoption of some emblem which would be distinctive in its design and meaning.

The secretary's report directed attention to the decision of the manufacturers of telephone and kindred apparatus not to entertain the delegates and guests.

The capital invested in independent exchanges was some $2,000,000, with 2,000,000 subscribers on January 1 of the present year. This was without considering the rural companies, which aggregate a half million more. One hundred and seventy-five cities, with over 20,000 population, have independent exchanges operating. The net earnings of twenty large companies during the last four or five years have been from eight to sixteen per cent. Eight years ago Indiana had 6,000 telephones; to-day there are 80,000 independent telephones in use. Iowa is the banner state, with 1,200 independent companies. There are from 80 to 100 independent companies incorporated each week.

The secretary also pointed out the necessity of the adoption of cooperative plans and alliances, and of legitimate combinations to defeat organized competitors. Capital must be convinced of the possibilities of profit in, and the permanency of, independent enterprises. The secretary stated that there were sufficient funds annually to carry out the plans contemplated in the report, and enabling the employment of competent men to take full charge and develop the various departments. A resolution was passed to refer the secretary's report to a committee of nine, for investigation of the recommendations, this committee to report back to the convention.

A committee of three was appointed to call on the Illinois Telephone and Telegraph Company, for the purpose of inviting Mr. Wheeler, of this company, to address the convention, and ascertain the company's intention regarding connection with outside city exchanges.

Professor W. E. Goldsborough, chief of the Department of Electricity, Louisiana Purchase Exposition, then addressed the meeting briefly with regard to the proposed meeting of the organization next year at St. Louis. P: S. D.

CHICAGO, ILL., Wednesday, December 9—The morning session was devoted to the inspection of exhibits, and a large number of the delegates accepted the invitation of the Illinois Telephone and Telegraph Company to inspect its system.

President Hull called the second session to order at two o'clock. The committee appointed on the previous day to confer with the Illinois Telephone and Telegraph Company, regarding its attitude to independent telephone companies requiring long-distance connection, reported that this matter could not be taken up at present. In the early spring it was expected that cable arrangements would be made so that long-distance connections would be possible with any company proposing, and that was able to furnish good service with metal lines.

Mr. B. F. Wasson, of Clinton, Iowa, addressed the convention regarding a collection of relics of the telephone industry, for an exhibition at the Louisiana Purchase Exposition. He suggested that this collection might be termed an exhibition of the independent telephone interests. Sixty square feet of space was first applied for, but an increase had been found necessary, and an exhibit space of 1,000 feet had been given. This exhibit would unquestionably be interesting, and the association's cooperation was desired. All express expenses would be defrayed for those sending exhibits. A motion to endorse this exhibit was unanimously carried.

Mr. Theodore Gary, of Macon, Mo., addressed the convention regarding the classification of freight rates and the treatment by the railroads of the smaller exchanges. The present dry battery instruments were under the same classification as the old wet battery, and cost four cents apiece from Cleveland to the western portion of Missouri, and three cents to Chicago. On returning empty cells, these were under the wet battery classification, instead of under the regular charter rate. Mr. Gary urged the appointment of a committee to look into this matter. The Missouri railroads demanded free telephone service, and the matter needed adjustment to give the small exchange operator a fair opportunity. After considerable discussion, three committees of three each were appointed—one to take up the question of freight classifications, one to secure paid telephone railroad service, and the other dealing with the express companies.

The committee appointed to act on suggestions and recommendations in the secretary's annual statement, reported that the convention was too short to prepare a permanent constitution and by-laws, and the chairman was authorized to appoint a special committee, consisting of President Hull, Messrs. Cheadle, Moulton and Goodrich, to prepare a suitable constitution, enabling the association to continue until permanent organization was perfected. This committee was to report to the full committee. It was recommended, first,

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that the association be incorporated, without capital, profit or liability; second, that the organization cover the present states in the association, with such other states or territories as may be deemed essential to cooperation; third, that the membership fee for operating exchange company, toll line company, individual or corporation, be $5 annually, with an additional tax, according to the character of the exchange; fourth, that contracts for toll line connections be uniform, with also, as far as possible, uniform rates based on telephones in operation.

The committee presented a resolution that a permanent committee, consisting of President Hull and Messrs. Rex, Coleman and Barnhart, be appointed to carry out these recommendations and effect the association organization.

Professor J. C. Kelsey read an interesting paper on "The Standardization of Apparatus," and urged that a committee be appointed by the association, composed of representative engineers of various companies, who would have power to make tests, with a view to the standardization of apparatus and material for all independent companies.

This was followed by a paper written by Mr. W. C. Polk, of Kansas City, Mo., and which was read by the secretary. The subject of this paper was "The Standardization of Construction," and set forth the difficulties of such standardization. The author suggested a national organization board, composed of experienced practical engineers and construction superintendents from all parts of the country, on which investors and operating owners could call for advice, which would be conscientiously and intelligently furnished.

Mr. H. V. Critchfield took the floor, representing President Wheeler of the Illinois Telephone and Telegraph Company. He confirmed the report of the committee, and stated that construction work would be started next spring, with a view to having toll lines radiating in many directions from Chicago.

The meeting adjourned after the committee on credentials recommended that no one be admitted to the future sessions unless possessed of a certificate endorsed by the company he represented.

P. S. D.

CHICAGO, Thursday, December 10—The third session opened promptly at 10 A. M. Several interesting papers were read and discussed. An important topic of discussion was "The Rights of Telephone Companies on Public Highways." Mr. Henry A. Barnhardt, of Rochester, Ind., read a paper entitled "Where Should the Line of Demarcation Be Drawn between Independent Operating Companies and Manufacturers, and the Bell?" Mr. David Prewitt read a paper on "What Should Be the Representation of Independent Companies in the Association in Voting?" Mr. J. S. Bailey, Jr., Toledo, Ohio, read a paper on "Independent Toll Line Systems, and Is the Time Ripe for Merging?"

Mr. Bailey said that during the past four years the large independent telephone interests in St. Louis, Indianapolis, Cleveland, Pittsburg, Buffalo, Philadelphia, Baltimore, Minneapolis, Kansas City and Chicago have been constructing and equipping long-distance systems with copper circuits to the territory in the vicinity of each of these cities. Up to date the investment had been made of between $15,000,000 and $20,000,000. A number of the above cities representing the square system are connected together by traffic arrangements. He predicted, within two years, the consolidation of these companies, representing by that time capital of not less than $50,000,000 and giving independent long-distance service as extensive as the Bell, and reaching fifty per cent more subscribers in the Western and Middle States. This service, when it comes, would be good to all points instead of to a few.

Mr. Brooks, of Minnesota, directed the attention of the convention to the action of the Postmaster-General, ordering the St. Paul post office to use only Bell service, although the postmaster had found independent service satisfactory. The reason given was that it was nothing political, but for the good of the public required that the company should be used which gave long-distance connection with Washington. This point was made only by eastern cities not possessing independent companies, as Boston, New York and Washington.

W. H. McDonough read a paper entitled "Are Our Telephone Periodicals Careful as to Business Relations Sustained by Contributors."

The following officers were elected:

President, the Hon. H. Barnhart, Rochester, Ind.

Vice-president, E. H. Moulton, Minneapolis.

Secretary, E. M. Coleman, Louisville, Ky.

Treasurer, A. B. Conklin, Aurora, Ill.

Executive Board—Illinois, the Hon. Charles E. Hull; Iowa, J. S. Bellamy; Indiana, O. Rex, chairman; Wisconsin, Richard Valentine; Ohio, W. Guy Jones; Missouri, H. G. Conger; Kentucky, W. Matthews; Kansas, Charles E. Wells; Pennsylvania, J. G. Splane.

Convention adjourned.

The afternoon was passed in visiting exhibits, after which the annual banquet was held, which was very largely attended.

P. S. D.

Parsons Steam Turbines in the United States and Canada.

Mr. George Westinghouse makes the important announcement that for the Westinghouse Machine Company, of Pittsburg, he has acquired from Mr. C. A. Parsons the full rights to manufacture in the United States and Canada the well-known Parsons steam turbines for all purposes, including marine propulsion, and that a special department will be organized at the works for the introduction of this engine in order to more effectively promote its use upon all classes of vessels, including warships of every type. This new department will work in close touch with all the steamship builders in the country.

Mr. Westinghouse when questioned, respecting the matter, said: "The steam turbine is not a new and comparatively untried invention as many laymen seem to think. There are half a million horse-power of Parsons steam turbines in daily operation in different parts of the world; 84,000 horse-power of these are in steam vessels. In the United States alone there are 60,000 horse-power of the stationary type used in connection with electric light and power in continual operation, and 150,000 horse-power more are already contracted for and now under construction at Pittsburg, where units as large as 8,000 horse-power are being built. The impression in the public mind that the steam turbine is a new thing, is probably due to the fact that attention is frequently called to new makes of turbines. The fact is, these new types have not demonstrated any superiority over the Parsons. I have made a broad investigation of this question, with the result that the Parsons turbine is the one with which I have concluded to ally my interest. We shall build up a great marine turbine industry in the United States. The importance of the marine turbine has not been overestimated, and it is long past the stage of experiment. For passenger ships, freight ships, yachts, and for battleships, not less than for torpedo boats, the turbine is unquestionably the best engine. For pleasure craft the turbine surpasses all other forms of engine, because of its absolute freedom from vibration. Its compactness recommends it for all classes of vessels. In torpedo boats the saving of room is needed to accommodate other machinery. In naval cruisers and battleships, the engines lie so much closer to the ship's keel as to make them far less likely to be injured by the enemy's shots. We need not call the turbine the engine of the future; it is decidedly the engine of the present."

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INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

A Synchronism Indicator.

The accompanying illustrations show a synchronizing indicator manufactured by the General Electric Company, Schenectady, N. Y. Fig. 1 shows the synchronism indicator with pivoted bracket. This indicator, however, is so designed that it can be used with a swinging bracket. Fig. 2 shows the external reactance and resistance used with the synchronism indicator.

This indicator is equally adaptable to single-phase, two-phase or three-phase apparatus. The phase displacement necessary for operation of the instrument is

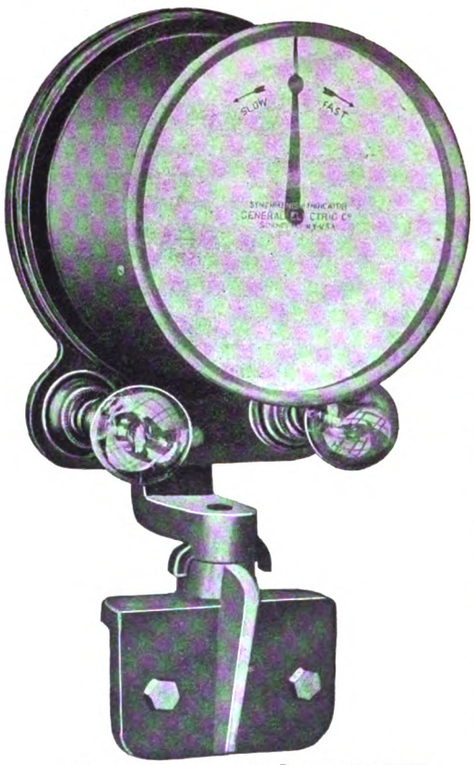


FIG. 1.—SYNCHRONISM INDICATOR WITH PIVOTED BRACKET.

accomplished by a suitable reactance and resistances mounted in an external cage. These indicators are made for back connections only.

This indicator shows whether the incoming machine is running too fast or too slow, and therefore presents many time-saving possibilities.

The diameter of the dial of the standard instrument is eight inches, thus permitting observation by the operator of the engine or water-wheel, as well as by the switchboard attendant. The construction of the indicator is similar to that of a small motor, the field of which is energized from the synchronizing buses excited by the machine that is running.

The armature is of the drum type,

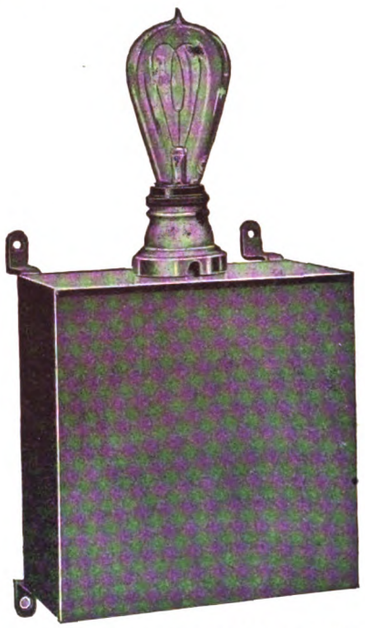


FIG. 2.—EXTERNAL REACTANCE AND RESISTANCE FOR SYNCHRONISM INDICATOR.

having two coils rigidly fastened at right angles to each other and connected in series.

Both the reactance and resistances are intended to be placed behind the board. The reactance is contained in a metal case, on the outside of which is fastened a socket containing an incandescent lamp, which serves as the resistance. All synchronism indicators are made for 110-volt circuits, unless otherwise specified, but the manufacturer states that they will operate properly on any voltage from 100 to 125.

The words "fast" or "slow" on the dial indicate that the frequency of the electromotive force at the terminals of one ma-

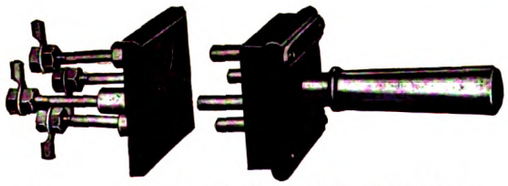


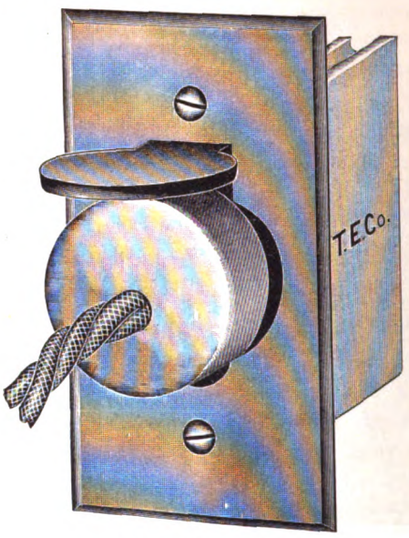
FIG. 3.—SYNCHRONIZING RECEPTACLE AND PLUG.

chine is respectively higher or lower than that on the other—that is, clockwise rotation of the pointer means that the incoming machine is running at too high a speed, counter-clockwise rotation meaning too low a speed.

These indicators are furnished without receptacles, plugs or brackets, unless otherwise ordered. Two styles of plug receptacles are necessary in synchronizing, and three styles of connection plugs are necessary. Fig. 3 is a typical synchronizing receptacle and plug.

A New Flush Receptacle.

The accompanying illustration shows the new flush receptacle made by the Trumbull Electric Manufacturing Company, of Plainville, Ct. The main features of this receptacle are that it fits into any standard switchbox, without the use of a special plug, and that it is made to



FLUSH RECEPTACLE.

take the ordinary Edison base-attaching plug, such as is used for tapping into incandescent lamp fixtures for a fan motor or a desk lamp. This device will be found of great convenience to any one using an Edison plug. When it is not plugged in, the apparatus presents a finished appearance, as it is fitted with a nickel-plated cover which drops smoothly into place.

Special preparations have been made at all of the theatres on the Proctor circuit for an appropriate observance of the Christmas holidays. The electrical features introduced by Mr. Proctor during this period will be of an exceptional nature. He is one of the pioneers in the adaptation of electricity for illumination and spectacular effects in theatricals, and the display during the coming holidays will be of a particularly elaborate nature.

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Straight-Bridge Transmitter.

The straight-bridge transmitter shown in the accompanying illustration is one of the products of the telephone department of the Electric Gas Lighting Company, of Boston, Mass.

This company claims that the best skill and the most painstaking effort of its mechanical and engineering departments have been involved in the creation of the Samson transmitter. The front is a heavy brass casting, well nickel-plated, and fitted with a genuine rubber mouthpiece. The main diaphragm is an aluminum disc two and one-half inches in diameter and insulated from the case by a pure rubber band. Dampening springs are used, having rubber terminals of improved design. The company claims to be the first manufacturer to dispense with the use of a heavy bent bridge and to substitute a perfectly flat one which is interchangeable. The construction of the moisture-proof granule chamber is new in design, and it consists of a rigid disc of metal fastened to the diaphragm having a depression in

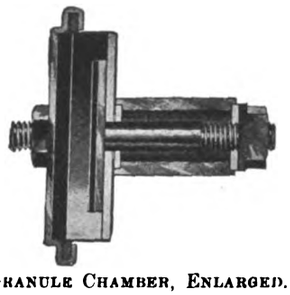
THE TRANSMITTER, THREE INCHES DIAMETER.

which is secured the front electrode of polished carbon. A cup of resilient metal forms the granule chamber and carries the polished carbon back-electrode. It is fastened to the disc by means of a ring and the lugs shown in the illustration. This mode of construction secures the full benefit of the vibratory action of the main diaphragm, and produces a granule chamber which is moisture-proof.

The case in the Samson transmitter forms no part of the circuit. Accidental contact with high-tension outside circuits is therefore avoided. The method of construction and location of the terminals is a new departure in transmitter construction. The connecting screw upon the heavy collar which is insulated from the bridge by mica forms the terminal of the front electrode, while the central post, also insulated by mica from the sleeve which formed a portion of the previous circuit, serves as the other terminal.

Power Plant Accidents.

Within the past thirty years the number of boiler explosions has increased so that many states have passed laws restricting the pressure carried and requiring examinations at frequent periods as a safeguard. During the past twenty years there has developed another factor in the power plant that is even more dangerous,



GRANULE CHAMBER, ENLARGED.

namely, the flywheel break, and records show a considerable loss of life and property from this source. The increase of heavy strains in the exacting duty of street railway, lighting and power work is, in a measure, responsible for this, but in the main the trouble can be traced to a great extent to the same cause as that which produces the boiler explosion—overload.

Whether a flywheel accident insurance

STRAIGHT BRIDGE SHOWING INSULATED TERMINAL.

policy is carried or not, there is another precaution that is becoming more generally recognized all the time by power plant managers and mill owners, namely, the automatic engine-stop, which is a mechanical device operated by electricity. It automatically closes the throttle at any

BACK OF TRANSMITTER.

predetermined overspeed, so that a flywheel can never reach the danger point, and by equipping with this automatic engine-stop, the accident is averted entirely, thus saving lives, destruction of property, and especially saves the loss of business due to shutdown for repairs. This preventative feature is where it surpasses actual insurance, for the latter only remunerates, and that only after the damage is all done.

With engine-stop "insurance," there is only one premium to pay—the first cost of the apparatus—and if the engine races, the engine-stop prevents an accident and no property is destroyed.

On September 10, the Boston *Herald* contained a despatch from New York regarding the discussion of liability underwriters about increasing rates when no engine-stop and speed-limit system is used. To quote the despatch:

"New York, September 9—A number of prominent officials of the liability insurance companies have been discussing informally the advisability of increasing rates upon manufacturing plants, where no engine-stop or speed-limit system is used.

"With the enormous increase in high-speed power the hazard from runaway engines, bursting flywheels, and similar avoidable accidents has become so great that liability underwriters feel that some material advance should be made in order to meet the extra risks. Hardly a day passes that the newspapers do not contain accounts of casualities which might have been avoided had an engine-stop or speed-limit system been installed.

"The liability underwriters argue that if the fire insurance companies can afford to differentiate between 'sprinkled' and 'unsprinkled' risks, the casualty companies should make a like distinction.

"The Consolidated Engine-Stop Company, of 100 Broadway, which controls the Monarch engine-stop and speed-limit system, which has been installed by a large number of progressive manufacturers, has made such a record for accidents avoided, that some of the most prominent liability underwriters have suggested that its use be made compulsory in the same way that certain safety devices are insisted upon by the board of fire underwriters in the installation of an electric plant.

"No definite action has been taken as yet, but it will be formally discussed in the fall."

The Consolidated Engine-Stop Company referred to in the despatch, has lately installed the Monarch engine-stop and speed-limit system in the power stations of the Boston & Northern Street Railway Company; Berkshire Street Railway Company, Pittsfield; Springfield & Eastern Street Railway Company, Palmers; Connecticut Railway and Lighting Company; Edison Electric Illuminating Company, Brockton; Lowell Electric Light Corpora-

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tion, Lowell; Malden Electric Company, Malden; Suburban Gas and Electric Company, Revere; Albany & Hudson Railway Company, Albany; Hoosac Valley Street Railway Company, North Adams. It is also equipping large numbers of manufacturing establishments throughout the country.

Electrical Company Reorganizes.

The Fidelity Electric Company, Incorporated, of Lancaster, Pa., formerly the George C. Towle Manufacturing Company, which has lately been reorganized for $50,000 capital, began business in 1896 in the two upper floors of a building, and has been gradually increasing in its product until it now has an extensive system of buildings.

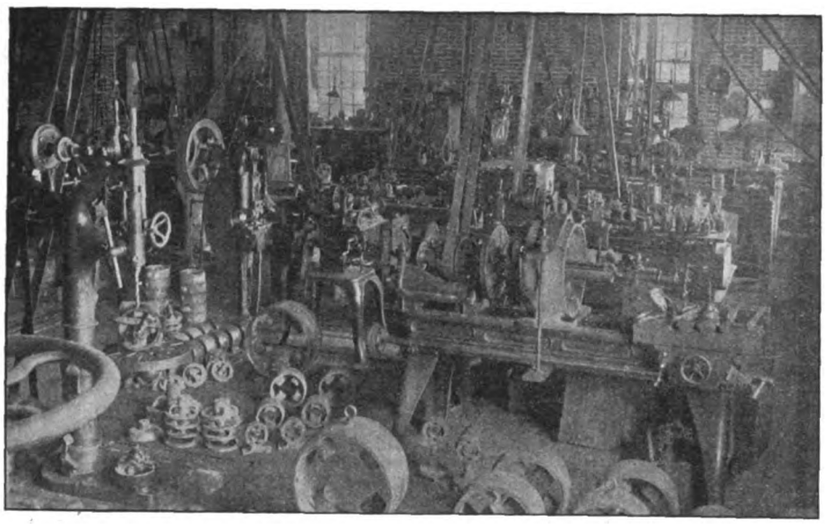


FIG. 1.—INTERIOR OF MACHINE SHOP, FIDELITY ELECTRIC COMPANY, LANCASTER, PA.

The company began as manufacturers of fan motors exclusively, then added a line of small power motors and generators, which it has gradually increased in capacity. Fig. 1 shows the interior of part of the machine shop, which is equipped with modern tools. The total floor space of its buildings is 12,000 square feet.

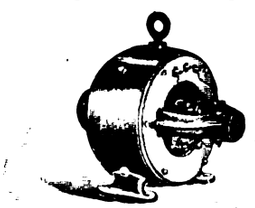


FIG. 2.—NEW TYPE MOTOR.

Among the latest types of motors is its type "P," shown in Fig. 2, built from one-sixteenth to ten horse-power, which recommends itself on account of its adaptability for back gearing, or for inverting for ceiling suspension. The motors are all multipolar and of moderate speed. The body castings are of cast steel, of the highest permeability, the body being cast in one piece.

The field coils are form wound and dipped in a special insulating compound and are wrapped with varnished linen before being taped.

The armature is barrel wound, and is of the ventilated type; air ducts being provided from the interior of the core to the exterior.

The commutators are constructed of drop forged bars and the washers and core of carbon steel to withstand the strain of drawing up in course of construction.

The sliding bases in the larger sizes are parallel machined sliding bars, and in the smaller, the now almost universally used platform base.

The officers of the new company are C. F. Stauffer, president; B. G. Stauffer, treasurer and general manager, and M. S. Graver, secretary.

An Automatic Time Switch.

The Hartford time switch, shown in the accompanying illustration, automatically opens and closes an electric circuit at any predetermined time. When the automatic use of the switch is not desired, it can be instantly disconnected from the clock, when the hand trip provides an independent means for operating the switch.

The time for automatically operating the switch can be quickly and easily changed. The eight-day Seth Thomas clock, which is used with this switch, ensures absolute accuracy in time and certainty in operation.

The switch is of the rotary, double-contact type, with quick break of approved length. The operation is entirely mechanical and no magnets are used.

By a special attachment the switch can be arranged to light show windows or signs for two periods each night.

Thorough and long tests in service have fully demonstrated the accuracy, durability and practicability of this switch under all climatic conditions and varying temperatures.

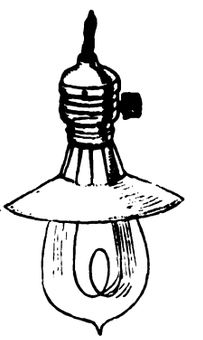
AUTOMATIC TIME SWITCH.

This apparatus is made in three sizes, ten, twenty and thirty amperes, any voltage up to 250, for alternating or direct current, by the Hartford Time Switch Company, Hartford, Ct.

A New Form of Reflector.

The Pardridge Shade and Reflector Company, 183 and 185 Dearborn street, Chicago, Ill., has placed on the market a reflector for incandescent lamps which is meeting with the approval of supply men all over the country.

This reflector can be adjusted to fit any incandescent lamp of any candle-power or base. It is four inches in diameter, one and three-eighths inches high, and is made of brass, heavily nickel-plated and highly polished on the inside. The device is fitted with a small ring attachment that prevents the metal spring of the reflector from coming in contact with the metal of the socket. This avoids any possibility of a short-circuit.



A NEW FORM OF REFLECTOR.

For decorative purposes, the reflector is furnished in colors—green, red, blue, and yellow.

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Interests Represented at the Convention of the Interstate Independent Telephone Association.

Kellogg Switchboard and Supply Company—W. W. Dean, A. E. Balke, R. H. Madison, F. J. Dommerque, R. S. Mueller, W. A. Lutz, Paul Bossert, A. B. Kratz, H. Klein and W. R. Hind.

Automatic Electric Company—H. D. Critchfield, J. F. Cook, H. S. Durant, H. D. Ogden, W. E. Cooke and F. L. Lucia.

The Central Telephone and Electric Company—J. S. Cumming, C. H. Wallis and W. F. Gradoulph.

Standard Underground Cable Company—J. R. Wiley, E. J. Peitzcher, W. M. Rogers and A. A. Anderson.

F. B. Badt & Company—F. B. Badt and G. M. Willis.

Williams-Abbott Electric Company—L. Sands.

Chicago Telephone and Supply Company—G. A. Briggs and R. L. McCoy.

American Conduit Company—John R. Cravens and W. J. Barrett.

Crouse-Hinds Electric Company—F. S. Skeel.

Moon Manufacturing Company—F. H. Wood and H. E. Procunal.

National Wire Corporation—R. B. Abbott.

Kaster Electric Manufacturing Company—A. J. Witherell and F. G. Vickeoson.

McRoy Clay Works—E. F. Kirkpatrick.

Illinois Electric Company—M. McNeil, C. J. Litschel and C. L. Pierce.

F. Bissell Company—M. S. Walker, E. B. Terry and W. S. Bissell.

Sterling Electric Company—W. E. Doolittle, H. A. Taylor, S. B. Fowler, H. S. Bullock, H. T. Doolittle, Evan Shelby, K. V. Murry and G. W. Metcalfe.

W. J. Ball Manufacturing Company—W. J. Ball and L. G. Le Baurveau.

Fulmer-Kuester-Schroeder Company—J. W. Fulmer, D. M. Fulmer and H. C. Miller.

W. H. Anderson & Sons—W. R. Anderson and Thomas Tapp.

Raber & Watson—A. D. Watson and P. E. Raber.

American Carbon and Battery Company—T. P. Gleeson.

Chicago Writing Machine Company—R. E. Hill, F. W. Pardee and S. J. Siegfried.

New Haven Novelty and Machine Company—H. G. Thompson and Charles Luke.

Warner Electric Company—T. W. Warner.

Indiana Steel and Wire Company—Robert Miller.

Western Telephone Manufacturing Company—J. E. Keelyn, W. G. Peacock and E. Schwartz.

Maltby Lumber Company—E. E. Reynolds.

The Allen-Hussey Company—C. J. Huff.

Miller Anchor Company—C. H. Miller and F. B. Miller.

Crawfordsville Wire and Nail Company—Robert Schweitzer and H. E. Cobb.

Electrose Manufacturing Company—H. E. Cobb.

American Stone Conduit Company—George Painter.

Chicago Nut Company—C. F. Messinger.

National Carbon Company—F. H. Murray, M. H. Moffett and A. V. Ward.

Frank B. Cook—Frank B. Cook, J. A. Cook, H. R. Cook, J. F. Thompkins, C. E. White and F. A. Parker.

Vesta Storage Battery Company—

Monarch Telephone Manufacturing Company—W. H. Trimm, E. E. Yaxley and J. C. Hubacher.

American Electric Fuse Company—F. H. Jones.

Gordon Battery Company—E. M. Deems.

Elmore - Fowler - Jacobs Company—J. H. Fowler and Ellinge Elmore.

Western Lumber and Pole Company—B. F. Vreeland.

North Electric Company—Charles H. North, F. F. Sapp, R. Hendrickson and F. Pratt.

Chicago Insulated Wire Company—W. M. Smith.

American Electrical Works—Francis E. Donohoe.

Gould Storage Battery Company—E. L. Drappen.

American Circular Loom Company—T. G. Grier.

H. B. Camp Company—J. A. Hammett.

C. L. Pierce, Jr.

Wesco Supply Company—J. W. Hardy.

Lindsley Brothers—E. A. Lindsley, secretary.

Baker Engine Company—Ellis B. Baker.

Okonite Company—George T. Manson.

Signal Phone Company—R. B. Rogers and E. E. Salisbury.

Eureka Electric Company—I. J. Kusel, V. Rosenow, H. G. Kusel, H. W. Foote and R. Mitten.

Nungesser Electric Battery Company—H. G. Rogers and Thomas Grier.

Hipwell Manufacturing Company—H. H. Hipwell.

American Electric Telephone Company—J. G. Ihmsen, P. C. Burns and H. P. Clausen.

John A. Roebling's Sons Company—W. W. Alfesk, George C. Bailey, W. H. Slingluff and G. W. Swan.

Ewing-Merkle Electric Company—William G. Brown.

Nicholas Selector Company—W. G. Rich, C. A. Rich and C. E. Nicholas.

Annual Meeting of the Electrical Trades Society.

The eighth annual meeting of the Electrical Trades Society, of New York, was held at Muschenheim's Arena, New York city, on Tuesday evening, December 8. The business meeting began shortly after six o'clock, and adjourned at 7.30 for dinner. The attendance was quite large, and a number of visitors from other societies were in attendance. The reports of the officers were very gratifying, and showed that the society was in a very healthy condition, and increasing in membership and importance.

The board of directors were elected for the ensuing year, as follows: H. A. Reed, J. H. Dale, R. E. Gallaher, J. P. Marshall, J. J. Gorman, F. V. Bennis and H. R. Swartz.

New York Electrical Society.

The 239th meeting of the New York Electrical Society will be held at the American Institute, 19 West Forty-fourth street, New York city, Wednesday, December 16, at 8 P. M.

The subject of the evening will be "The Evolution of the Electric Railway Motor," by Mr. S. T. Dodd, of the Stanley Electric Manufacturing Company, Pittsfield, Mass. The lecture will be freely illustrated by lantern slides.

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BOOK REVIEWS.

"Whittaker's Electrical Engineers' Pocketbook." Edited by Kenelm Edgecumbe. New York. The Macmillan Company.*

*In the issue of the ELECTRICAL REVIEW for November 21, 1903, the price of this book was given as $1. The publishers have since informed us that this should have been $1.75, and regret that this error (on their part) was made.

"Cours d'Électricité." Vol. ii. H. Pellat. Paris. Gauthier-Villars, Imprimeur-Libraire. Paper. 6½ by 10 inches. 554 pages. Supplied by the ELECTRICAL REVIEW at $4.

These books have been prepared by the author for use in the course of the Faculty of Sciences, Paris. Vol. i considered electrostatic, Ohm's law, thermoelectricity; and the present volume takes up electrodynamics, magnetism, induction and electrical measurements. The ground is covered very thoroughly, and without an excessive use of mathematical demonstrations.

"Electric Toy Making." Fifteenth edition. T. O'Conor Sloane. New York. Norman W. Henley & Company. Cloth. 183 pages. 5 by 7 inches. Numerous illustrations. Supplied by the ELECTRICAL REVIEW at $1.

This little book describes the simpler forms of electrical apparatus with which an amateur is most likely to be supplied. It gives instructions for constructing electromagnets, and several simpler forms of electric motors, as well as some ingenious toys. Instructions are given for constructing simpler telephone and telegraph instruments, and a number of pretty and interesting experiments is described.

"Arithmetic of Electricity." Sixteenth edition. T. O'Conor Sloane, New York. Norman W. Henley & Company. Cloth. 162 pages. 5 by 7 inches. Diagrams. Supplied by the ELECTRICAL REVIEW at $1.

This book is a practical treatise on electrical calculations of all kinds, reduced to a series of rules, involving only ordinary arithmetical operations. Each rule is illustrated by one or more problems, showing the application and assisting greatly in making the method clear. It should be a valuable book to the practical man, and especially to those who can not use algebra and the higher mathematical processes.

"Wireless Telegraphy." Charles Henry Sewall. New York. D. Van Nostrand Company. Cloth. 229 pages. 5½ by 8½ inches. Many illustrations and diagrams. Supplied by the ELECTRICAL REVIEW at $2.

This work is marked by conciseness of text, logical and instructive arrangement of matter, and clearness of illustration. Inventors and inventions named have been discriminatingly treated, and their work described with a restraint that indicates a mastery of the subject. A feature of merit is the chapter on receiving devices, containing many not generally known. Another is the discussion of the comparative merits of wireless and wire telegraphy, in the course of which the backwardness of American telegraph companies to adopt improved methods of transmission is made very plain. It is cleverly indicated that the commercial future of wireless will have a strong competitor in the existing wire lines under their use with systems of rapid telegraphy already practically perfected. The reader is given the impression—in the reviewer's opinion, a just one—that the achievements of space telegraphy so far would make us feel ashamed of our primitive use of a wire line, capable as it is of bearing electric waves with a facility that makes emission of signals from a vertical wire seem difficult indeed by comparison. The quantity of matter warrants a fuller index, and the book might legitimately have been enlarged both in matter and in contemporary value by a fuller expression of the author's running comments. There is undue condensation of the theoretical part: if the history and nature of Hertz waves were elaborated more, the admirable conciseness of descriptions of different systems would be better appreciated. The omission of some matters, perhaps of too recent occurrence to be included, is to be regretted. The work of Tesla is given considerable attention. The Stone system, constituting what is probably the most scientific treatment of genuine tuning, and the most recent work of Lodge and Muirhead, are not referred to in the book. The chief fault, however, is that one wishes there was more of it. It is to be hoped that future editions will remedy this defect. At any rate, the present edition can not be omitted from any collection of works on wireless telegraphy.

"The Electrical Engineer's Pocketbook." Horatio A. Foster. New York. D. Van Nostrand Company. Flexible leather. 1,000 pages. 4¼ by 6¾ inches. Numerous illustrations. Supplied by the ELECTRICAL REVIEW at $5.

This is the third corrected edition of an already popular handbook. The several departments have been revised by specialists in each line, and the whole work has been carefully prepared by the author in collaboration with a number of eminent professional men. There are numerous tables, and the formulæ are not only given, but the manner in which these are derived is also shown. Accurate descriptions of measuring instrument tests are given, and a short treatise is accorded to each piece of apparatus. The tables of dimensions and constants are accurately worked out, and are so arranged as to afford easy reference. Every method described in this handbook is carefully illustrated, and practical examples are given showing the use of the formulæ. The book has been brought up to date, and affords the engineer the most modern conclusions of experimenter and designer. It will not only be valuable to the electrical engineer, but the information is so complete that the mechanical and the civil engineer will also find the book of great practical value.

Wireless Telegraphy Notes.

The London *Times*, of November 10, states that during Marconi's voyage to Gibraltar, on H. M. S. Duncan, messages were received on board daily after the vessel left Portsmouth. During rough weather one of the special wireless gaffs was carried away, but, notwithstanding that this reduced considerably the height of the masthead wires, the reception of the messages on board continued in an uninterrupted manner. During the several days' stop at Gibraltar, tests were carried out with the object of ascertaining the relative efficiencies of different forms and arrangements of aerial wires. Messages were always received from England with regularity when the arrangement which Mr. Marconi had anticipated would be necessary for the purpose was used. These messages passed across the whole of Spain. It seems that messages could not be sent from Gibraltar to Poldhu with the apparatus on the ship.

It is reported that a large wireless telegraph station is being constructed at Bari. The station will be able to communicate with other stations established along the Italian coast, with vessels in the Adriatic, and the Montenegran station at Antivari. The wireless telegraph stations at Maddalena, Monte Mario, near Rome, Palmaria, Cozzo and Spadafora, Italy, are already working. The first two are exclusively for military purposes; the others will be open to the public. The site for another powerful Italian station has been chosen at San Rassone. It is said that this station will be able to communicate with Argentina and with the stations at Table Head, Cape Cod and Poldhu. A new Marconi station has been commenced at Fraserburgh, on the Aberdeenshire coast, for the purpose of testing the large power stations overland.

The report of the Indian Telegraph Department (India) states that wireless telegraphy has been established between Sangor Island and the Sandheads, and difficulty is encountered only during thunder-storms.

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CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

TELEPHONE COMPANY NOT TO APPEAL—It has been decided by the American Telephone and Telegraph Company not to ask for a rehearing before the United States Court of Appeals in the Western Union-Bell Telephone royalty case, which was decided in favor of the telegraph company on October 7 last. Counsel for the telephone company has notified counsel of the Western Union Telegraph Company to this effect. The telephone company had thirty days in which to petition for a rehearing, which was extended to December 4. The next step in the case will be the appointment of an auditor by the court to determine the payment to be made by the telephone company, or a petition for a writ of certiorari for a hearing before the Supreme Court.

EXTENSIVE IMPROVEMENTS AT DURBAN, SOUTH AFRICA—About $14,000,000 is the estimated cost for the projected port improvements at Durban, South Africa. For the construction of three-story wharf sheds about $250,000 will be expended. A customs and bonded warehouse will cost some $250,000. Cranes and other machinery will entail an expenditure of nearly $60,000. For extensions to the hydraulic system $125,000 has been allotted. The expenditure of about $100,000 will be incurred for the equipment of new workshops. Additions to the electric lighting and power plants will mean an expense of about $125,000. The installation of mechanical coaling facilities is also provided for. Sir Wolfe Barry, of London, is one of the chief consulting engineers for the Durban improvements.

ENGLISH CAPITAL MAY CONTROL MORE MEXICAN POWER SCHEMES—Negotiations looking to Canadian interests taking over and enlarging the electric lighting and power system at Puebla, one of the larger Mexican cities, have been broken off. A. E. Worswick, formerly chief engineer of the Mexico City electric traction system, who has an option on the Puebla plants, has gone to Europe, and is understood to be negotiating with the London financial house of Wernher Beit & Company, which controls the Mexico City system, to purchase the Puebla plants. The Pazuelo Electric Light and Power Company is the name of the concern which furnishes power to Puebla. It operates a 4,000-horse-power hydraulic plant. Should the deal go through the horse lines in the same city are likely to be converted into electricity and extended. The existing tramways are about twenty miles long.

PROPOSED MEXICAN TRACTION SYSTEM—Guadalajara, one of the most prosperous cities located in western Mexico, is to have an extensive electric traction system. A company styled La Electra Sa was recently organized in Mexico for the purpose of taking over the horse car lines—about thirty miles in length—and acquiring the Compania de Luz Electrica de Guadalajara, which electrically lights the city, power being derived from a 2,500-horse-power water plant. In addition to several cars, etc., the equipment for a new power station will be purchased. This plant will have an initial capacity of 1,500 horse-power and will furnish energy for operating the proposed new traction system. The power station will be located on the Rio Grande, at a point about two miles distant from Guadalajara. C. A. Malau, the consulting engineer for La Electra, is now engaged in drawing up plans for the conversion and extension of the lines and for the new power-house. American equipment, machinery, etc., will be purchased.

CAN NOT BUILD OPEN SLOT SYSTEM BECAUSE OF TIDES—Dock Commissioner Hawkes has announced that he had been notified by representatives of the New York City Street Railway, succeeding the Interurban, that the engineers of the road had forwarded to him a report of their investigations concerning the proposed running of an overhead trolley road down West street, New York city, to replace the present horse car belt line. The conclusion of the engineers is that any but an overhead trolley line is wholly impracticable on the street from Tenth street down owing to the high tides, which, they report, would render dangerous and valueless an underground trolley system there. It is the desire of the road to replace the horse car belt line with convertible cars, which can be used as underground trolley cars above Tenth street and as overhead trolley cars below that line, and it seeks the consent of the dock commissioner, who has the power to grant the consent of the city as the property owner along the entire west side of West street, that side of the street consisting of piers and bulkheads owned by the municipality.

CONNECTICUT TROLLEY REPORTS—The following street railway companies which are controlled by Boston capitalists have filed their annual reports with the railroad commissioners. The Norwich Street Railway Company reports that its operating expenses were $71,990, and its net earnings were $43,539; surplus, $7,672. It carried 2,641,058 passengers. The Montville Street Railway Company reports that its operating expenses were $51,249, and its net earnings $43,866; surplus, $11,355. The number of passengers carried was 1,583,626. The New London Street Railway Company states that its operating expenses aggregated $47,907, while its net earnings amounted to $22,936; deficit, $499. It carried 1,535,279 passengers. The Somers & Enfield Electric Company states that its operating expenses were $7,473, and its net earnings $4,691; surplus, $3,941. It carried 250,501 passengers. The three trolley companies owned by the New York, New Haven & Hartford Railroad Company have filed their reports as follows: the Worcester & Connecticut Eastern Railway Company reports that its operating expenses were $100,373, and its net earnings $26,823; surplus, $117,517. It carried 2,464,000 passengers. The Meriden Electric Company reports that its operating expenses were $94,588, and its net earnings, $54,880; surplus, $15,601. It carried 3,470,480 passengers. The Stamford Street Railroad Company announces that its operating expenses were $55,411, while its net earnings were $27,542; deficit, $15,956. It carried 2,101,304 passengers. The Fair Haven & Westville Railroad Company, which represents New Haven's trolley system, reports that its gross earnings were $1,013,542; its operating expenses, $642,962; net earnings, $370,580; surplus, $4,264. It carried 25,804,187 passengers. The Danbury & Bethel Street Railway Company reports that its operating expenses were $61,072, and its net earnings were $19,831; deficit, $3,383. The number of passengers carried during the year was 2,001,790. The Torrington & Winchester Street Railway Company states that its operating expenses amounted to $30,341, while its net earnings aggregate $20,552; deficit, $14,099. It carried 1,030,460 passengers. The Greenwich Tramway Company reports operating expenses of $28,151, and net earnings of $18,267; surplus, $18,077. It carried 928,384 passengers. The Middletown Street Railway Company states that its operating expenses were $31,683, and its net earnings, $10,267; deficit, $156. It carried 1,000,923 passengers.

LEGAL NOTE.

INSULATING ELECTRIC WIRES—A company furnishing electric power, the Supreme Court of Arizona holds, in the case of Phœnix Light and Fuel Company *vs.* Bennett (74 Pacific Reporter 48), is not guilty of negligence because in carrying its wires into a building it fails to insulate against electricity having its origin in the clouds or atmosphere. "An essential ingredient to any conception of negligence," says the court, "is that it involves the violation of some legal duty which one person owes another—a duty to take care for the safety of the person or property of the other. This duty may be assumed by contract, or it may be imposed by implication of law. Where a person, proceeding in a lawful business, exercises a reasonable care, the law does not make him an insurer against those consequences of his actions which reasonable care and foresight could not have prevented. The law justly ascribes such consequences to inevitable misfortune or to 'the act of God,' and leaves the harm resulting from them to be borne by him on whom it falls." If the electric light company, the court concludes, insulated the wires in such a way as to protect the house against injury from the ordinary current carried on those wires, it did all that it could be required to do. Its duty did not call for the insulation of the wires "in a manner to protect against injurious consequences of a lightning stroke, for the evidence shows that it was not practicable to insulate them against lightning, and there is nothing in the record which indicates any assumed or implied obligation of this character."

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TELEPHONE AND TELEGRAPH.

DRYDEN, N. Y.—The Home Telephone Company has opened an exchange at Marathon.

ROCHESTER, N. H.—A telephone line is to be installed from this city to Barrington.

CEDAR FALLS, IOWA—The Boone County and Ogden Telephone companies have been merged.

GREENFIELD, MASS.—A suburban telephone line is being installed connecting Orange and North New Salem.

WESTLAND, PA.—The people of Westland are said to be contemplating the installation of a telephone system.

ERIE, PA.—The Mutual Telephone Company's stockholders have agreed to increase the capital stock from $75,000 to $150,000.

NEW YORK, N. Y.—The Baiting Hollow and Roanoke Telephone Company will increase its capital to $20,000.

NEWARK, N. J.—The Merchants and Farmers' Telephone Company has secured the right of way to Three Bridges, and will extend its lines to that place.

MUSKEGON, MICH.—The Oceana Telephone Company will increase its capital $200,000 and change the name of the company to the Lake Shore Telephone Company.

JACKSON, MICH.—The Valley Telephone Company has established a circuit from Saginaw to Frankenmuth, and has also built a pole line from Saginaw to Caro, with a branch to Vassar.

MANCHESTER, N. Y.—The Red Jacket Telephone Company is extending its lines through the town of Farmington, using the poles of the Interocean Telephone Company, with wires on a separate arm.

KNOXVILLE, TENN.—The American Telephone and Telegraph Company has completed its line through Knoxville from North Carolina to Harriman, and is now building a line from Chattanooga to Lexington, Ky.

TROY, N. Y.—The Eastern New York Telephone and Telegraph Company has reelected these directors for the ensuing year: Watson M. Holmes, C. B. Story, G. Frank Rising, L. E. Worden, Francis Riley and Louis Haussler.

CHARLOTTE, N. C.—It is learned that the Seaboard Air Line Railway is now making preparations to install a complete telephone system over its lines in this section and the south, utilizing the telegraph wires for transmitting the electrical current.

YOUNGSTOWN, OHIO—The Beaver Telephone Company, it is stated, will extend its system to New Springfield. The company now has connection with the Columbiana Telephone Company on the south and the Youngstown Telephone Company on the north.

ST. LOUIS, MO.—The cable which will connect the Illinois lines of the Pike County Telephone Company with the Missouri lines of the Bluff City Telephone Company, at Hannibal, has been laid in the Mississippi river at Hannibal. The cable is over 3,000 feet long.

SIOUX CITY, IOWA—The Sioux City Telephone Company announces that it will spend $350,000 to establish its plant here. Its exchange building will be a three-story fireproof structure, and the equipment will be of the latest type. Poles will be set this winter, and wires and cables are to be strung before spring. The underground work will not be started before next April.

DUBUQUE, IOWA—The city council has adopted the ordinance asked for by the Iowa Telephone Company. By the terms of the ordinance all telephone companies operating in the city must place their wires underground. The Iowa company will expend about $140,000 on its system within the next twelve months. A new building, to be devoted exclusively to telephone purposes, will be erected.

LAKE CITY, MICH.—A deal has been consummated by which the Swaverly Telephone Company, of Kalkaska, parts with all its toll lines in Missaukee County. The purchasers are all Missaukee County people, chiefly those who first installed the lines. The lines extend from Manton to Lake City, and from Lake City to Moorestown, in all about thirty-five miles, with a dozen or more substations. Many improvements are under consideration for the lines.

ABERDEEN, S. D.—The Dakota Central Telephone Company has closed contracts for the material necessary for its contemplated extensions, aggregating $150,000. The company has made traffic arrangements with the lines running from the southern part of the state into Iowa and Minnesota, and the new lines to be built will be for through business to connect Aberdeen, Huron, Mitchell, Pierre, Madison, Sioux Falls and other important cities, as well as intermediate points, with Sioux City and other cities of Iowa and southern Minnesota.

ALBANY, N. Y.—The North Shore Telephone Company has been incorporated to carry on operations over the following route: through the towns of Riverhead, Brookhaven, Smithtown and Huntington, Suffolk County. The points to be connected are the villages of Riverhead, Port Jefferson, Smithtown, Northport and Huntington. The capital stock is placed at $7,500, and the directors of the company for the first year are Ralph J. Hawkins, J. E. Overton, J. H. Davis and Charles V. Platt, of Port Jefferson; A. B. Copley, of Stony Brook; Frank H. Tuthill, of Rocky Point; Charles A. Squires, of Echo, and William A. Davis, of Mount Sinai.

PERSONAL MENTION.

MR. G. F. STILES has resigned as chief electrician of the Atchison, Topeka & Santa Fe Railway Company.

MR. CHARLES H. HIVES has been appointed electrical engineer of the Canadian Pacific Railroad, with headquarters at Montreal, Canada.

MR. R. H. SOULE, mechanical engineer, has opened an office at 29 West Thirty-fourth street, New York city, as consulting and designing engineer.

MR. GEO. A. McKINLOCK, president of the Central Electric Company, Chicago, is spending a few days in New York, accompanied by Mrs. McKinlock.

MR. W. W. DEAN is now chief engineer of the Kellogg Switchboard and Supply Company, of Chicago, Ill., in full charge of the laboratory and all exchange work.

MR. N. H. HOLLAND, the well-known telephone engineer, has resigned from the Couch & Seeley Company, and is now with the Holtzer-Cabot Electric Company, at Brookline, Mass.

COMMANDER ROBERT E. PEARY, C. E., U. S. N., has returned from a six weeks' trip to England and Germany, where he has been for the purpose of inspecting naval barracks as constructed in those countries.

MR. F. E. ROTCHKA, formerly sales manager of the Sterling Electric Company, Lafayette, Ind., has recently associated himself with the Stromberg-Carlson Telephone Manufacturing Company, and is now connected with the Chicago office of this company.

MR. W. E. WILLIAMS, B. Sc., of the University College of North Wales, has been elected a fellow of the University of Wales for 1904. He proposes as his subject of investigation, to be carried on at Glasgow University, "The Effect of Magnetization on the Electrical Properties of Nickel Steel."

MR. A. GIDEON, civil engineer, attached to the War Department, is now in San Francisco, Cal., en route for the Philippines. Mr. Gideon was one of the engineers who designed the sewer system for the city of Havana. He will be connected with the installation of the new system in the city of Manila while in the Philippines.

MR. H. F. J. PORTER, who has been associated with the Westinghouse interests since the first of the year, as the assistant manager of the publishing department, has been selected as second vice-president of the Nernst Lamp Company, with the duties of general manager, with headquarters at Pittsburg. Mr. Porter assumed charge on December 1.

MR. L. E. SPERRY, who was a foreign representative of the Western Electric Company for several years, with headquarters in Japan, has assumed the management of the California Electrical Works, which is the Pacific agency of the Western Electric Company. Mr. Salt, the former manager, has gone to New York, where he will hereafter be connected with the Western Electric Company at that place.

MR. FRANK MARTIN, who for several years has been in charge of the electrical department of yards and docks at the Brooklyn Navy Yard, has tendered his resignation in order to take charge of the University Power Company, Princeton, N. J., which has just installed a large plant for supplying light, heat and power to the citizens of Princeton. The company's customers include the Princeton University. Prior to his work at the Navy Yard, Mr. Martin was connected with the Edison Electric Illuminating Company, New York.

MR. FRANK C. McCONNELL, of Youngstown, Ohio, has been appointed manager of the Northern Ohio district of the Central

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Union Telephone Company, with headquarters in Akron. Mr. McConnell took up his new duties December 1. He is well and favorably known in telephone circles, having had a wide experience in the business. Akron will be the headquarters of the district, which will extend from Mansfield on the south to Norwalk on the west, the eastern and northern limits being the state line and Lake Erie, respectively.

MR. ELIAS E. REIS, electrical engineer and patent expert, 116 Nassau street, New York city, has written a lengthy letter to Mr. McDougall Hawkes, dock commissioner of New York city, with regard to the equipping of West street, New York city, with an electric traction system. Considerable comment has recently been caused by reason of the adverse reports of the engineers with regard to an electric traction system of the open-slot type. This is due to the adverse conditions which are well known in that vicinity, because of the high tides which prevail at frequent periods, inundating the underground section of that quarter. Mr. Reis suggests the use of a combination or mixed system which he invented some years ago, and which has been in successful operation both in the United States and abroad. This system consists of carrying a set of lightweight batteries for the short run which will be necessary, in addition to the regulation plows which would enter the slot of the conduit system.

MR. THOMAS W. VARLEY has resigned as engineer of the testing department of the New York Edison Company, to accept a position with the Boston, Mass., branch of the Westinghouse Electric and Manufacturing Company. On the evening of Saturday, December 5, Mr. Varley was given a dinner at the Café Martin by a number of old-time friends and associates of the New York Edison Company. Among those present were Mr. W. H. Lawrence, Mr. A. H. Ackerman, Mr. W. J. Chisholm, Mr. Frank Martin and Mr. Edward Durant. Mr. Varley is a comparatively young man in the profession, and has been successful to a considerable degree. He is the inventor of the Varley ground detector, which enables the location of faults on high-tension circuits while the cable is in service. His latest invention is the Varley rotating voltmeter, which gives a true reading while the meter is near a large generator where magnetic disturbances are liable to be a maximum. Mr. Varley is a brother of Mr. Richard Varley, of Providence, R. I., the well-known expert on electromagnets.

ELECTRICAL SECURITIES.

The rally in prices last week, while apparently encouraging, is viewed in many quarters with distrust, as there seem to be evidences that this is artificial, and will not prove stable under aggressive bear manipulation. However, the developments intensified the general confidence in the outlook that the market had been turned, and, notwithstanding the discouraging sentiment mentioned above, there is considerable hope that the higher prices will be maintained. The industrial outlook is said to be improving, and while this is coincident with the rise in prices, rather than a part of it, the idea is prevalent that it may have a good deal to do in shaping further improvements.

The electrical securities, particularly Brooklyn Rapid Transit, led in the rally of prices, and it seems entirely possible that these stocks will be the chief feature for some time.

The report of the managers of the Westinghouse Electric and Manufacturing Company is to the effect that fully as much business is expected in 1904 as has been the case in 1903, and this is not without importance as a factor in maintaining faith in electrical securities.

Call rates for money have gone as high as nine per cent, with six and one-half and seven per cent the average for the business of the week.

ELECTRICAL SECURITIES FOR THE WEEK ENDING DECEMBER 5.

New York:	*Closing.*
Brooklyn Rapid Transit	48⅛
Consolidated Gas	178
General Electric	160
Kings County Electric	175
Manhattan Elevated	141¼
Metropolitan Street Railway	120
New York & New Jersey Telephone	145
Westinghouse Manufacturing Company	185

A quarterly dividend of 2 per cent will be paid January 2, 1904, to stockholders of record of the Commercial Cable Company on December 19, 1903. The transfer books will be closed December 19, 1903, and reopened January 4, 1904.

The quarterly report of the Interurban Railway system has been forwarded to the State Railroad Commissioners. The report gives the aggregate earnings of the twelve separate properties embraced in the system, and is the first report of the kind which has been made, the earnings of the properties having been treated separately in previous reports. For the quarter ended September 30, 1903, the gross earnings of the company amounted to $5,570,212.03, and the operating expenses to $2,761,600.40, leaving net earnings of $2,808,611.63, as compared with $2,635,668.44 for the same quarter of the preceding year, an increase of $172,943.19. Income from other sources amounted to $370,224.65, bringing the total income up to $3,178,836.28. Subtracting deductions from income, which amounted to $3,015,459.63, makes the surplus for the quarter $163,376.65, as compared with $146,369.83, for the same period of 1902, an increase of $17,006.82.

Boston:	*Closing.*
American Telephone and Telegraph	126½
Edison Electric Illuminating	240
Massachusetts Electric	77½
New England Telephone	120
Western Telephone and Telegraph preferred	81

The Massachusetts Electric Companies has declared a regular semi-annual dividend of 2 per cent on the preferred stock.

The income account of the Boston Elevated Railway Company for the year ended September 30, just issued, shows that the gross earnings of the company for the year were $11,959,511, and the operating expenses $8,259,860, leaving a balance of $3,699,654. Other income amounted to $59,856, making the total net income $3,759,510. $3,730,556 was paid in charges and dividends, leaving a surplus of $28,954, as compared with $21,898 for 1902. The total assets of the company are $20,358,058, and the total liabilities $18,030,371, making the surplus $2,327,687, as compared with a surplus of $483,733 for the preceding year. For the year the number of passengers carried was 233,563,578, against 222,484,811 in 1902 and 213,107,600 in 1901.

Philadelphia:	*Closing.*
Electric Company of America	8
Electric Storage Battery common	50
Electric Storage Battery preferred	50
Philadelphia Electric	6⅛
Union Traction	44⅞
United Gas Improvement	81½
Chicago:	*Closing.*
Chicago Telephone	123
Chicago Edison Light	141
Metropolitan Elevated preferred	50
National Carbon common	20
National Carbon preferred	86
Union Traction common	5
Union Traction preferred	27

Chicago Telephone directors have declared the regular quarterly dividend of 2½ per cent, payable December 31. Books close December 24 and reopen January 2. The gain in the instrument output for November was 1,668, making the total now in use 99,570.

Lake Street Elevated reports for the year ending June 30, 1903, show a deficit of $49,170, against a surplus of $3,693 for 1902. The gross increase was $40,000, but operating expenses and charges increased $90,000.

The South Side Elevated for November carried a daily average of 143,398 passengers, an increase of 60,099. The gain is said to be due to the City Railway strike.

Metropolitan Elevated carried an average of 114,148 passengers in November, an increase of 3,859.

Northwestern Elevated carried a daily average in November of 71,422 passengers, an increase of 4,186.

AUTOMOBILE NOTE.

THE AUTOMOBILE CLUB OF AMERICA, 753 Fifth avenue, New York, announces the conditions governing entries in the United States for the Gordon Bennett Cup Race, which will be held in Germany in the summer of 1904, which are as follows: each entrant shall deposit with the club the sum of six hundred dollars. The racing committee of the club shall decide which of the entrants may compete in the race. This decision may be arrived at by a contest, or by the committee without a contest. Any entrant who is not nominated by the racing committee for the cup race shall have his entrance fee returned to him. Any entrant who after being nominated by the committee does not start shall forfeit his entrance fee. If three entrants are nominated to take part in the cup race, each entrant shall have two-thirds of his entrance fee (after deducting his proportion of the expenses incurred in holding the race) returned to him, provided he starts in the race. If two entrants are nominated, each of such entrants shall have one-half of his entrance fee (after deducting his proportion of the expenses incurred in holding the race) returned to him, provided he starts in the race. These rules are supplemental to the rules of the Gordon Bennett Cup Race, by which each entrant agrees to abide.

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ELECTRIC RAILWAYS.

CEDAR FALLS, IOWA—Construction work on the Newton & Northwestern Railway is said to be progressing rapidly.

TONAWANDA, N. Y.—Engineers are making surveys for the tracks of the Niagara Transfer Railway Company. The new railroad is to be built along the Niagara river from Buffalo to Tonawanda.

BLOOMSBURG, PA.—The town council has granted the Danville & Bloomsburg Electric Railway entrance to the town. The new road will be ten miles in length, extending from Danville to Bloomsburg.

FALL RIVER, MASS.—A charter has been granted to the Horseneck Beach Street Railway Company with a capital of $200,000. The road is to run from Dartmouth to a point on the state line at or near Adamsville, R. I., a distance of nineteen miles.

CHAMBERSBURG, PA.—The People's bridge over the Susquehanna has been sold at last. The deal was closed for $210,000. The purchaser is the Central Pennsylvania Traction Company and the bridge will be used exclusively for trolley purposes.

MORGANTOWN, W. VA.—The Morgantown & Fairmont Traction Company has been reorganized. It is now known as the Morgantown & Pittsburg Railway Company, with a capital stock of $750,000. The incorporators are J. H. McDermott, Davis Elkins, T. R. Dille and C. R. Dille, of Morgantown, and C. W. Swisher, of Fairmont.

JERSEY CITY, N. J.—Papers have been filed at the county clerk's office in Jersey City by Frank Cook and R. W. G. Welling, of Manhattan, and Richard F. Tully, of Jersey City, incorporating the Interurban Traction Company, with a capital of $1,000,000, to operate electric and steam railways. Of the capital, $100,000 has been paid in.

BALTIMORE, MD.—The construction department of the United Railways Company has practically completed the extensive improvements begun about a month ago. More than fifteen miles of nine-inch girder rails were laid, and the system of lighting has been largely added to. It is estimated that about $500,000 was expended on the betterments.

ATHENS, GA.—The people of Gainesville have raised $10,000 for the electric line from Athens to Carnesville, and $20,000 more has been raised by the counties through which the line will extend. E. H. Van Wey and W. F. Brown, representing the new company, are in Gainesville, and the first work on the thirty-two-mile road will be commenced at once.

CHAMBERSBURG, PA.—Capitalists of the Cumberland Valley have subscribed funds sufficient to ensure the formation of a company which will build a trolley line from Harrisburg or Mechanicsburg through the valley to Hagerstown, connecting Harrisburg, Mechanicsburg, Carlisle, Shippensburg, Chambersburg, Greencastle, Waynesboro and Hagerstown.

NASHVILLE, TENN.—It is announced here that negotiations have been perfected for the requisite capital with which to build the Nashville & Lewisburg electric railway. It is estimated that it will cost $1,000,000. Chicago, New York and St. Louis capitalists have agreed, it is said, to put up the necessary money. Work on the railway is expected to begin next spring.

PHILADELPHIA, PA.—According to an official of the Philadelphia & West Chester Traction Company, the purpose of increasing the indebtedness from $400,000 to $1,000,000, which the stockholders will be asked to approve on January 11, 1904, is to refund the present $400,000 of five per cent bonds outstanding at four per cent, pay for construction work recently completed, and provide for future extensions and improvements.

CINCINNATI, OHIO—Peter Eichels is organizing a traction road with Charles E. Roth and several others as associates. Incorporation papers have been signed and mailed to the secretary of state, incorporating the Chester Park, Norwood & Red Bank Belt Line Traction Company, a $10,000 corporation proposing to build a traction railroad girding the city of Cincinnati, connecting the resorts at the end of the present city lines and all the outlying suburbs.

NASHVILLE, TENN.—Promoters of the McMinnville, Woodbury & Nashville Electric Railroad have decided to increase the capital stock from $10,000 to $1,000,000. Later on it is proposed to raise this to $2,500,000. It is said the contract for building the road has already been let to the Ellis Construction Company, of Chicago. One of the directors says the road will be extended into the coal fields beyond McMinnville some twenty miles. The road will have both freight and passengers.

GENEVA, N. Y.—It is announced that the Geneva, Waterloo, Seneca Falls & Cayuga Lake Traction Company, which operates a trolley line between this city and Cayuga lake, will next spring put on heavy vestibule interurban cars, similar to those with which the Rochester & Eastern is equipped. It is thought that this equipment is part of the plan to consolidate the three trolley companies which are now operating lines between Rochester and Syracuse along the line of the Auburn branch of the New York Central.

MEMPHIS, TENN.—The legislative council of this city has granted a franchise to the City Street Railway Company for the building and operation of an electric railway line in this city. The company has until the beginning of the year to accept or reject the franchise. St. Louis and local capitalists are interested in the project, Corwin H. Spencer and L. G. McNair, of St. Louis, being the largest stockholders. The present capitalization is $50,000, but this amount is to be increased to $500,000. Work must begin within six months.

WABASH, IND.—The following directors were elected at a meeting of the stockholders of the Wabash & Rochester Traction Company, in this city: P. E. Wilcox, Geneva, Ohio; C. E. Baney, Cleveland, Ohio; S. A. Holbrook, Bradford, Pa.; L. A. Smart, Cleveland; E. S. Pratt, Strattonburg, Pa.; Charles Crain, Geneva; G. S. Robertson, Geneva; Alva Taylor, Wabash; H. B. Shively, Wabash; S. E. Strong, Cleveland. There was a discussion of the project of building the road to Rochester from this city, and it was announced that work on the road would begin in the spring. All contracts for financing the road have been closed and a part of the construction material has been bought.

HAZLETON, PA.—The directors of the recently organized Hazleton, Weatherly & Mauch Chunk Traction Company have decided to begin work on the construction of the line as soon as the detailed surveys have been completed, which will be within two months. A Philadelphia syndicate, it is reported, will back the enterprise. Frank Larned, of Wilkesbarre, is president of the company. The road will be about twenty-four miles long, and will eventually connect with the trolleys running from Mauch Chunk to Tamaqua, and from Mauch Chunk to Lehighton, at which point connections are to be established with Allentown, making a continuous line from Philadelphia to Hazleton.

CHICAGO, ILL.—Articles of incorporation have been issued to the Blue Island, Riverdale & Hammond Street Railway Company, principal office Chicago, with a capital stock of $50,000. The line is to be constructed from Chicago south through Harvey, Phœnix, South Holland, towns of Calumet, Thornton, Chicago Heights and Steger, in Cook County, and Crete, in Will County, thence west to Joliet; and from Blue Island through Calumet, Riverdale and Dalton, thence northeast through Thornton, West Hammond; also a line from Tinley Park in an easterly direction through Homewood, Thornton and Lansing. The incorporators and first board of directors are William R. Owen, August W. Miller, John F. Noel, Henry Schanze and Michael J. Corcoran, all of Chicago.

WATERBURY, CT.—The Naugatuck Valley Electric Railway Company has perfected organization, with these directors: A. M. Young, of New York; Allen W. Paige, of Bridgeport; W. H. H. Wooster and Edmund Day, of Seymour, and A. D. Warner, of Beacon Falls. The directors have chosen Mr. Wooster president, Mr. Paige secretary, and Mr. Young treasurer. The corporation is to build a connecting link from Naugatuck through Beacon Falls to Seymour. At Naugatuck the line will connect with the Naugatuck division of the Connecticut Railway and Lighting Company's system and at Seymour with the Ansonia division of that company's system. The construction of the link will put Waterbury in direct trolley communication with New Haven and Bridgeport. The road, which will probably be constructed next summer, will be operated by the Railway and Lighting Company.

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ELECTRIC LIGHTING.

MASONVILLE, IOWA—An electric light plant is to be installed here.

DETROIT, MICH.—Alden is to have a commercial electric lighting plant next spring.

GUTHRIE CENTER, IOWA—The electric light plant, that has been in course of erection for several months past, is now completed and the lights turned on. The plant cost $16,000.

WATKINS, N. Y.—The Consolidated Electric Light and Gas Company of this village changed hands the first of November and is now the property of Alfred L. Sweeney, of New York city.

MONTGOMERY, ALA.—The $15,000 bonds recently voted by Ozark to install an electric lighting plant for the city, have been sold by Mayor W. W. Kirkland to New York parties at par.

MALONE, N. Y.—The Fort Covington Light, Heat and Power Company has been incorporated with a capital of $12,000. The incorporators are Patrick Keefe, Nida M. Keefe and John C. Weeks.

PHILADELPHIA, PA.—Bids are invited for a power-house to be built at League Island. It will be one story high, 104 by 106 feet, and will be of brick and steel. Bids will be due December 26.

SPRINGFIELD, MASS.—The work of extending the electric light system from the Point to Broad Brook will be started as soon as possible, under the direction of the Windsor Locks Electric Light Company.

ELKHART, IND.—Superintendent Hewitt, of the power plant between Elkhart and Mishawaka, says it is the first of a chain of power plants to be erected on the St. Joseph river by eastern capital. The next plant is to be begun next spring just above Elkhart.

MILWAUKEE, WIS.—The International and the Phoenix light companies have consolidated under the name Phoenix-International Light Company, with a capital of $50,000, and elected Jacob Leenhouts, president; Theodore Roth, vice-president; A. M. Rodems, first vice-president; Joseph Sable, secretary; John Debbink, treasurer; Max Perwein, manager.

ALAMOGORDO, N. M.—Work has been begun on the electric light plant for Alamogordo. The concern is being promoted by H. Fisher, manager of the electric company already here, and several eastern capitalists are said to be interested. New lines will be built and the company will furnish power as well as light. The power-house will be thirty by sixty feet.

MOLINE, ILL.—A bill of $65 a light for 210 lights or more on a contract extending over a period of five years has been accepted by the city council from the People's Power Company. The bid was reported by the fire, water and light committee, and the committee was instructed to enter into contract with the company for that length of time dating from the expiration of the present contract next February.

GENEVA, N. Y.—The common council at its regular meeting let the contract for the street lighting of the city for the next five years to the Geneva Power and Light Company, at $75 per year for 107 arc lamps and $20 per year for forty-two incandescent lamps. According to the provisions of the new contract, the light company is to replace the old Brush lamps, now used in the city, with the latest improved enclosed arcs. It will also be obliged to light all of the city buildings free of charge and furnish the current for the operation of the city fire-alarm system.

JACKSON, MICH.—The Vincennes Electric Light and Power Company and the Citizens' Gas Light Company, both of Vincennes, Ind., have been purchased by Edward M. Dean & Company, and consolidated under the name of the Vincennes Light and Power Company, capitalized at $200,000. A first mortgage for $200,000 has been given and of the sum thus raised a quarter has been reserved for future extensions. The balance, amounting to $150,000, issued for the purchase and improvement of the property, has nearly all been subscribed in Indiana. The present capacity of the plants is to be doubled.

MENOMINEE, MICH.—One of the generators and dynamos of the new machinery for the power-house of the Menominee Light and Traction Company has been started and the other will be ready shortly. This new outfit cost the company $20,000 and nearly doubles the capacity of the plant. It includes two 5,000-light generators, a new marble switchboard, and other necessary apparatus. The machines supply power for lighting and street car locomotion. The capacity of the Menominee power plant will now be much greater than that of Marinette and some of the power will be transmitted to that city for lighting purposes.

ATLANTA, GA.—The Atlanta Water and Electric Power Company in the Superior Court of Fulton County filed a mortgage deed of trust to the Knickerbocker Trust Company, of New York, to ensure payment of its first mortgage. The first mortgage is to secure five per cent gold bonds, amounting to $1,500,000, due January 1, 1943, or on call after January 1, 1908. The security consists of land lots in Fulton County along the Chattahoochee river and lots in Cobb County along the Chattahoochee river. The security also includes all the buildings, machinery, and all other properties of the company. The security was dated October 1, 1903.

TOLEDO, OHIO—The council committee on gas and lights has approved the ordinance granting a franchise to the East Toledo Heating and Lighting Company with the amendments proposed by the subcommittee. The original franchise ordinance provided that the East Side company should pay two per cent of its gross proceeds to the city in exchange for its right to do business. The amendments demand that the company shall pay the city $10,000 cash before it begins construction, and that it shall heat and light all East Side school buildings, police and fire stations and other public buildings free of charge and that it shall also provide lights for the parks, free of cost to the city.

DAVENPORT, IOWA—The committee on fire and light recommends that the bid of the People's Power Company for lighting the city for a term of five years be accepted, and that the mayor and city clerk be instructed to enter into a contract with the company. This was the only bid offered and was at the rate of $65 per light for 240 or more lights. The specifications in the contract will also provide that all of the towers now giving light shall be taken down and the lights will be placed in the territory that they are now intended to illuminate. Under the contract now in force, which expires in February, the city pays $72 per light for the low lights and $82 for those on the towers.

FAIRMOUNT, IND.—After having been in darkness for the past four years the streets of this city will again be lighted. Several years ago the town bought an electric light plant, but after a few months it was closed down on account of poor management. Recently, the business men, seeing the need of street lights, took upon themselves the task of raising money to install a plant, and have succeeded in doing it. They sold stock for $50 a share, and each stockholder was given six small or one arc light free for one year. In all, more than $5,000 was raised. A committee has been appointed to put the plant in operation. It is the intention of the company to place about fifty arc lights in the town.

BALDWINSVILLE, N. Y.—At the regular meeting of the village board of trustees a lighting contract was entered into between the village and the Seneca River Power Company. The new contract is substantially as agreed upon several weeks ago. The lighting company is to furnish twenty-four arc lamps of 2,000 candle-power at $90 each and seventy-five incandescent lamps at $16 each, making the total cost of lighting under the new contract $3,360 per year as against $2,880 now paid for the ninety Nernst lamps used. The contract calls for the completion of the new system so that it will be in operation by April 1, and provides that the village may at any time meter the lamps to measure the current supplied and if it is found that the lamps are not up to the specified requirements a pro rata reduction is to be made on the lighting bills for the deficiency. The service is to be all night, the lamps burning from dusk to dawn. The village will have to be rewired for the new system.

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INDUSTRIAL ITEMS.

THE ELECTRIC APPLIANCE COMPANY is advertising Zenith lamps for the Christmas trade and reports a big Chicago stock, so that prompt shipments may be made.

THE BROWN & SHARPE MANUFACTURING COMPANY, Providence, R. I., has published a fine catalogue showing its mechanical machinists' tools. This gives illustrations, descriptions, and prices of rules, squares, micrometer calipers, gauges and accurate test tools.

THE PITTSBURG SEWER PIPE AND CONDUIT COMPANY, Pittsburg, Kan., is getting out a new booklet illustrative of its various products. This includes chimney tops, chimney flue pipe, vitrified clay conduits, glazed wall coping, drain tile, fireproofing, sewer pipe and fittings, hollow brick, and partition tile.

THE WESCO SUPPLY COMPANY, St. Louis, Mo., is placing on the market a new dry cell, named the "Red Shield Dry Battery." This is adapted for all open-circuit work where a quickly recuperating cell is desired. The company states that this cell is the product of long study and is possessed of extremely long life. It has an electromotive force of 1.5 volts.

THE EWING-MERKLE ELECTRIC COMPANY, St. Louis, Mo., is sending out a large mailing card endorsed with the phrase-question, "Are You Up a Tree?" The company kindly offers to remove the obstacle in descending and suggests a remedy in its "Green Book." If this is not in the possession of any one requiring supplies, the company will mail it on application.

THE NEW CENTURY CORRESPONDENCE SCHOOLS, Wilkesbarre, Pa., have been organized to absorb and to increase the magnitude and scope of the American Correspondence Schools. The officers of the company are H. H. Zeiser, president; L. Floyd Hess, secretary, and W. S. Casterlin, treasurer. The school purposes to give a complete course of instruction in science and art, and will be pleased to send a prospectus to enquirers.

THE BULLOCK ELECTRIC MANUFACTURING COMPANY, Cincinnati, Ohio, has ready for distribution bulletin No. 1019, descriptive and illustrative of "Alternating-Current Generators and Motors." This shows both water-wheel and belted types, as well as engine-type apparatus. A partial list of Bullock alternating-current installations shows how well this company is represented in every part of the world.

B. W. PAYNE & COMPANY, 39 Cortlandt street, New York city, announce that on November 30 the firm of B. W. Payne & Company was dissolved, and all outstanding accounts were taken over by Mr. Milton W. Curry, who also assumed the liabilities of the firm. In settlement of accounts, checks should be sent to Mr. Curry at the above address. The company further announces that business will hereafter be conducted at the same place by Mr. Benjamin W. Payne, under the old firm name.

MESSRS. DODGE & DAY, Nicetown, Pa., will be pleased to mail a copy of their pamphlet on "Betterment Reports" to station men and manufacturers looking to increasing their plant efficiency. Dodge & Day have made a thorough study of "modernizing" to the end of securing increased production, increased economy, and better facilities. The pamphlet has been prepared in the office of Ray D. Lillibridge, and, consequently, represents the best available in the printers and lithographers' powers.

THE MICA INSULATOR COMPANY, 218 Water street, New York, and 117 Lake street, Chicago, Ill., will send on request a new catalogue showing samples and giving specification of "Empire" insulating cloth. This is a linseed oil cloth of high insulating quality. The company has added to its line and changed the numbers of its old grades, so that in future its cloths will be known by the numbers in this new catalogue. The company also manufactures "Linotape." This is a tape coated with linseed oil and left with an adhesive surface.

THE BUFFALO FORGE COMPANY, Buffalo, N. Y., is distributing a couple of handsome catalogues descriptive of the Buffalo improved ventilators and the Buffalo disc wheels. These catalogues give a concise description of this apparatus, and a number of clear illustrations supply a good idea of the appearance and construction. These disc wheels are made for driving by either pulley, steam or electric power. The company has also issued a twelve-page pamphlet on "Heating and Ventilation of Factory Buildings," by W. H. Carrier, M. E. This is of great interest to consulting engineers engaged in this work.

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, Pittsburg, Pa., announces that Westinghouse gas engines are to be adopted in a new central station under erection at Berlin, Ontario. The initial installation will aggregate 460 horsepower, comprising three thirteen by fourteen three-cylinder 125-horse-power, and one eleven by twelve three-cylinder eighty-five-horse-power vertical engines. These engines will operate on city illuminating gas of 650 B. T. U. calorific value, and drive direct-current generators for furnishing municipal lighting. The publishing department of the company has just issued a new circular, No. 1,066, descriptive of type H induction motors.

THE CHARLES WARNER COMPANY, Wilmington, Del., sales agent for "Nazareth" Portland cement and "Sovereign" Portland cement, has published the results of some interesting tests on "Nazareth" cement and "Limoid." The use of "Limoid" is claimed to result in great economy to the contractor and builder, due to the spreading properties imparted by the hydrated lime. The mixture contains a large proportion of Portland cement, and the limoid in the mixture is hydrated with extreme care. It has the manufacturer's guarantee of non-pitting. The above tests were made by Booth, Garrett & Blair, and were of one part of the mixture and two parts of sand, to make direct comparison with standard Rosendale cement. The tests were made for seven days, twenty-eight days and three months, respectively, and show more favorably for the hydrated mixture. The company will be pleased to send this report in full on request from those who are interested in this work.

THE PACKARD ELECTRIC COMPANY, Warren, Ohio, will send to interested parties a booklet describing its gas engine cable. Instead of using a single wire for carrying current, forty strands of No. 30 tinned copper wire are used. This gives a more flexible connection, without danger of breaking, having at the same time a carrying capacity equal to a No. 14 solid conductor. Two layers of cotton thread are woven about the forty strands of conducting wire, and after each weaving the cable is passed through a bath of insulating liquid and baked in a steam-heated oven. Next in order come several layers of specially prepared tape, the number of thicknesses used depending upon the service for which the finished cable is designed. Each layer of tape receives two baths of insulating liquid and two bakings before being wound upon the cable, and one bath and one baking after being wound in place. The booklet mentioned gives a complete description of the process, and items concerning the ingredients of the insulating liquid. In addition to this, the booklet also contains interesting suggestions for automobile users.

THE ELECTRIC CONTRACT COMPANY, 202-204 Centre street, New York city, will be pleased to send its catalogue on dry batteries, electrical novelties and automobile specialties to any one requiring this list. This new catalogue illustrates the "Ecco" pocket lamps, "Evening Star" lamps, electric candles, night lights, illuminated watchstands, illuminated clock stands, electric scarf pins, electric gas lighters, medical sets, portable electric lanterns, surgeons and physicians' lamps, aseptic dental lamps, test sets, pocket battery outfits, dry cells and batteries, Williams spark coils—for which the company is the general selling agent—Jaeger bulbs, candelabra lamps, sockets and receptacles for candelabra and miniature screw bases, and "Handy" receptacles for Christmas tree and general decorative work. This receptacle is fitted with two triple insulated leading wires, and is provided with a sharp-pointed screw, thoroughly insulated by mica washers. This screw sticks easily into either hard or soft wood. The receptacle is furnished with either candelabra or miniature shells, and may be used for series or multiple work.

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CHARLES W. PRICE . . . . . PRESIDENT AND EDITOR
STEPHEN H. GODDARD . . . . . SECRETARY AND MANAGER
WM. HAND BROWNE, JR. . . . . TECHNICAL EDITOR
AINSLIE A. GRAY . . . . . ASSISTANT EDITOR

PUBLISHING OFFICE . . . . . 13-21 Park Row, New York
WESTERN OFFICE: 40 Dearborn Street, Chicago, Ill. . . CHARLES FRENCH, Manager
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TO ADVERTISERS

CHANGES for advertisements should be in this office by *Friday noon* for the following week's issue.

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CONTENTS.

EDITORIAL:
Electricity and Smokeless Peat . . . 883
The Growth of Electric Central Stations . . . 883
Electrical Conductivity of Mercury Vapor . . . 884
Power for Traction in a Large City . . . 884
A Method for Determining Rates and Prices for Electric Power, by Frank B. Perry . . . 885
The Testing of Electric Generators by Calorimetry . . . 888
Radium Industry . . . 888
Industrial Electrochemistry and Electrometallurgy, by John B. C. Kershaw . . . 889
The Siemens-Schückert Multiple Unit System of Electric Train Control, by Emile Guarini . . . 890
Rapid Submarine Cabling . . . 892
Turbine Operated with Gas Engine Exhaust . . . 892
Electrical Section of the Canadian Society of Civil Engineers . . . 892
Interurban Electric Traction Systems, by P. M. Lincoln . . . 893
A Demonstration of the Cooper Hewitt Mercurial Vapor Lamp at the Technology Club, New York City . . . 897
Electrical Notes from Europe . . . 898
The Operation of a Commutator in Oil . . . 899
British Institution of Electrical Engineers . . . 900
An Independent Telephone Directory . . . 901
Conductivity of Mercury Vapor, by Peter Cooper Hewitt . . . 902
Electrical Patents . . . 905
REVIEWS OF CURRENT ENGINEERING AND SCIENTIFIC LITERATURE . . . 906
The Committee on Steam Turbines of the National Electric Light Association . . . 907
INDUSTRIAL SECTION.
Fifty-one-Inch Boring and Turning Mill with Motor Drive . . . 908
Angle Wall Sockets . . . 908
The Susquehanna Development . . . 908
High-Potential Oil Switches . . . 909
A New Current Interrupter . . . 909
Spring Binding-Post . . . 910
New Electric Lighting Specialties . . . 910
An Elevator Alarm System . . . 910
A New Automatic Track Switch for Electric Roads . . . 911
Sleet Cutter and Contact for Third-Rail Systems . . . 912
CURRENT ELECTRICAL NEWS . . . 913

Descriptions of new processes in which electrical energy is put to what may be called illegitimate uses continue to be given out. Thus, one of the latest to be announced is that for preparing a smokeless fuel from ordinary peat. This process has been put forward in England. It consists in drying the peat by a centrifugal method, as thoroughly as possible, and then passing an electric current through to complete the work. Particular virtue is attached to this last stage, as heat is developed throughout the mass. The product is described as a clean, smokeless fuel, and it is claimed that it is equal to the best South Wales coal, and is much less expensive. Now, heat is heat, however developed, and the necessary heat required for finishing the drying process could certainly be obtained in a much less expensive manner, by the simple process of combustion. Fortunately, the commercial failure of this process is not likely to reflect in any way upon the suitability of other electrical processes.

THE GROWTH OF ELECTRIC CENTRAL STATIONS.

Bulletin No. 5 of the Bureau of the Census, issued November 30, gives the statistics of central electric light and power stations in the United States from 1881, the year which may be considered as the beginning of this industry, to the end of June, 1902. These statistics cover private and municipal plants, but they do not take into consideration electric railway stations and isolated plants, though a few of the stations classified here supply power to railways. At the time of enumeration—that is to say, seventeen months ago—there were 3,620 electric stations in operation. The cost of their construction and equipment amounted to $504,740,352. These stations furnished employment to 23,330 wage-earners, who received $14,983,112 during the year. The power plant equipment consisted of 5,930 steam engines, with 1,379,941 indicated horse-power, and 1,390 water-wheels, with a rated horse-power of 438,472. The generating plant consisted of 12,484 dynamos of every description, with a rated horse-power of 1,624,980.

Municipal Stations.

Of these 3,620 central stations, 815 are operated under the control of municipalities. These cost $22,020,473, and gave employment to 2,467 wage-earners, who were paid $1,422,341 in wages. While the number of municipal stations seems surprisingly large, being 22.5 per cent of the total, these stations represent only 4.35 per cent of the total cost. Evidently, it is the small towns that run to municipal plants.

Work of the Stations.

From the private stations 334,903 arc lamps were operated and power supplied for 16,616,593 incandescent lamps, stationary motors representing an aggregate of 19,283 horse-power and 2,370 street cars. Municipal plants operated 50,795 arc lamps, 1,577,451 incandescent lamps, 5,403 horse-power in motors, and nine railway cars. The gross income from private plants was, for the year ended June, 1902, $78,735,500, and for the municipal stations, $6,965,105, this figure including the estimated income from public service.

A Marvelous Growth.

These figures give some idea of the magnitude of this one branch of electrical application and the totals are truly marvelous when it is remembered that at the time the report was made the industry was only twenty years old. The report is now seventeen months old, and at the rate of increase indicated by the yearly figures, the number of stations should now be nearer to 4,100 than to 4,000. Also, the more recent stations are, as a rule, far more elaborate and expensive than the older ones, as there has been a growth in size of stations as noteworthy as the increase in their number, and it is very probable that the total value of the electric stations is increasing at a greater rate than they are growing numerically.

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ELECTRICAL CONDUCTIVITY OF MERCURY VAPOR.

In the various published descriptions of the mercury vapor lamp and the several other devices invented by Mr. Peter Cooper Hewitt, which depend for their action upon the phenomena observed in the lamp, reference has been made to the complicated nature of these phenomena. Mr. Hewitt, in his work, has collected a large amount of data bearing on the subject, but it seemed advisable to make a systematic investigation with a view to deducing general laws.

Three Groups of Phenomena.

The reactions taking place in the tube may be divided into three groups—those taking place at the positive electrode; those taking place at the negative electrode, and the behavior of the vapor itself. In a study of any one of these groups, it is necessary to eliminate the effect of the other two, and this is not easy. Mr. Hewitt has, however, with the assistance of Dr. A. P. Wills, made a very complete investigation into the behavior of the mercury vapor, and the results of this work are to be found in a paper appearing on another page of this issue.

The Method of Conducting the Test.

The conduction of electricity through a vapor is supposed to be brought about by streams of positively and negatively charged particles, each leaving its respective electrode and traveling toward the other. These streams of charged particles, under proper conditions, form a luminous column, which varies in character with the current passing, the vapor pressure and the size of the enclosing vessel. It is necessary, therefore, to investigate the effect of variations of these three quantities, as well as to separate the three sets of phenomena. In the work described by Mr. Hewitt, the behavior of the vapor alone is described, all the electrode effects being eliminated. To obtain the latter condition was by no means easy, but Mr. Hewitt is satisfied that he has succeeded. The investigation was carried out by enclosing the tube to be experimented with in a box, arranged so as to vary the temperature. The fall of potential along the column of vapor was measured by introducing two electrodes, at a known distance apart, into the sides of the lamp. Lamps of various diameters were used, the density of the mercury vapor was varied by varying the temperature of the lamps, this temperature being determined by thermo-couples, and the current passed through the lamps was varied. It was also necessary to get rid of any impurities which might be contained in the tube. This latter condition was secured by using pure materials and carefully exhausting the tube. Under the conditions of the tests, the conducting column was perfectly uniform throughout its length, and there was a uniform fall of potential along it.

Results of the Work.

The results of the work are embodied in the curves given by Mr. Hewitt. They have not yet been formulated into mathematical equations, but this is now being done. In general, the behavior of the mercury vapor may be stated in this way: the resistance per unit length of the vapor column decreases with an increase in the diameter of the tube, with an increase in the current flowing, and with a decrease in the vapor pressure. The watts absorbed per centimetre of length vary, of course, with the current and the resistance. Other things being equal, they increase with an increase in current, with an increase in the diameter of the tube, and with an increase in the vapor pressure. The luminous efficiency of the lamp varies with other conditions, but there is a certain ratio between vapor density and current at which the ratio of the light given out to the energy absorbed is a maximum. Other conditions may affect the behavior of the vapor column, but are not here considered. Thus, if the tube be placed in a magnetic field, the resistance of the vapor increases.

Value of the Work.

The study of electrical conduction through gases has been prosecuted vigorously under Dr. J. J. Thomson, and work on this subject has not only added greatly to our knowledge of electrical phenomena, but has probably done more to enlighten us as to the nature of matter itself than any other study. While Mr. Hewitt's work was carried out with mercury vapor alone, his results are, no doubt, general for all saturated vapors. His work is an important contribution to the knowledge on the subject and, at the same time, has a very practical bearing on the proper conditions to be secured in the mercury vapor lamp. To mention but one point: since there is a certain density for maximum luminous efficiency, lamps should be operated at this point. Lamps should then be constructed so that they will have this fixed relation between definite vapor density and current.

POWER FOR TRACTION IN A LARGE CITY.

An idea of the magnitude of electric railway development is given by an examination of the equipments of the power stations of Greater New York. The power obtainable from all the railway stations now in operation, at the nominal rating, is 142,170 kilowatts. This total does not include an additional 10,800 kilowatts in generators, about to be installed in one of the large stations, and 15,000 kilowatts in storage battery, which can be drawn on for one hour. In addition, one of the elevated systems has retained eighty steam locomotives, representing a total of about 11,400 kilowatts, for use during the season of heaviest traffic, because as yet it has been impossible to bring the equipment of the new generating station up to the requirements of a rapidly increasing traffic.

The Overload Rating.

Allowing an overload rating of forty per cent of the nominal rating of the power stations, the total power available for moving cars in this city to-day is 224,970 kilowatts, or nearly 300,000 horse-power. In addition to this, the new units already contracted for will give an additional output, at a nominal rating, of 10,800 kilowatts; and the nominal rating of the equipment at the power-house for the Rapid Transit system will be 50,000 kilowatts when completed. This will add to the total overload rating of 224,970 kilowatts, as given above, about 90,000 kilowatts; but, by the time all the new units are in operation, there will, undoubtedly, have been other additions in several of the older stations. The figures point to a minimum of 425,000 horse-power as the overload rating of the railway power stations of Greater New York in the near future. There is hardly a doubt but that it will greatly exceed this figure.

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A METHOD FOR DETERMINING RATES AND PRICES FOR ELECTRIC POWER.[1]

BY FRANK B. PERRY.

1. That the future will show a rapid growth in the application of electricity to industrial pursuits, operated from a centrally located steam-driven electric power station, has led me to present the following data to our members, many of whom will doubtless find the methods suggested applicable to their own interests. The advent of driving textile and other mills from a plant of this character has opened a question for discussion as to the establishment of a proper basis for rates to be charged for electric current supplied in large quantities.

2. The contracts drawn up by electric companies with their customers sometimes contain a clause similar to the following, which is given for the purpose of illustration, and is not intended to cover any specific case: for a period of years from date the lessor agrees to furnish, and the lessee to receive and to pay for, within the times and on the terms set forth, all the power that may be required to properly operate and light his plant. The amount of power to be determined by meter readings, and to be billed monthly at the rates recited below, *viz.:*

1,800 to not more than 2,160 kilowatts at rate of $31.50 per kilowatt per annum.

More than 2,160 kilowatts and not exceeding 2,520 kilowatts at rate of $30 per kilowatt per annum.

More than 2,520 kilowatts and not exceeding 2,700 kilowatts at rate of $28.50 per kilowatt per annum.

All in excess of 2,700 kilowatts at rate of $27.60 per kilowatt per annum.

3. The above rates are based on an annum of 3,000 hours. From this schedule the following tables are derived:

TABLE I.

Rate per Kilowatt per Annum.	Equivalent Rate per Horse-Power per Annum.	Rate per Kilowatt per Hour.	Rate per Horse-Power per Hour.
$31.50	$23.499	$0.0105	$0.007833
30.00	22.38	0.0100	0.007460
28.50	21.261	0.0095	0.007087
27.60	20.5896	0.0092	0.006832

Table I is self-explanatory. An examination of table II shows plainly the faults that exist in a schedule such as that usually followed.

4. By using 2,161 kilowatts, or one additional kilowatt more than 2,160 kilowatts, a yearly saving of $3,210 may be made; similarly an increase of one kilowatt above 2,520 kilowatts effects a reduction of $3,751.50 per annum, and one extra kilowatt over 2,700 kilowatts lessens the yearly expense by $2,402.40.

TABLE II.

Kilowatts Used.	Cost per Annum.	Cost per Month.
1,800	$56,700.00	$4,725.00
2,160	68,040.00	5,670.00
2,161	64,830.00	5,402.05
2,268	68,040 00	5,670.00
2,520	75,600.00	6,300.00
2,521	71,848.50	5,987.37
2,652.7	75,601.95	6,300.16
2,700	76,950.00	6,412.05
2,701	74,547.06	6,212.30

5. While these figures show the points in the schedule at which the greatest saving may be made, many other qualities which are given in a later table illustrate equally well the irregularity of prices based on such a list of rates. The inconsistency of this method is further shown by the fact that 2,268 kilowatts cost the same as 2,160 kilowatts, or 108 kilowatts may be utilized without any increase in expense to the consumer. The price is also practically the same for 2,652.7 kilowatts as for 2,520 kilowatts, which indicates that any number of kilowatts between these limits may be used without additional cost to the person buying power.

6. It would appear from these figures that the electric company makes more profit at some places in the schedule than at others, and on that account could furnish certain amounts of power gratis. Of course, this is not true, but tends to convince one of the absurdity of the system that is customarily used by central electric stations. It is also evident that the customer, if he were so disposed, might watch his meter and so adjust his consumption of current as to bring about a substantial decrease in his bill for the month. For example, he might install a few extra machines that would not only serve to increase his product, but would also be the means of diminishing his bill. As an extreme case, the use of one additional kilowatt would bring about this result. It also might prove economical to burn electric lights during the day in order to increase the current consumption.

7. Both of these examples mentioned serve as illustrations of the fact that it is within the consumer's jurisdiction, by the terms of his agreement, to use power advantageously with a resultant financial loss to the electric company. While such a procedure may be perfectly legitimate, it would be fairer to all concerned to prevent contingencies of this kind from arising, and at the same time to provide a system of rates which would be to the mutual interests of both parties.

8. The horizontal lines on chart No. 1, Fig. 1, indicate the rates for power, and the diagonal lines represent the price per month for electric current covering the entire range of the above-mentioned schedule. The latter lines show at a glance the unfairness of the system, and prove conclusively that rates can not be adjusted properly on the customary basis.

9. The subsequent discussion is intended to give a method of rearranging a schedule of rates based on the "step-system," and for convenience the aforesaid figures will be used. The principles, however, may be applied to any other rates made up in a simlar manner.

10. Referring to table II and applying the well-known formula $(a + l)\frac{n}{2}$, giving the sum of the terms of an arithmetical progression we obtain for each step, assuming a common difference of one kilowatt, the following figures:

	Value of "a."	Value of "l."	Value of "n."
(1) 2,161—2,520 kw..	$64,830.00	$75,600	$360
(2) 2,521—2,700 kw..	71,848.05	76,950	180

11. The value of *"a,"* or the first term of the series represents the product of 2,161 kilowatts by its rate per kilowatt per annum. In a similar way the other terms of the series are obtained, *"l,"* indicating in each case the last term and *"n"* the number of terms.

12. Since the rate is constant from 1,800 to 2,160 kilowatts, we will compute simply the sum of the series beginning at 2,160 kilowatts.

Sum of (1) = (64,830 + 75,600) 180 = $25,277,400
" " (2) = (71,848.5 + 76,950) 90 = 13,391,865
1,160 kw. at $31.50 = 68,040
(3) Total sum of two series = $38,737,305

13. With a varying rate of power, diminishing in a fixed ratio between any two amounts, it is possible, by the substitution of proper quantities in an equation herein deduced by the writer, to compute the value of the sums of the product of each succeeding kilowatt by its corresponding rate.

14. The horizontal spaces of the charts, or abscissæ, represent in terms of kilowatts a progressive increase in each successive number by the addition of any desired equal amount.

Let (a) = first term. (l) = last term. (d) = common difference. (n) = number of terms. (s) = sum of terms.

[1] A paper presented at the New York meeting (December, 1903) of the American Society of Mechanical Engineers, and forming part of vol. xxv of the *Transactions*.

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Then 1st term $= a$,
2d " $= a + d$,
3d " $= a + 2d$,
4th " $= a + 3d$,
$l = a + (n-l)d$,
$s = (a + l)\frac{n}{2}$.

15. The vertical spaces of charts, or ordinates, represent in terms of rates per kilowatt annum, or per kilowatt hour, a progressive decrease in each successive number by the subtraction of any chosen equal quantity.

Let (b) = first term. (k) = last term. (r) = common difference. (t) = sum of terms. (m) = number of terms.

Then 1st term $= b$,
2d " $= b - r$,
3d " $= b - 2r$,
4th " $= b - 3r$,
$k = b - (m-l)r$,
$t = (b + k)\frac{m}{2}$.

16. Multiplying the corresponding terms of these two series, we obtain the following:

(4) Product of 1st term $= ab$,
(5) " " 2d " $= (a+d)(b-r)$,
(6) " " 3d " $= (a+2d)(b-2r)$,
(7) " " 4th " $= (a+3d)(b-3r)$,
(8) " " last " $= \{a+n-l)d\}\{b-(m-l)r\}$.

17. Adding these products, and developing the quantities enclosed in parenthesis, we obtain for the sum of 1st and 2d term, designated (4) and (5).

(A) Sum of products 1st and 2d terms $= 2ab + bd - ar - dr$.

Multiplying equation by $\frac{2}{2} = \frac{4ab + 2bd - 2ar - 2dr}{2}$.

Substituting values $n = 2$ and $m = 2$ in the above, we find

$$(A) = \frac{2abn + bdn - arm - drm}{2} = \frac{bn}{2}\left\{2a + (n-l)d\right\} - \frac{rm}{2}(a+d).$$

18. In a similar manner (B) = sum of (4), (5) and (6), and (C) = sum of (4), (5), (6) and (7),

$$(B) = \frac{bn}{2}\left\{2a + (n-l)d\right\} - \frac{rm}{2}(2a - 3\tfrac{1}{3}d),$$

$$(C) = \frac{bn}{2}\left\{2a + (n-l)d\right\} - \frac{rm}{2}(3a + 7d).$$

19. Comparing equations (A), (B) and (C), we find that they are alike in all respects excepting the coefficients of "a" and "d" of the negative terms.

20. Substituting these values, viz., for coefficient of "a" $(m-l)$, and for coefficient of "d"

$$\left\{\frac{2}{3}(m-2) + l\right\}\left\{m - l,\right\}$$

we have for the sum of any number of products containing "n" and "m" terms.

$$\text{Total sum} = \frac{bn}{2}\left\{2a + (n-l)d\right\} - \frac{rm}{2}\left\{a + \left[\frac{2}{3}(m-2) + l\right]d\right\}\left\{m - l\right\}.$$

$$(D)\quad \text{Total sum} = \frac{bn}{2}(a+l) - \frac{rm(m-l)}{2}\left\{a + \frac{d}{3}(2m-l)\right\}.$$

21. In order to apply this formula to the case in question, let us consider the rate as beginning at \$31.50 per kilowatt per annum for 2,160 kilowatts and varying in amount to \$27.60 per kilowatt per annum for 2,700 kilowatts. By so doing, we preserve the limiting features of the schedule both for rates and for the quantities at which they are applicable. Since the successive steps in the first mentioned schedule show an even decrease in rate for equal increments of power up to 2,520 kilowatts, it is safe to assume that a list of rates may be made up to vary uniformly from 2,160 to 2,520 kilowatts and regularly, but at a different rate, from 2,520 to 2,700 kilowatts.

22. Let x = rate per kilowatt per annum for 2,520 kilowatts.

$a_1 = 2{,}160$	$a_2 = 2{,}521$
$b_1 = 31.50$	$b_2 = x$
$d_1 = 1$	$d_2 = 1$
$l_1 = 2{,}520$	$l_2 = 2{,}700$
$r_1 = \frac{(31.5 - x)}{360}$	$r_2 = \frac{(x - 27.6)}{180}$
$n_1 = 361$	$n_2 = 180$
$m_1 = 361$	$m_2 = 180$

23. Substituting these respective values in equation (D) gives

$$D_1 = \frac{31.5 \times 361}{2}(2{,}160 + 2{,}520) - \frac{(31.5 - x) \times 361 \times 360)}{2 \times 360}\quad \{2{,}160 + \tfrac{1}{2}(722 - 1)\}$$

$$D_2 = \frac{180x}{2}(2{,}521 + 2{,}700) - \frac{(x - 27.6) \times 180 \times 179}{2 \times 180}\quad \{2{,}521 + \tfrac{1}{2}(360 - 1)\}$$

From the above,

$$D_1 = \frac{159{,}655{,}860 - 81{,}886{,}171.5 + 2{,}590{,}561x}{6}$$

$$D_2 = \frac{2{,}819{,}340x - 1{,}418{,}038x + 39{,}137{,}848.8}{6}$$

24. Then in order to fulfil the conditions of the first-named schedule, $D_1 + D_2$ must equal (3) or

$$D_1 + D_2 = 38{,}737{,}305.$$

Substituting values of D_1 and D_2 and solving,

$$4{,}000{,}863x = 115{,}516{,}292.7$$
$$x = 28.872.$$

25. This value of "x" substituted in expressions for rates gives $r_1 = \$0.0073$ and $r_2 = \$0.00706\frac{2}{3}$ as the variations in charges for each kilowatt per annum from 2,160 to 2,520 kilowatts, and from 2,520 to 2,700 kilowatts respectively.

26. The rates per kilowatt-hour become $r_1 = \$0.0000024\frac{1}{3}$, $r_2 = \$0.0000023\frac{2}{3}$; for 30 kilowatt-hours, $r_1 = \$0.000073$ and $r_2 = \$0.0000706\frac{2}{3}$.

27. Using this system as a basis for rates, the wording of the agreement for power would be changed to read as follows:

"The charge for electric current furnished under this contract shall be made as per the chart attached hereto, and made a part hereof."

28. The line plotted on chart No. 2, Fig. 2, indicates the rates per kilowatt per annum which would, in this instance, replace the original schedule as given by chart No. 1, Fig. 1.

29. The results obtained by following these lines of rates necessarily gives, on account of the above reasoning, the same average price per month as that computed by the "step" system. Chart No. 3, Fig. 3, is an example of the form of chart which would be embodied in a contract for electric power in order to meet the rates outlined in the original agreement. It also gives an idea of the simplicity of interpreting rates and prices for power by making use of the scheme proposed.

30. Line No. 1 is drawn through points plotted in accordance with the rates specified on chart No. 2, Fig. 2; the ordinates being equal to rates per kilowatt-hour and the abscissæ representing kilowatts. From 1,800 kilowatts to 2,160 kilowatts and above 2,700 kilowatts the rate is constant at \$0.0105 and \$0.0092 per kilowatt-hour as respectively indicated by the horizontal portions of the line. From 2,160 to 2,520 kilowatts the rate diminishes in a fixed

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ratio for each additional kilowatt used, namely, from $0.0105 to $0.010062 per kilowatt-hour; also from 2,520 to 2,700 kilowatts the rate diminishes uniformly,

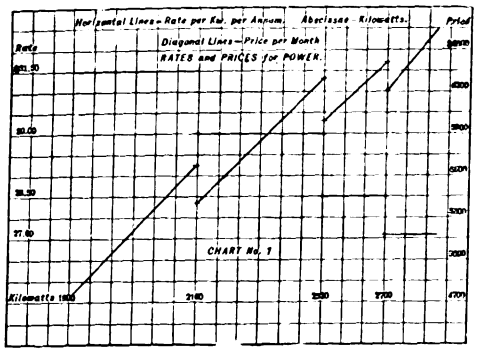
Horizontal Lines—Rate per Kw. per Annum. Abscissæ—Kilowatts.
Diagonal Lines—Price per Month
RATES and PRICES for POWER.
CHART No. 1

FIG. 1.—RATES AND PRICES FOR ELECTRIC POWER.

but not so rapidly as between the points previously stated, from $0.010062 to $0.0092 per kilowatt-hour. It will be noted that the ordinates may be read easily to one one-thousandth of a cent per kilowatt-hour and the abscissæ to three kilowatts without estimating fractional division of the spaces.

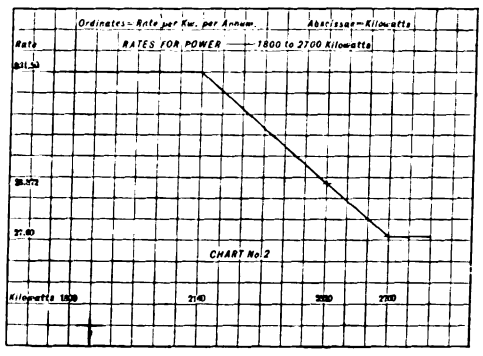

FIG. 2.—RATES AND PRICES FOR ELECTRIC POWER.

31. Line No. 2 is deduced from the foregoing, and by its means one may determine at a glance, knowing the wattmeter reading, the amount of each month's bill for power consumed.

32. The lower line of figures on the chart represents meter readings in kilo-

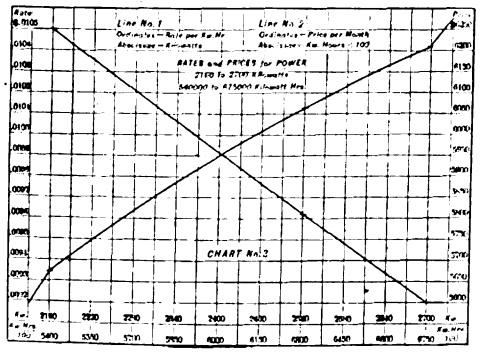

FIG. 3.—RATES AND PRICES FOR ELECTRIC POWER.

watt-hours divided by one hundred. These quantities are computed by multiplying the kilowatt readings by 250, the average hours per month, of one-twelfth the total for the year as limited by the contract. Two ciphers are omitted from these results to avoid repetition of figures. To obtain the bill per month, find the number on charts corresponding to that recorded by the wattmeter, and note the point vertically over same on line No. 2. In the column at the right-hand side of the chart, horizontally opposite this intersection, will be found the price of bill for the amount of power in question. The abscissæ may be read accurately to 750

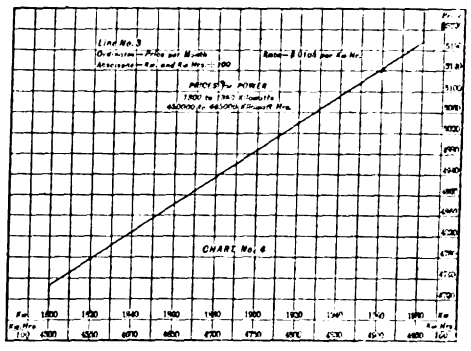

FIG. 4.—RATES AND PRICES FOR ELECTRIC POWER.

kilowatt-hours and the ordinates to $5 for the corresponding spaces, and by estimation of tenths these differences may be proportionately reduced.

33. Charts No. 4 to No. 8 (Figs. 4 to 8) inclusive are similar to, and may be considered as supplementary to chart No. 3. Each chart includes a section of 180 kilowatts of one-fifth of the entire range from 1,800 to 2,700 kilowatts.

34. Lines No. 3 and No. 4 indicate prices for power up to and including 2,160

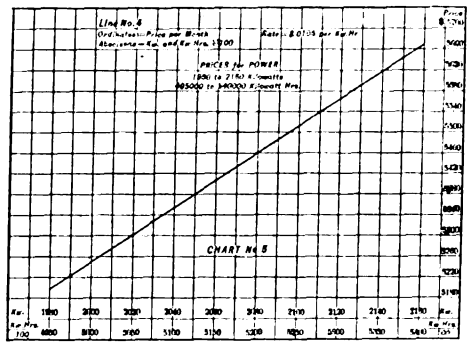

FIG. 5.—RATES AND PRICES FOR ELECTRIC POWER.

kilowatts at a constant rate of $31.50 per kilowatt per annum, or $0.0105 per kilowatt-hour. Lines No. 5, No. 7 and No. 9 represent rates

varying respectively from	$31.50	to	$30.186	per kw. p. an.
" " "	30.186	"	28.872	" " "
" " "	28.872	"	27.60	" " "
or from	$0.0105	to	$0.010062	" " hr.
	0.010062	"	0.009624	" " "
	0.009624	"	0.0092	" " "

35. Lines No. 6, No. 8 and No. 10 show prices per month for power, varying in the order given from 2,160 to 2,340 kilo-

watts, from 2,340 to 2,520 kilowatts and from 2,520 to 2,700 kilowatts. Each of the spaces on the charts No. 4 to No. 8 inclusive occupied by the abscissæ repre-

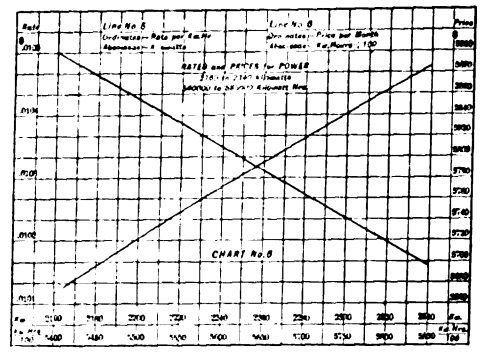

FIG. 6.—RATES AND PRICES FOR ELECTRIC POWER.

sents one kilowatt or 250 kilowatt-hours as the case may be, consequently are well within the limit that it is possible to read a recording wattmeter of 3,000 kilowatts capacity.

36. Greater accuracy is also attainable in determination of rates per kilowatt-hour or the total bill for the month.

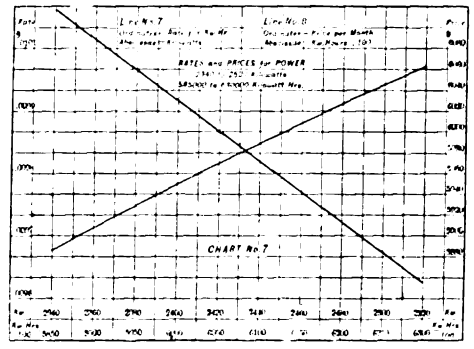

FIG. 7.—RATES AND PRICES FOR ELECTRIC POWER.

This may be carried to a still further degree of refinement by an increased subdivision of the amounts of power and their accompanying rates. The principles enumerated may be applied equally well to a given list of powers with any predetermined rates. The table III is pre-

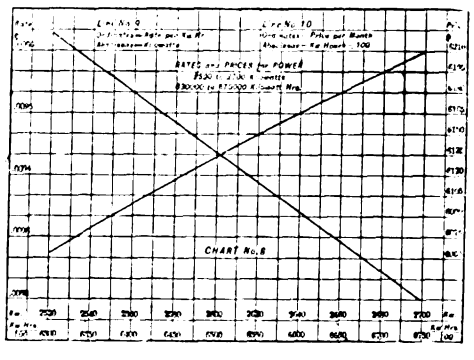

FIG. 8.—RATES AND PRICES FOR ELECTRIC POWER.

sented to show the comparison of prices per month that would be paid for various amounts of power by the original agree-

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ment, and also by the lines illustrated on charts No. 3 to No. 8 inclusive (Fig. 3 to 8).

37. Referring to the tabulation, one may observe that between 2,190 and 2,370 kilowatts, the chart gives figures higher than the schedule, while from 2,370 to 2,520 kilowatts the monthly bills are lower. As previously stated above, the average is practically the same. The last line of the table shows that for the points taken the discrepancy between the chart and the schedule amounts to about three hundred and forty-seven-one-thousandth of one per cent. This difference would be lessened by choosing smaller subdivisions and would finally amount to zero when the points are taken at one-kilowatt intervals. Of course, if the meter should indicate a use, say, of 2,520 kilowatts per month considerably more would

TABLE III

Equivalent Horse-Power.	Kilowatts.	Kilowatt Hours per Month of 250 Hours.	Rate per Kilowatt Hour.	Monthly Bill.		Difference.	
				By Chart.	By Schedule.		
2,894.1	2,160	540,000	$0.0105	$5,670.00	$5,670.00	—	.....
2,935.7	2,190	547,500	.010127	5,708.78	5,475.00	—	$233.78
2,977.2	2,220	555,000	.010354	5,746.47	5,550.00	—	196.47
3,016.1	2,250	562,500	.010281	5,783.06	5,625.00	—	158.06
3,056.3	2,280	570,000	.010208	5,818.56	5,700.00	—	118.56
3,096.5	2,310	577,500	.010135	5,852.96	5,775.00	—	77.96
3,136.7	2,340	585,000	.010062	3,886 27	5,850.00	—	36.27
3,176.9	2 370	592,500	.008989	5,918.48	5,925.00	+	6.52
3,217.2	2,400	600,000	.009916	5,949.60	6,000 00	+	50.40
3,257.4	2,430	607,500	.009843	5.979.62	6,075.00	+	95.38
3,297.6	2;460	615,000	.00977	6 008.55	6,150.00	+	141 45
3,337.8	2,490	622.500	.009697	6,036.38	6,225.00	+	188.62
3,378.0	2 520	630,000	.009624$\frac{1}{2}$	6,063.12	6,300.00	+	236.88
3,418.2	2,550	637,500	.00955331$\frac{1}{3}$	6,090.25	6,056.25	—	34.00
3,458.4	2,580	645.000	.0094826$\frac{2}{3}$	6.116.32	6,127.50	+	11.18
3,498.6	2.610	652,500	.009412	6,141.33	6,198.75	+	57.42
3,538.8	2,640	660,000	.00934131$\frac{1}{3}$	6 165.28	6 270.00	+	104.72
3,579.1	2,670	667,500	.00927063$\frac{2}{3}$	6,188.17	6,341.25	+	153.08
3,619.3	2 700	675,000	.0092	6.210.00	6,412.50	+	202.50
Total.....				$113,333.20	$113,726.25	—	$393.05

be paid to the central station by the chart system than by the schedule. It is equally true that there are points on the chart lines where, if the meter should read the proper amount, the bill would be less than by the schedule.

38. The convenience of this method in determining the value of bills rendered each month should be appreciated both by the electric company and by the user of current. There is no conflicting of rates or prices with such a system, and bills increase gradually and consistently, as they ought, in proportion to the amount of power used. This method, which is equally fair to producer and to consumer has, to the best of my knowledge, not been used up to the present time by any central electric station for finding costs of current where varying rates per kilowatt annum or per kilowatt-hour are involved.

39. These ideas are submitted with the belief that their adoption will bring about more satisfactory results than can ever be realized by a continuance of the so-called "step" system of rates.

The Testing of Electric Generators by Air Calorimetry.

At the meeting of the British Institution of Electrical Engineers, held November 26, a paper was read by Mr. Richard Threlfall, describing a calorimetric method of testing generators, which he had devised and used with much success. The method was devised in order to test a generator which was so situated that it could not be coupled up to another machine and tested by the Hopkinson method. Mr. Threlfall's method consists in enclosing the generator in an air-tight case, which is protected against leakage of heat, and through which a steady stream of air of known volume is forced. Knowing the quantity of air passed, its humidity and density, and the rise in temperature, the losses in the generator are easily computed, as they are taken up as heat by the air. One advantage of the method is, that the losses are measured directly, and, since they constitute, for a generator of medium or large size, not more than ten per cent of the full load output, a considerable error in their measurement will cause but a small error in the figure deduced for the efficiency.

In applying this method, the first difficulty lies in determining accurately the quantity of air passed through the casing. It was fully determined that a Pitot tube gave the most satisfactory results. This is a tube extending into the air duct, with an opening directed against the stream of air. The tube is U-shaped, the other extremity being let into the tube with a flanged mouth. The U part of the tube is filled with water, and the difference in the level of the two legs of the tube is directly proportional to the velocity of the air at the intake of the tube. It is necessary to determine the rate of flow in all portions of the tube, but, having done this, a position can be found which gives the mean value, and it was ascertained that this position does not change with different rates of flow.

To protect the casing against loss or absorption of heat from external sources, the mean temperature of the air at the intake and the outlet, is maintained equal to that of the external air. The casing is also lined with silver paper to make it air-tight and this is also a good heat insulator. In places it is lined with felt. The apparatus was tested by placing within the casing, resistance strips, and expending in these a known amount of energy. The quantity measured by the calorimetric method agreed closely with that shown by the electrical instruments. The machine tested was rated at 300 kilowatts. Its efficiency was found to be eighty-nine per cent. It was driven by a two-cylinder tandem gas engine, and, after the efficiency of the apparatus as a generator has been determined, it was used as a brake to test the gas engine, the following being the results of this test: The gross total indicated horse-power was 517; absorbed in pumping and friction at no load, seventy horse-power, giving a mechanical efficiency of 86.5 per cent. The mean power was 301.42 kilowatts, and the efficiency of the dynamo was 88.93, showing that 338.9 kilowatts were delivered by the engine. The indicated kilowatts were 385.75, and the resulting mechanical efficiency was 87.86. These figures, the author believes, are the most reliable that have yet been obtained for a gas engine of this size.

Radium Industry.

Consul-General Richard Guenther, at Frankfort, Germany, reports that notwithstanding the difficulty in its production (many tons of ore being required to produce one gramme) a radium industry has already developed in Germany and France, and although one gramme is sold at a little less than $2,000 the manufacturers are said to have orders for several hundred grammes.

The demand for medical purposes exceeds the supply. Radium possesses all the important qualities of the Rœntgen rays, in addition to the invaluable property of being ready for use at any time and furnishing its rays without the employment of apparatus.

The fact that radium exerts a very peculiar influence upon light-emitting bodies has given rise to the hope that it may eventually play an important rôle in the industry of light. A minute quantity of radium is sufficient to produce a strong light from a layer of zinc pyrites.

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INDUSTRIAL ELECTROCHEMISTRY AND ELECTROMETALLURGY.

NOTES ON PROGRESS IN EUROPE AND AMERICA.

BY JOHN B. C. KERSHAW.

The Nickel Refining Industry and Its Prospects.

In a note on nickel production in Canada published in the issue of the ELECTRICAL REVIEW for January 31, 1903, the writer referred to the plans for erecting an electrolytic refining works at Sault Ste. Marie, for treatment of the copper-nickel matte obtained from the Canadian ores, and to the absence of reliable information relative to the process which was to be employed at this refinery. Ulke in an article on the electrolytic nickel refining industry, recently published in an American contemporary, has referred to the proposed works at Sault Ste. Marie, but since he has not given the definite information required, it is evident that the process to be used at this refinery is not yet settled. Ulke recommends a combination of his own patented process and of Thum's for the mattes to be treated; and it will be interesting to note whether his recommendation will be adopted.

The prospects of the various nickel companies are undoubtedly improving, for nickel-steel is coming more and more into use, especially for railway purposes. It is doubtful, however, whether this increased consumption of nickel will require any large adoption of electrolytic processes for refining the crude nickel. Ulke, in the article referred to, has pointed out that the managers of the Orford Copper and Nickel Company, one of the oldest producing companies, have learned how to obtain nickel testing 99.2 per cent by the ordinary metallurgical process, and that in consequence they have ceased to send the raw metal for electrolytic treatment by the Balbach company. It would seem probable, therefore, that the bulk of the nickel which will find its way into the iron and steel industries will not be submitted to electrolytic treatment for removal of the last traces of impurity—especially as these impurities would not be chiefly silver and gold, and so pay for the cost of the refining operation, as in the copper industry. Electrolytic refining in the nickel industry is therefore likely to be reserved for metal intended for special uses, in which the cost of the metal is of secondary consideration. It is interesting to note in this connection that Johnson has recently published details of a research relating to the deposition of thick plates of nickel. His experiments have proved that one important condition is to have a gas free electrolyte, and by passing his solutions through a vacuum apparatus he has been enabled to obtain this condition of success. The explanation is, that the hydrogen which otherwise would be occluded by the deposited metal is dissolved by the electrolyte. The process has been patented.

Water Power Centres in Italy.

A greater development of water power for electrochemical and electrometallurgical purposes has occurred in Italy during the last three years than in any other European country. Fuel is scarce in that country, and its cost is therefore high. The prospects for central water power stations, especially in the North where water power is plentiful, are good, and it is in the northern districts that such a development has recently been occurring with the aid of French and German capital. As pointed out by the writer in a recent note upon the progress of similar undertakings in America however, there is a general tendency for financiers to underestimate the capital required, to bring such developments to a successful issue; and Italy has not escaped the troubles caused by this miscalculation on the part of the promoters. The Italian Electrochemical Company owns two water power concessions in the northern provinces; one at Bussi, on the river Ticino, being rated at 6,000 horse-power; and the other on the R. Pescara, at 38,000 horse-power. The original capital of the company was $1,300,000, but this has proved insufficient to develop both the concessions, and so far only the water power at Bussi has been dealt with. Caustic alkalies and bleach were produced at this place. Owing to various causes, the company has lost heavily, and it has become necessary to write down the value of the original share-capital by forty per cent; to issue new shares to the extent of $540,000; and to convert its floating debt of $550,000 into a bond issue of like amount. The Franco-Swiss company for electrical undertakings was financially interested in this company, and is reported to have lost $160,000 in consequence of the depreciation in the value of its shares. In spite of this unfortunate setback to the prosperity of one of the larger power companies in the north of Italy, Dr. A. Bolis, who has written on this subject in the *Chemiker Zeitung*, considers the prospects in Italy are good for electrochemical and electrometallurical undertakings; and that with greater attention to both the scientific and financial sides of the business, the Italian water power schemes and subsidiary industries will eventually pay those who have been bold enough to sink capital in them in these early days of their development. As evidence of the growth of the industries, Dr. Bolis states that since 1897 eleven electrochemical companies have been founded in Italy, with a total capitalization of $6,000,000.

Aluminum in the United States and Canada.

The 15,000 horse-power (see ELECTRICAL REVIEW of February 7, 1903) now being applied to the electrolytic extraction of aluminum from bauxite and alumina at the three works situated in America, has not so far had any very marked effect upon the production figures, but possibly the returns for 1903 will show a largely increased output. The figures for the production of aluminum in America during the past five years have been as follows:

	Pounds.
1898	5,200,000
1899	6,500,000
1900	7,150,000
1901	7,150,000
1902	7,200,000

There is a proposal to float a new company for production of the light metal in Canada, and a bill with this object in view has been passed through the New Brunswick Legislative Assembly. The title of the new company is the Aluminum Production Company of New Brunswick; and a capital of $6,000,000 is to be raised for erection of an aluminum reduction works at the Grand Lake coalfields, in Queen's County. The promoters of this company are interested in the manufacture of McAdamite, an alloy containing aluminum as chief ingredient. I am unable to say what process the promoters of the new company intend to use, but possibly they have in mind the fact that the various original aluminum extraction patents have only a few more years to run before they lapse. The manufacture of aluminum will, therefore, soon be an open industry.

As regards the applications of aluminum, its utilization for bare overhead transmission lines and for printing purposes seems at present to be developing most rapidly. The latter use has extended to the United Kingdom, and many of the leading lithographic firms are now employing rotary aluminum presses for high-class poster work. The Aluminum Rotary Press Company has opened an office in London, and in a recently issued catalogue it states that eighteen British firms are now regularly using its presses for printing color work.

After a long fight, aluminum has therefore gained a permanent footing in the printing world. As the plates used in these presses can be employed repeatedly, this application of the metal can, however, add very little to the annual consumption, expressed in tons.

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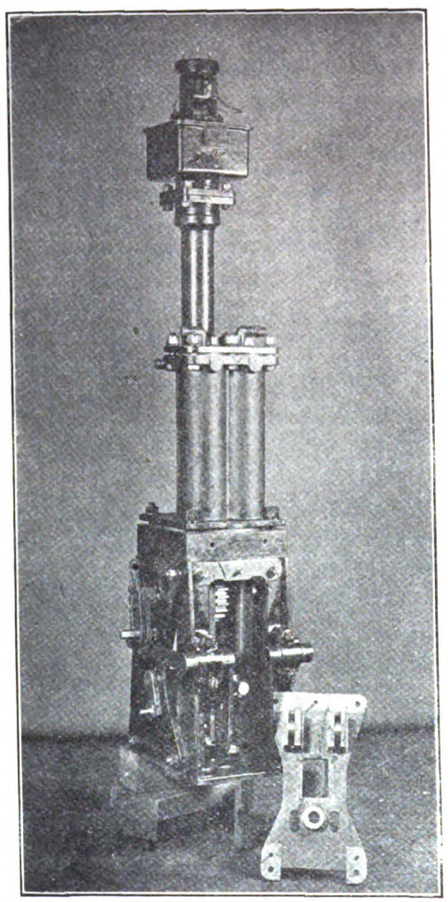
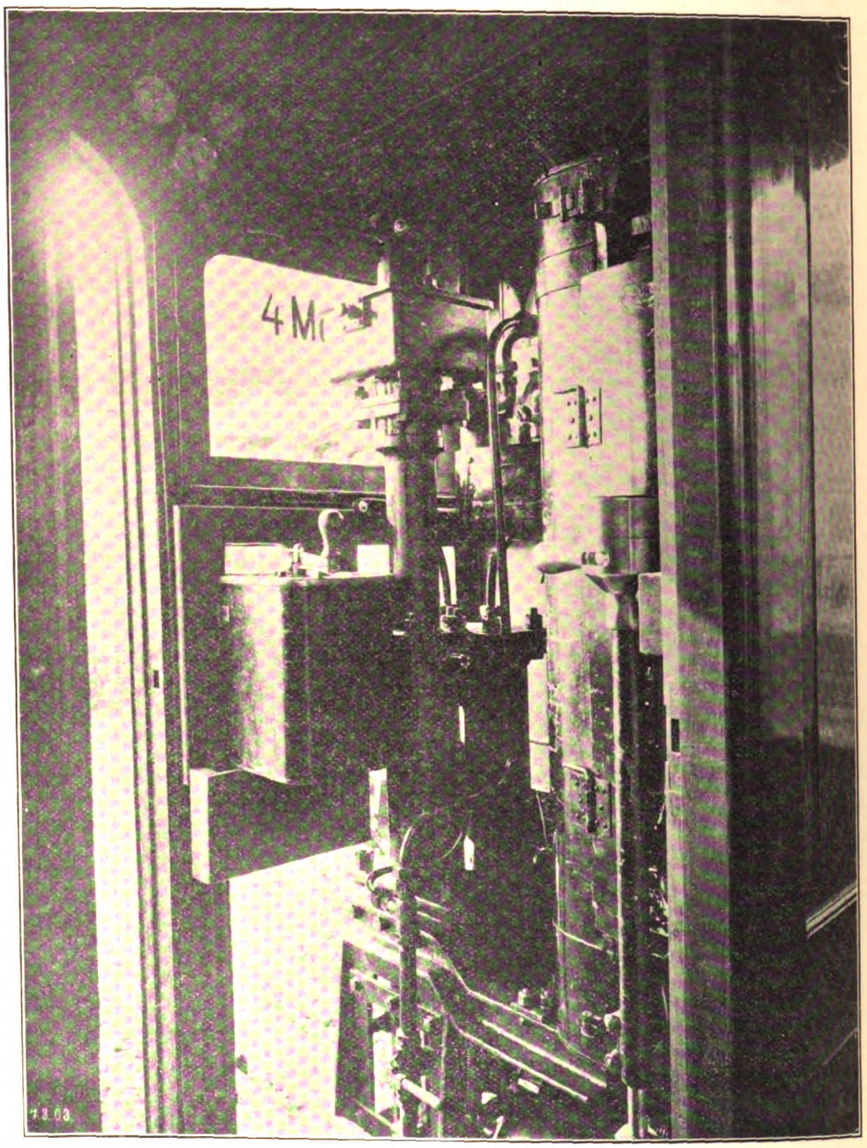
The Siemens-Schückert Multiple Unit System of Electric Train Control.

By Emile Guarini.

THE more electric traction develops, the greater are the efforts made by technical men to bring it to perfection and render its superiority over steam traction ever more conspicuous. One of the greatest advantages of electricity is, that it gives more elasticity to the traffic by permitting the economical running of a considerable number of light trains instead of a limited number of heavy ones. As the amount of goods and the number of passengers to be transported are not constant, it is evident that the weight of the train and the number of cars will vary according to the circumstances. The motor of the locomotive must, therefore, be capable of working under variable loads, sometimes above and sometimes below the normal, with fair efficiency. And what is more, when the power is centralized in a single locomotive, whose useful adhesive weight—that is to say, tractive power at the wheel—is only one-sixth of the total weight, an addition to the train of cars which need for themselves, for example, a force of 300 kilogrammes each, requires the locomotive to have a surplus weight of as many times two tons as cars are to be added. The multiple motor system, on the other hand, makes it possible, when an addition of cars is suddenly necessitated by any particular circumstance, to add at the same time the necessary supplementary motor, which is mounted on the car itself, and that without any relative increase of the useful dead weight.



Operating and Reversing Cylinders—Siemens-Schückert System of Multiple Unit Control—Back View.



Interior of Motorman's Cab, Showing Master Controller of the Siemens-Schückert System of Multiple Unit Control.

Until now there were known two multiple unit systems of electric train control: first, that of Sprague, which is exploited by the General Electric Company, and that of the Westinghouse Electric and Manufacturing Company. The former is entirely electrical; the latter is operated entirely by compressed air.

To these two there has just been added the Siemens-Schückert system, which is the result of long and painstaking experiments, justified by the serious disadvantages which, according to this firm, the two other systems possess. Thus in the purely electrical method of control, as the Siemens-Schückert Company states, the drawbacks are the difficulty of employing small motors for reversal of direction with pressures of 800 volts and over, the enormous dimensions and weight (up to 1,000 kilogrammes) of the traction magnets, the rise of self-induction, violent sparking at the distribution line, the inconvenience of looking after the bearings and brushes of the motors, etc. In the system of control by compressed air, pure and simple, which it otherwise admits to possess serious advantages, it objects to the large number of

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parts, frequent refusals to operate, the absence of dependence for power on the motor current and of well-defined main positions for the interrupters, etc. In view of the great superiority which it recognizes in the control by compressed air and in order to overcome the disadvantages cited above, the Siemens-Schückert Company has devised a mixed system, in which electricity serves only for the operation of compressed-air valves. This system, after having been practically tried on the Gross-Lichterfelde experimental line, has recently been installed on the underground line at Berlin.

Compressed air has been adopted for the actual operation of the controllers, the pneumatic valves being actuated by a low-voltage current. Two separate controllers, namely, a reversing and a speed controller, are under the control of the motorman. The speed controller has two main positions, one for putting the motors in series, the other for putting them in parallel. In order to ensure the immediate interruption of the circuit in case the train parts, the current actuating the valves flows all the time, while the train is in motion. The interruption of the current for any reason disconnects the motors from the circuit.

The following considerations have prevailed in the development of this system:

1. The number of parts must be very limited.

2. The controllers must be of the ordinary type, which have stood practical trial.

3. The speed controller must have two main positions—"in series," for half speed; "in parallel," for full speed. It must be able to occupy intermediate positions.

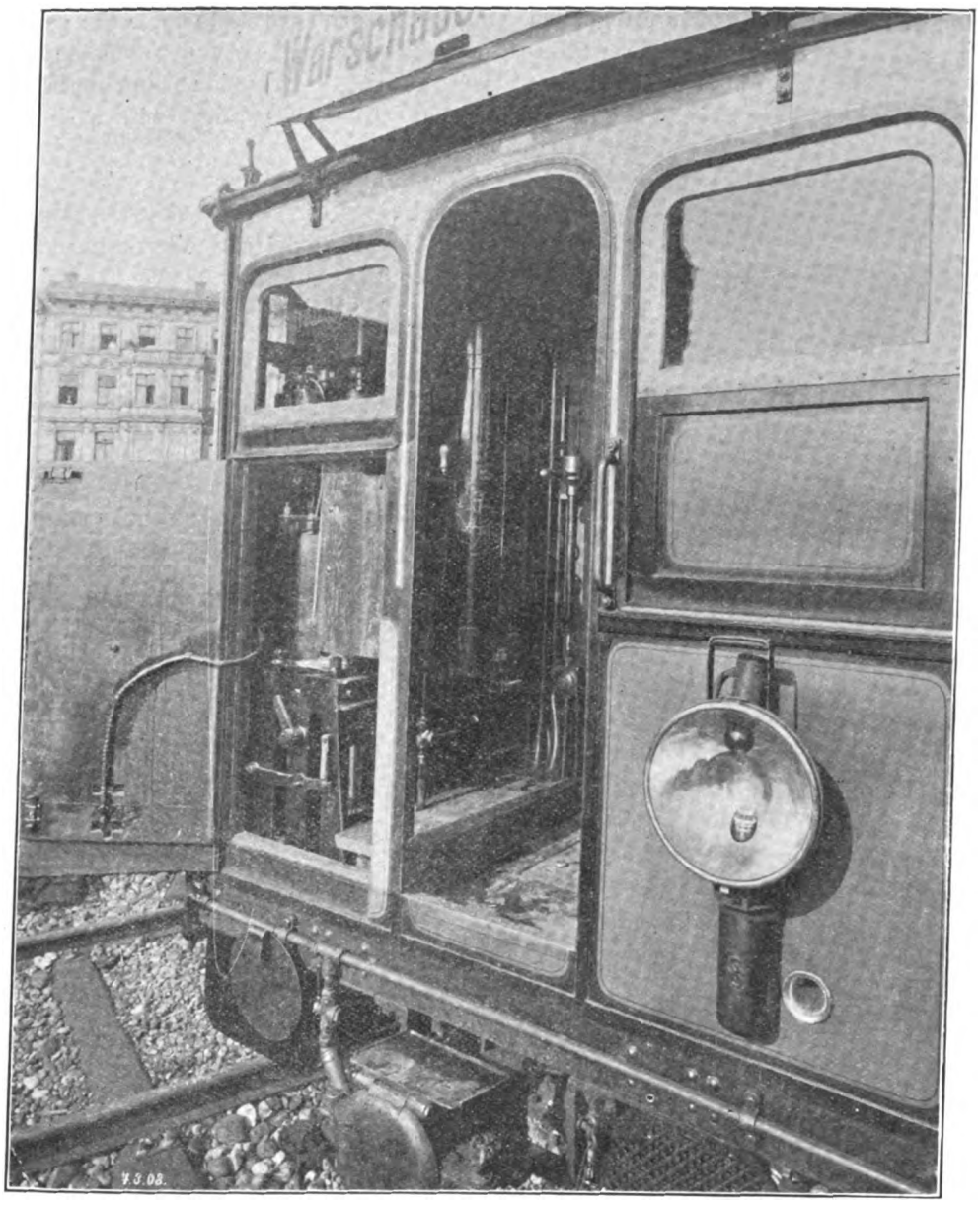
4. Direct current is to be employed, so that the breaking of the circuit may be effected by interrupting the line current.

5. The management must not require any skill. A wrong manipulation must not entail any bad consequences.

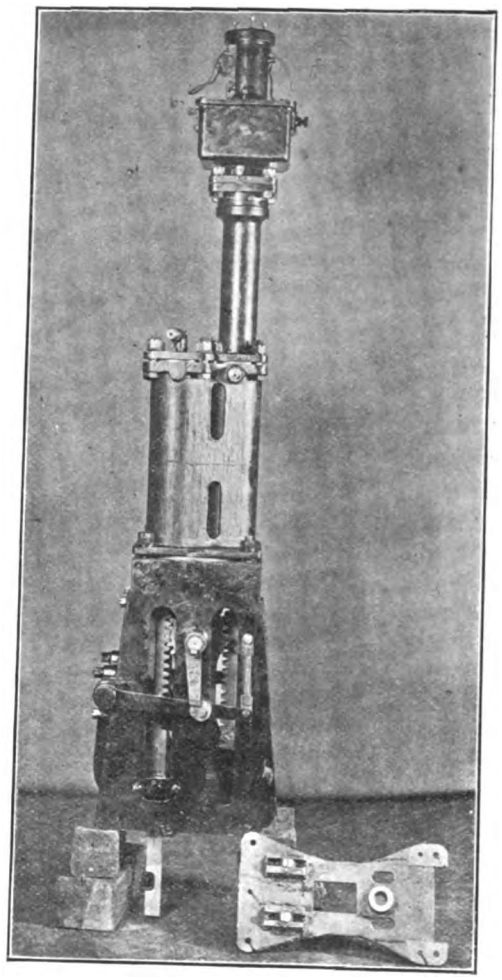
The accompanying illustrations relate to the Siemens-Schückert system. One shows the front of a train equipped with this system; the interior of the motorman's cab may be distinguished in it; another shows the interior of the cab, alongside of the controller there is visible a set of cylinders, the object of which will be explained presently; two others show this set of cylinders in two different positions.

The complete apparatus comprises, besides the motorman's switch, two relays which operate the valves, letting the compressed air into the two cylinders, whose piston rods may act (1) on the reversing controller; (2) on the piston rod of a third cylinder which is always under air pressure. The rod of this latter piston is a toothed rack geared with the speed controller.

Supposing now that the motorman puts the controller handle in the position "series-forward" *b;* this action has the effect of operating one of the relays which, by attracting its armature, opens the valve that lets compressed air into one of the cylinders; the piston of the latter moves forward, acts on the reversing con-



FRONT OF CAR EQUIPPED WITH SIEMENS-SCHÜCKERT SYSTEM OF MULTIPLE UNIT CONTROL—SHOWING APPARATUS IN MOTORMAN'S CAB.



OPERATING AND REVERSING CYLINDERS—SIEMENS-SCHÜCKERT SYSTEM OF MULTIPLE UNIT CONTROL—FRONT VIEW.

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troller, the position of which it fixes, and pushes the toothed rod of the third piston. By its motion this piston disengages the speed controller, which is arrested at a certain point by a ratchet. The attendant may, however, stop the movement at any desired point by placing the handle in the position "series-forward" *a*.

The motors are now in series and half speed is obtained. To reach full speed the motorman moves the handle to the position "parallel-forward" *b*. This has the effect of actuating the second relay which, in operating a valve, causes the admission of compressed air into the second cylinder. The piston of the latter advances, adjusts the reversing controller, frees the rack from the ratchet that retains it (as has been explained above) and moves the toothed rack forward. The latter, in advancing, turns the speed controller. Its motion may be stopped at any point by placing the handle in the position "parallel-forward" *a*.

When it is desired to stop, the handle is put in the position "off." The first two pistons then take up their initial positions, again moved by the pressure of the compressed air in the third cylinder which, as already stated, is always under pressure. In going back the toothed rack turns the speed controller backward, and finally the first two piston rods, in returning, make the reversing controller resume its original position.

For running backward the handle is placed in the position "series-back" *b*. The second relay is then operated and the compressed air admitted to the second cylinder; the reversing controller is moved to the position "back," but the speed controller works in the same manner as before. In running backward the motors can not be coupled in parallel. The connections "parallel-back" may be used, if necessary, as a brake; in this case, as also in the former ones, an automatic circuit-breaker protects the machinery against excessive currents.

The apparatus located on the trains and shown in the illustrations, although identical in principles, is not absolutely so in construction. It has been found necessary to take into consideration in the design the limitations of the space at disposal, and for the purpose of economizing it the first two cylinders are placed side by side, and the above summarily described construction of the reversing controller and other organs of this part has been replaeed by a combination of gears and pinions, of which an idea may be formed from the illustration. The contacts of the speed controller are provided with powerful magnetic spark blow-outs. Provisions have likewise been made for rapidly disconnecting either motor from the circuit; in such a case the car is run by one single motor.

For the sake of clearness, no mention has been made of several accessory organs, the necessity for which has been felt in practice. Thus the movements of the piston of the third cylinder are regulated by the play of a fourth piston in a cylinder filled with oil. This oil flows into a reservoir or runs back into the cylinder by the operation of different valves actuated by a relay, in the circuit of which the automatic circuit-breaker is inserted.

The trials have proved that the Siemens & Schückert multiple unit system of electric traction attains a high degree of perfection. It combines all the advantages of electrical transmission and retains at the same time all those of control by compressed air. It overcomes in this manner the disadvantages inherent in compressed air conduits and the multiplicity of electrical conductors required by other systems.

Rapid Submarine Cabling.

According to the London *Electrician,* recent cricket matches in Australia have been the means of giving much publicity to the question of speed of transmission on the submarine cables between England and that country. The two systems are owned, respectively, by the Eastern and the Eastern Extension Telegraph companies, and the Pacific Cable Board, and the following is the schedule of times occupied by the two routes in transmitting the accounts of the match from New South Wales. On Friday, November 20, the Eastern route occupied nineteen minutes, as against seventeen minutes on the Pacific cable. On Saturday, November 21, the Pacific cable took fifty minutes to get through, as against twelve by the Eastern. On Monday, November 23, the Eastern got the result of the match over in fifteen minutes, whereas the Pacific took only eleven minutes. In order to get these messages through, the whole route had to be cleared.

Turbine Operated with Gas Engine Exhaust.

A British patent has been obtained by Mr. F. W. Lanchester, of Birmingham, England, having for its object to provide an improved construction of turbine suitable for employment on the exhaust of an internal combustion engine, for utilizing the residual pressure. This turbine is described in the November 28th issue of the *Mechanical Engineer,* London. It is specially designed to permit the employment of gases at variable temperatures. The working parts of the turbine consist primarily of a pair of fixed and revolvable discs containing pockets of curvilinear outline, so arranged as to force the gases to react between them and rotate the revolvable disc, the reaction being repeated as many times as required with a single pair of discs.

The rotating disc may be provided with several rings of pockets, at greater radii than the first one, and alternating with similar guide pockets in the fixed disc. This construction allows a greater expansion of the gases. If the temperature of the gases is very high, the amount of the disc occupied by the actuating nozzles is a very small angular proportion of the whole disc. A relatively large cooling period is thus provided.

Electrical Section of the Canadian Society of Civil Engineers.

The second meeting of the Electrical Section of the Canadian Society of Civil Engineers was held recently in Montreal. President R. B. Owens was in the chair.

The first paper was by Mr. P. M. Lincoln, of Pittsburg, and discussed the Westinghouse single-phase traction system, comparing it with direct-current systems. Particular reference was made to the Washington, Baltimore & Annapolis Electric Railway.

Mr. A. H. Armstrong, of Schenectady, read a paper which compared steam and electric methods for heavy railroad work.

Mr. Lincoln gave careful estimates of costs of both the construction and operation, which showed a substantial advantage in favor of the alternating-current system in the ideal case taken, which was a line sixty miles long, with power station centrally located, transmission to substations at 20,000 volts, and trolley voltage of 3,000, reduced on the cars to a suitably low voltage. The proper starting effect was secured by lowering the voltage applied to the motors.

Mr. Armstrong's paper showed that a saving could be effected by the application of electric motive power to heavy trains of 1,000 and 1,500 tons.

Professor L. A. Herdt read a paper describing the polyphase equipments of European high-speed electric railways.

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INTERURBAN ELECTRIC TRACTION SYSTEMS.[1]

COMPARISON OF ALTERNATING AND DIRECT-CURRENT SYSTEMS.

BY P. M. LINCOLN.

Practically all the traction work in America has been done by direct current. American engineers have consistently refused to adopt the polyphase induction motor for traction purposes on the ground that it is not suitable for that purpose. The principal reasons for this stand are two in number:

(1) That the polyphase induction motor is inherently a constant-speed motor and therefore not adapted to traction purposes. Continual change of speed is one of the characteristics of traction work.

(2) The second reason against the use of polyphase induction motors for traction purposes is the necessity for providing at least two overhead conductors. Maintenance of insulation on such overhead conductors when they are at high voltage is naturally a difficult problem, much more difficult than to maintain the insulation between a single conductor and ground, as would be the case in the single-phase system.

American engineers, instead of endeavoring to adapt the unsuitable induction motor to traction purposes, have devoted their energies to the development of a suitable alternating-current motor. The only alternating-current single-phase motors which have a characteristic suitable for electric traction purposes are those of the commutator type. In no other type of motor are the speed and torque characteristics such as to be suitable for traction purposes.

The principal advantages of the alternating current electric traction over the direct-current are as follows:

(1) Limits to trolley voltage are removed.

(2) Avoidance of rheostatic losses.

(3) The necessity for rotary converter substations abolished.

(4) Manual attendance at the substations done away with.

(5) Danger of electrolysis by return current avoided.

To take up these points more in detail:

(1) *Voltage Limit Removed*—Six hundred volts at the motor in a direct-current traction system is practically the limit at which present designers and manufacturers are willing to guarantee their operation except in some special cases. The alternating-current system, providing the possibility of greatly increasing the voltage of the distributing system, thus cuts down largely the cost of this distributing system.

In addition, by raising the voltage of the secondary system, the current taken by a locomotive may be reduced and consequently the difficulty with collecting devices may be made to disappear.

(2) *Rheostatic Losses Avoided*—With the alternating-current system, on the other hand, the voltage at the car may be controlled by suitable means and rheostatic loss thus avoided.

(3) *Necessity for Rotary Converters Avoided*—In the alternating-current equipment the rotary converter has no place, thus avoiding not only a large item of cost of substations, but also one of the largest items of the loss of power.

(4) *Attendance at Substations Done Away with*—Alternating-current substations consist of static transformers only. Making the switching devices entirely automatic in their operation avoids the necessity of attendance for this purpose.

(5) *Electrolysis*—Electrolysis of parallel conducting systems is generally recognized as one of the most serious dangers in connection with present direct-current trolley systems, and the fact that an alternating-current system avoids this danger entirely need only be mentioned in order to be recognized as a marked advantage.

The disadvantages which necessarily accompany the use of the alternating-current traction system are as follows:

(1) Additional weight.

(2) Difficulty of operating on existing lines.

(3) Increased rail loss.

(4) The fact that an active electromotive force exists between field turns.

(5) Possible interférence with telephones.

(1) *Additional Weight*—An alternating-current motor of a given capacity is necessarily somewhat heavier and somewhat more expensive than a direct-current motor for the same capacity. Further, in order to make use of the advantages of high trolley voltage, the alternating-current equipment should preferably be provided with a step-down transformer on the car. Also, in order to obtain the advantages of avoiding rheostatic losses, some provision must be made for controlling the voltage on the car. The transformer, the voltage control apparatus and the greater weight of the motors make the alternating-current equipment necessarily heavier than the direct-current.

(2) *Difficulty of Operating on Existing Lines*—Practically all interurban roads run through cities on existing tracks and must therefore use the existing sources of direct-current power. In order to meet this condition, the equipment for an alternating-current interurban road must be so arranged as to operate on alternating current outside the city and on direct current inside. Although this is entirely possible, it must necessarily prove to be a matter of considerable complication. The most important part of the equipment—the motors—can be operated from direct as well as alternating current.

(3) *Increased Rail Loss*—Experiments have shown that with alternating current from 2,000 to 3,000 alternations, the actual loss which takes place with a given current through the iron rails is from three to five times that which the same direct current would give. But when it is considered that in order to utilize the main benefit of the alternating current, a higher trolley voltage is used and, therefore, smaller currents in the return conductor, the element of rail loss in an alternating-current proposition may be made even a smaller proportion of the total than in the direct current, in spite of this apparently large handicap.

(4) *Active Electromotive Force Between Field-Turns*—The space that can be assigned to the motor for operating a car is necessarily limited. When we consider the alternating-current motor, the question of space available becomes still more exacting, first, because the alternating-current motor is necessarily heavier and therefore occupies more space than an equivalent direct-current motor; and, second, because between field-turns of the alternating-current motor there is an active electromotive force similar to that between the turns of a transformer winding. A short-circuit between field-turns in an alternating-current motor, therefore, means a destructive short-circuit and an immediate interruption of service from that motor. As an offset against this disadvantage of an active electromotive force between field-turns, the alternating-current motor possesses the advantage of being capable of operation at low voltage, thereby reducing the number of turns on the series field and increasing the proportionate space for insulation. The use of a step-down transformer on the car makes available any desired voltage at the motor.

(5) *Interference with Telephones*—It

[1] Abstract of paper read at recent meeting of the electrical section of the Canadian Society of Civil Engineers, Montreal.

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DIRECT-CURRENT RAILWAY SYSTEM.

POWER REQUIREMENTS.

Average K.W. at car in typical 2-mile run (Fig. 1)	67.2	K.W.
No. cars running at one time	8	
No. substations	5	
Average No. cars per substation	1.6	
$\sqrt{\text{Mean}^2}$ amps. per car	185.3	
$\sqrt{\text{Mean}^2}$ amps. per substation = m	279.0	
With substations 12 miles apart, 80 lbs. track rail and 60 lbs. 3d rail, resistance between adjacent substations is = r	0.9	ohm
D. C. line loss per substation $\frac{r\,m^2}{6}$ =	16.1	K.W.
Average K.W. per substation at cars = 67.2 x 1.6 =	107.5	
Average K.W. per substation at substation	123.6	K.W.
Per cent loss in 3d rail	15.5	per cent
Per cent loss in step-down transformers	3.5	per cent
Per cent loss in rotaries	10.0	per cent
Per cent loss in high tension line	2.5	per cent
Per cent loss in step-up transformers	3.5	per cent
Total per cent loss from cars to P.-H.	39.5	per cent
Average K.W. consumed by 8 cars at the cars	537	K.W.
Average K.W. at power-house for 8 cars	750	K.W.
Max. load per substation—worst condition, 2 cars starting	560	K.W.
One 400 K.W. rotary will take care of this 40 per cent overload.		
Average load on rotary	30	per cent
Rotary substations are of sufficient size so that one can be cut out temporarily.		
Max. load on P.-H., say	1,200	K.W.
Can be taken care of with three 400 K.W. generators—one for spare.		

STEP-UP TRANSFORMERS.

Seven 150 K.W. transformers—one for spare.

HIGH-TENSION LINE.

One No. 6 B. & S. gauge line each way from P.-H. 20,000 volt, 3-ph.		
Max. loss, about	8.25	per cent
Aver. loss, about	2.50	per cent

SUBSTATION EQUIPMENT.

5 substations in all. 1 in P.-H.
Each of 4 substations to contain:
- Three 135 K.W. step-down transformers
- One 400 K.W. rotary converter.
- Switchboard.
- Step-down transformers omitted in power-house substation.

LOW-TENSION DISTRIBUTING SYSTEM.

Entire length of track equipped with 60 lbs. conductor rail.

CAR EQUIPMENTS.

Each car equipped with two 150 H.-P., D.-C. railway motors and multiple control apparatus complete.

ESTIMATED FIRST COSTS OF ELECTRICAL EQUIPMENT.

POWER STATION.

Three 400 K.W., 25 cycle, 360 V., 3-ph., A.-C. gens., at $6,500 each	$19,500
Seven 150 K.W., 350 to 20,000 V., self-cooling, oil-insulated trans., 25 cycle, at $1,225	8,575
Switchboard	4,500
	$32,575

HIGH-TENSION LINE.

48 miles of 20,000 V., 3-ph. transmission line. No. 6 B. & S. gauge conductors are $900 per mile	$43,200
Lightning protection	2,500
	$45,700

SUBSTATIONS.

Twelve 135 K.W., 20,000 and 360 V., 25 cycle, oil-insulated, self-cooling transformers, at $1,175 each	$14,100
Five 400 K.W., 600 V., 25 cycle rotary converters, at $5,200 each.	26,000
5 switchboards, at $2,800 each	14,000
	$54,100

LOW-TENSION DISTRIBUTION SYSTEM.

63 miles of 60 lbs. conducting rail at $2,500 per mile installed	$157,500
Bonding main track—63 miles at $400 per mile	25,200
	$182,700

CAR EQUIPMENT.

12 D.-C. car equipments complete, consisting of 2 No. 50-C motors, with multiple control outfit, heaters and contact shoes, at $5,217 each	$62,604
Total first cost electrical equipment	$377,179

ESTIMATE OF YEARLY OPERATING EXPENSES.

D.-C. SYSTEM.

5 men at P.-H., 2 shifts, aver. wage $900 per yr	$9,000
1 man at each of 4 substations, 2 shifts, at $900 per year each	7,200
Fuel, water, oil, etc., at ½ ct. per K.W. hr—4,890,000 K.W. hr	24,450
Repairs and maintenance of P.-H. (3 per cent of cost per year)	971
Repairs and maintenance of H.-T. line (5 per cent of cost per year)	2,285
Repairs and maintenance of substations (4 per cent of cost per year)	2,064
Repairs and maintenance of 3d rail (1 per cent of cost per year)	1,822
Repairs and maintenance of car equipments (12 per cent of cost per year)	7,512
Total yearly operating expenses	$55,404

ALTERNATING-CURRENT RAILWAY SYSTEM.

POWER REQUIREMENTS.

Average real K.W. at car in typical 2-mile run (Fig. 2)	73.9	K.W.
No. cars running at one time	8	
No. substations	5	
Average No. cars per substation	1.6	
$\sqrt{\text{Mean}^2}$ apparent K. W. per car	129.0	
$\sqrt{\text{Mean}^2}$ amps. per car (3,000 volts)	43.0	
$\sqrt{\text{Mean}^2}$ amps. per substation = m	68.8	
With substations 12 miles apart, 80 lbs. track rail and No. 0000 trolley, resistance between substations allowing for increased rail resistance	4.2	ohms
Trolley and rail loss per substation = $\frac{r\,m^2}{6}$ =	3.32	K.W.
Average real K.W. per substation at cars = 73.9 x 1.6 =	118.0	
Average real K. W. per substation at substation	121.32	K.W.
Per cent loss in regulator and car transformer	5.0	per cent
Per cent loss in trolley and rails	2.8	per cent
Per cent loss in step-down transformers	3.5	per cent
Per cent loss in high tension line	2.5	per cent
Per cent loss in step-up transformers	3.5	per cent
Total per cent loss	18.4	per cent
Average real K.W. consumed by 8 cars at the cars	591	K.W.
Average real K.W. at power-house for 8 cars	700	K.W.
Average apparent K.W. at power-house, about	825	K.W.
Max. load per substation—worst condition, 2 cars starting (say, 275 apparent K.W. each)	550	K.W.
One 350 K.W. transformer will take care of this with fifty per cent overload.		
Average load on substation, about	40	per cent
These transformers are sufficiently large to take care of road if one is cut out.		
Max. load on P.-H. in apparent K.W., say	1,400	K.W.
Can be taken care of with three 450 K.W. generators—one for spare.		

STEP-UP TRANSFORMERS.

Three 400 K.W. transformers—load can be carried by two in case of emergency.

HIGH-TENSION LINE.

One No. 3 B. & S. gauge line each way from P.-H. 20,000 volt, 1-ph.		
Max. loss, about	8.2	per cent
Aver. loss, about	2.7	per cent

SUBSTATION EQUIPMENT.

4 substations. P.-H. feeds directly into 3,000 volt trolley.
Each substation to contain:
- One 350 K.W. transformer.
- Switchboard.

LOW-TENSION DISTRIBUTING SYSTEM.

Entire length equipped with No. 0000 B. & S. gauge trolley.

CAR EQUIPMENTS.

Each car equipped with two 165 H.-P., A.-C. railway motors with multiple control apparatus complete

ESTIMATED FIRST COSTS OF ELECTRICAL EQUIPMENT.

POWER STATION.

Three 450 K.W., 25 cycle, 3,000 V., 1-ph., 2,000 alt. gens., at $7,000 each	$21,000
Three 400 K.W., 17 cycle, 3,000 to 20,000 V., oil-insulated, self-cooling trans., at $2,500	7,500
Switchboard	3,800
	$32,300

HIGH-TENSION LINE.

48 miles of 20,000 V., 1-ph. transmission line. No. 3 B. & S. gauge conductors at $1,200 per mile	$57,600
Lightning protection	2,000
	$59,600

SUBSTATIONS.

Four 350 K.W., 2,000 alt., 2,000 to 3,000 V., oil-insulated, self-cooling transformers at $2,200 each	$8,800
5 switchboards, at $1,500 each	7,500
Auxiliary signaling lines for operating substation switches	7,500
	$23,800

LOW-TENSION DISTRIBUTION SYSTEM.

63 miles of No. 0000 trolley wire in place at $900 per mile	$56,700
Bonding main track—63 miles at $400 per mile	25,200
15 miles of pole line construction, not included in H. P. lines, at $630 per mile	9,400
	$71,300

CAR EQUIPMENT.

12 A.-C. car equipments complete, consisting of two 165 H.-P. motors, with multiple control outfit, heaters and trolley, at $8,482 each	$101,774
Total first cost electrical equipment	$308,774

ESTIMATE OF YEARLY OPERATING EXPENSES.

A.-C. SYSTEM.

5 men at P.-H., 2 shifts, aver. wage $900 per yr. each	$9,000
Fuel, water, oil, etc., at ½ ct. per K.W. hr.	23,050
Repairs and maintenance of P.-H. (3 per cent of cost)	969
Repairs and maintenance of H.-T. line (5 per cent of cost per year)	2,980
Repairs, maintenance and inspection of substations (six per cent)	1,428
Repairs and maintenance of trolley (4 per cent per year)	3,652
Repairs and maintenance of car equipments (10 per cent)	10,177
Total yearly operating expenses	$51,256

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is a question whether alternating current in the rails will interfere with telephones and similar instruments more than the direct current which they have to contend with at present. In any event, the amount of current in the rails can be reduced by the use of higher voltages so that this source of interference can be made less than it is with the present direct-current system. Further means have been proposed whereby the current can be confined entirely to separate conductors provided for the purpose and not allowed to wander at will through any return circuit that may exist, as is the case with the direct-current system. This can be done, of course, only at the expense of erecting a separate system for the return currents and a system of series transformers whereby these currents can be confined to this return system.

Comparison of Costs of Direct and Alternating-Current Systems—To determine by which of the two systems can a given service be rendered most economically, we shall assume a certain typical interurban road, ascertain the first cost of both systems and the cost of operating by both systems and compare the results. Suppose the typical road which we will assume to be as follows:

Length, sixty miles.

Schedule speed, thirty miles per hour.

Cars running half hour apart.

Number of stops, thirty—that is typical run, two miles long.

Weight of direct-current car, complete, thirty-five tons.

Weight of alternating-current car, complete, 41.3 tons.

It may be noted here that the above difference in weight of the cars is not the minimum that can be obtained. A large part of the difference in weight comes in the induction regulator, with which it is assumed the alternating-current car is equipped.

Fig. 1 shows the speed-time and kilowatt-hours curve of a direct-current car of thirty-five tons over the typical run. The equipment, gear, ratio, acceleration, etc., are given on the curve.

Fig. 2 shows the same for an alternating-current typical run and in addition gives also the apparent kilowatt and power-factor. It will be noted that the difference in power at the car is only ten per cent in favor of the direct-current equipment, in spite of the fact that the difference in weight is eighteen per cent in favor of the direct current.

The location of the power-house is assumed in both cases to be on the line of the road midway between the termini, therefore thirty miles from each terminus.

In each case, also, one of the substations is located in the power-house. In the alternating-current proposition the generators are wound for trolley voltage (3,000 volts) and feed directly into the trolley.

In each case, also, there are supposed to be four feeding points besides the power-house, thus making the substations twelve miles apart in both cases.

Further, in both cases the secondary is a single network, thus gaining the advantage of two feeding points except beyond the end substations. In neither system are secondary feeders figured on, the alternating current being simply a 4-0 trolley wire throughout, and the direct-current a sixty-pound conductor rail. In the direct-current system the high-tension line is supposed to be along the right of way of the road and the high-tension poles are utilized for supporting the trolley wire with a bracket construction.

Recognition of the fact that the alternating-current car is the heavier and requires more energy is made and larger motors than on the direct-current car estimated on.

In the direct-current proposition the generators, transmission line, etc., are supposed to be three-phase, naturally making necessary smaller transformers than in the single-phase system.

The parallel columns in the table give comparison of the power consumption, the losses in the various transmissions and transformations, the first cost of the apparatus used and an estimate of the operating expenses. The conditions are taken as nearly as possible to those in the typical road. Location will, of course, make differences in many of the items considered, but especial care has been used in estimating those items in which the two systems present a difference.

NOTES ON THE ABOVE COMPARISON.

First Cost—In the first cost of the two systems above compared no allowance is made for the fact that the alternating-current system requires less energy at the power-house and therefore will economize to a considerable extent in both engines and boilers. On account of the greater apparent kilowatt for the alternating-current system, generators and transformers will be larger in capacity, but the engines and boilers need not be so great in capacity. So far as transformers are concerned, the alternating-current system has the advantage because it allows the use of considerably larger units than the direct-current where three-phase transmission is necessary instead of single-phase, as is the case in alternating-current system. The alternating-current switchboards also have the advantage in that two switches per panel are required instead of three.

To render a given service over high-tension line, more copper is required for a single-phase line than for a three-phase line, and this makes the copper for the alternating-current system somewhat more expensive than for the direct-current system. The largest difference, however, in the high-tension line items comes from the fact that the poles for the high-tension line are spaced sufficiently close to allow the trolley brackets to be supported from the same poles. In the direct-current system, the spacing need be only sufficient for the requirements of the high-tension line alone.

So far as substation transformers are concerned, the alternating-current system has the advantage of single-phase over three-phase in that larger units are used. By far the largest item of saving in substation equipment between the two systems is of course in the omission of rotary converters in the alternating-current system.

The greatest difference in first cost of the two systems is of course the great difference in the cost of the secondary network. A glance at the comparative values will show that this difference in the case we have considered amounts to nearly $100,000, and is therefore nearly thirty per cent of the total cost of the direct-current system.

In first cost the alternating-current car equipments are of course considerably higher than the direct-current. I would call attention to the fact, however, that the costs of the alternating-current car equipment include an induction regulator. If some other style of regulator, such as, for instance, loops on the car transformers, has been figured upon, the cost of the alternating-current car equipments might be diminished by something like six per cent; that is, something over $6,000. The saving in weight by the same change and the consequent saving of power in the alternating-current system would amount to nearly four per cent of that which have been figured upon. In the item of maintenance of the control apparatus, however, it is believed that the induction regulator has the advantage in that it is not necessary to break the current in going from step to step.

The alternating-current system throughout is figured on the basis of using a fre-

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quency of 2,000 alternations per minute. This frequency could be increased to, say, 3,000 alternations per minute at the expense of first, a considerably decreased power-factor and, consequently, increased apparent kilowatts; second, increased generator and transformer capacity; third, increased line and rail loss; and fourth, increased cost of motors. This difference might run the cost of the alternating-current car equipment some five per cent higher than figured on. It will be noted that the great saving comes in changing from direct current to alternating current, and that a change in frequency within moderate limits affects a change by no means comparable with that which is affected by going to alternating current.

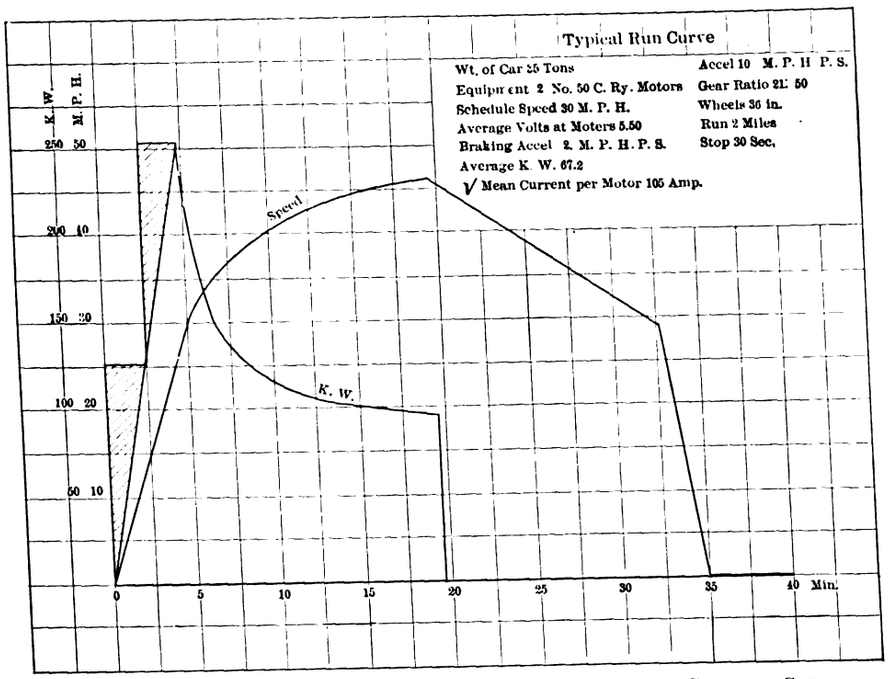
Typical Run Curve
Wt. of Car 35 Tons
Equipment 2 No. 50 C. Ry. Motors
Schedule Speed 30 M. P. H.
Average Volts at Moters 550
Braking Accel 2. M. P. H. P. S.
Average K. W. 67.2
Mean Current per Motor 105 Amp.
Accel 10 M. P. H P. S.
Gear Ratio 21. 50
Wheels 36 in.
Run 2 Miles
Stop 30 Sec.
K. W.
M. P. H.
Speed
K. W.
0 5 10 15 20 25 30 35 40 Min.

FIG. 1.—SPEED TIME AND KILOWATT-HOUR CURVES OF A DIRECT-CURRENT CAR OF THIRTY-FIVE TONS, OVER THE TYPICAL RUN.

Operating Expenses—In the labor item it will be noted that the main saving comes in that substation attendance is avoided by the use of the alternating-current system. In other respects the labor items will be the same.

The fuel item for the alternating-current system is somewhat smaller than for the direct-current system, as the actual energy at the power-house is less in the former case than in the latter.

Besides labor and power, the main operating expense for any interurban railway system comes in the items of repairs and maintenance. It will be noted that this item of repairs and maintenance has been included in the above comparison by assuming that it is a certain percentage of the first cost in each case. There may be some difference of opinion as to the percentage that should be assumed in the various cases of this item of repairs and maintenance, but I have endeavored to make the comparison between the two systems as fair as possible. It is not intended to include any item of depreciation in these repairs and maintenance figures. It will be noted that a marked difference is made between the maintenance of a third rail and trolley by allowing one per cent in the one case and four per cent in the other. The apparent discrepancy in allowing five per cent for the maintenance and repairs on the high-tension line and only four per cent for that of the trolley is explained by the fact that the five per cent on the high-tension line includes the repairs and maintenance and the supporting structure for the trolleys.

The matter of inspection of the alternating-current substations is taken care of by allowing six per cent in the case of the alternating-current substations instead of four per cent as in the direct-current substations.

In the matter of repairs and maintenance of the car equipments, it will be noted that twelve per cent is allowed in the direct-current system and only ten per cent in the alternating-current system. Even this difference in percentage allows $10,000 per year for the maintenance of the alternating-current equipments in the place of $7,500 for the direct-current, or twenty-five per cent more for the alternating current than for the direct current. The alternating-current motors being lower in voltage and being protected from direct lightning discharges by the intervention of a transformer ought to have at least a no higher maintenance bill than the direct-current motors. The number of motors in each case is the same. The alternating-current system, however, will require a certain amount of attention for the transformers and regulators. This item, though necessarily not based on experience, is estimated to represent the comparative conditions as closely as is possible at this time.

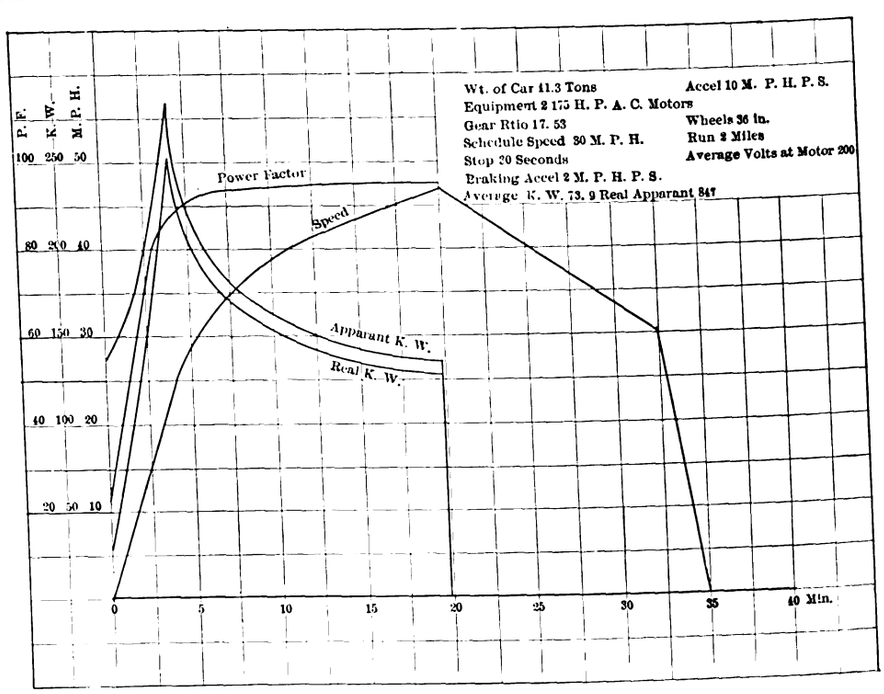
Wt. of Car 41.3 Tons
Equipment 2 175 H. P. A. C. Motors
Gear Rtio 17. 53
Schedule Speed 30 M. P. H.
Stop 20 Seconds
Braking Accel 2 M. P. H. P. S.
Average K. W. 73. 9 Real Apparant 847
Accel 10 M. P. H. P. S.
Wheels 36 in.
Run 2 Miles
Average Volts at Motor 200
P. F.
K. W.
M. P. H.
Power Factor
Speed
Apparant K. W.
Real K. W.
0 5 10 15 20 25 30 35 40 Min.

FIG. 2.—SPEED TIME AND KILOWATT-HOURS CURVE OF AN ALTERNATING-CURRENT CAR OF FORTY-THREE TONS, OVER THE TYPICAL RUN.

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A Demonstration of the Cooper Hewitt Mercurial Vapor Lamp at the Technology Club, New York City.

The Technology Club, of New York city, at its meeting on the evening of Thursday, December 10, had the great privilege of listening to an address by Mr. Peter Cooper Hewitt on the production of his mercurial vapor lamp, and witnessing a demonstration of this apparatus by Mr. Percy H. Thomas.

Mr. Calvin W. Rice introduced Mr. Hewitt, paying a tribute to the work he has done, and dwelling on the good fortune of the Technology Club in having before it so prominent a speaker.

Mr. Hewitt described briefly the technical features of the lamp, and told of some of the difficulties which had been overcome in bringing the lamp up to the condition in which it exists to-day. He caused considerable amusement by stating that the lamp has a serious disadvantage, in that all who had the fortune or misfortune of being under its rays had every appearance of being those who "had been."

The operation of the lamp depended upon three important functions: the resistance, respectively, of the positive and negative electrodes, and of the mercury vapor column. It was found in the early experiments that a careful adjustment of the radiating area made considerable differences in the illuminating intensity of the mercury vapor column. Everything in the lamp had to be worked out in certain proportions, as it was found that the current used varied with the cross-section of the electrodes and directly with the length of the vapor column. One of the most important features of this lamp, and one which gave probably the greatest amount of trouble, was the very great resistance at the negative electrode. This resistance has the ability of forming very rapidly, and is sometimes of such a nature that a pretty large sized piece of platinum used as an electrode would be fused and kept in a molten state by the increased resistance. Another property which gave great trouble was the electrostatic charge which gathered on the outside of the glass, this sometimes piercing the glass through a bubble and causing a leak in the tube. This difficulty had been overcome by the use of what Mr. Hewitt calls his starting band.

The lamp is now made in two forms. One form of lamp is suspended in a practically horizontal direction, a mercury electrode being used at one end, and an iron electrode at the other. The arc is started by the use of an induction which gives a high-potential kick, after which the current at low voltage is maintained across the conducting vapor. The other form, or tilting method, employs a shunt resistance with the lamp, and in this case the lamp is tilted until the mercury runs from the positive electrode to the negative; and after it is tilted back, the arc persists until the mercury has flowed back to the positive electrode. The current then takes the vapor path, the vapor at the same time becoming brilliantly incandescent. It is noticed that at first the light has a good deal of green in it, but as the tubes warm up and the condensation on the inside of the tube flows back to the mercury chamber, the light becomes nearer to a white, and more intense.

Mr. Hewitt felt confident in the great commercial utility of this lamp. Already it was enthusiastically received by commercial photographers and was having a wide adaptation in photo-engraving processes. In many places, such as drafting rooms and factories, the lamp was superior to any other form of illumination, in that its intensity was constant and it possessed absolutely no single bright point, eliminating entirely all sharp shadows. It was not only as a method of producing illumination that the lamp had its utility. Its development had brought to the notice of the inventor other phenomena which would have great practical uses in the art. The same phenomena which obtained in the mercurial vapor lamp were being made use of in the mercury vapor converter, the discharge-gap or interrupter, and the circuit-breaker or switch. In each of these apparatus the high negative electrode resistance was made use of in a most stable and perfect manner.

Again, Mr. Hewitt thought that the lamp would probably become very useful in employing other vapors. With each gas there was a very active chemical work, but with many forms of vapor which had been experimented with there was a disintegration of the leading-in wires, or even the glass. He said that mixed vapors appeared to have a very much higher resistance than the mercury vapor column.

Following Mr. Hewitt, Mr. Percy H. Thomas gave a demonstration of the work of the lamp, starting several lamps by the high-potential kick, and also by the tilting method. He exhibited the various forms of the lamp, stating that the normal lamp is too long for use in some installations, as at present constructed. In order to satisfy a certain demand, a standard form of lamp had been made, two of which were used in series on 110 volts. The normal lamp took about three or four amperes at 110 volts. Mr. Hewitt, he said, had not only produced a practical lamp, but had also done a great deal in clearing up a number of questions of the properties of gases in a high vacuum, through which an electric current was being passed. He presented several interesting analogies as to the functions of the lamp, and stated that the salient features were the great quantity of illumination, the extreme economy, the effective distribution of light, and the great actinic power for photographic purposes. The lamp could be made to give a better color by the use of screens treated with fluorescent dyes, and he stated that these screens were now being used in several studios, interposed between the object and the lamp.

He then described the action of the mercury vapor interrupter and of the alternating-current rectifier. Both of these had been described at length in the technical press, and were well known. The alternating circuit-breaker, however, had not been given, Mr. Thomas thought, the attention which it deserved. It was remarkable that this apparatus, hardly larger than a man's fist, could quietly open a circuit handling, say 14,000 kilowatts, and which, with a mechanical switch, it was necessary to have an elaborate oil-break apparatus. This mercury vapor switch is a simple adaptation of the negative electrode resistance which obtains in each of the three pieces of apparatus. The application of the apparatus to the breaking of alternating current is quite simple. Suppose an alternating current is passed through the lamp. With the negative electrode resistance the current goes out at the end of the first alternation. If, however, by some means the current to be interrupted is made to pass through the lamp, it simply means that a mechanical circuit be established, which will be kept intact as long as the mechanical circuit is not disturbed. The switch is so constructed that when the globe is tipped in one direction, it connects the mercury in the electrodes, establishing a mechanical circuit. When it is tipped in another direction the arc persists across the vapor until the current arrives at the zero point. The negative electrode resistance then prevents the return of the alternating wave, and the current can not reform. In this way the current dies out quietly without any exhibition of the pressure phenomena usual with a switch handling high-potential currents.

Following the address by Mr. Thomas, there was a short discussion, in which he answered several questions which were raised.

A vote of thanks was tendered to Mr. Hewitt and Mr. Thomas for the address and demonstration, after which the meeting adjourned.

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Vol. 43—No. 25

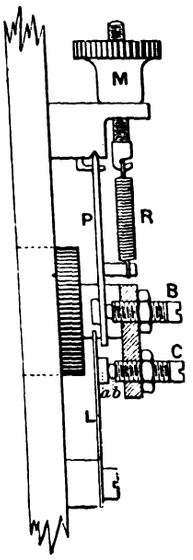
Electrical Notes from Europe.

By Our Special Correspondent.

PARIS is soon to have an electric plant which will be one of the largest in Europe. The new station will be erected by the Société Energie Electrique, a large company which has been recently founded for distributing light and power in the city and suburbs. It is also expected to supply some of the new substations of the Metropolitan underground. The plant will be located on the banks of the Seine in the suburb of St. Denis, where it will easily secure a supply of water and coal. Machines to the extent of 60,000 horse-power will be installed in the new station, and one of the interesting features will be the use of steam turbines to give the motive power. These turbines are of the Brown-Boveri-Parsons type, which have been already used with considerable success in Switzerland and elsewhere. The turbines for the Paris station are to have an unusually high power. Each of the direct-coupled units is expected to give 10,000 horse-power at the maximum. These turbines, as well as the dynamos, are to be built in France by the Compagnie Electro-Mecanique, who hold the license for the system here. The first part of the station outfit will include four of the large turbine and dynamo sets, giving a total of 40,000 horse-power on a maximum load, or 30,000 for an average. Alternating-current machines will be used, and the fields will be excited by a direct-coupled turbine group of 350 horse-power. Part of the exciting current will also be furnished by a rotary converter. It is expected to use a large battery of accumulators in parallel on the exciting circuit.

A new form of X-ray apparatus has been invented by Dr. Oudin, a prominent specialist of Paris. Its principal feature is the powerful effect which he produces by concentrating the rays. The essential part of the apparatus is an improved Crookes tube which allows of applying the X-rays to the treatment of cancer situated in the interior of the body. The rays are collected and greatly concentrated by means of a tube having the shape of the finger, with a protected extremity. The new form of tube is said to give a radiating power which is fifty times that of the ordinary tube. At the same time, special precautions have been taken to protect the tube so that in case it should break the patient will not suffer from the action of the spark which might be thus produced.

The new telephone station which is being erected at Moscow will be one of the most complete in Russia. The building has five stories with a large basement. The main telephone room is situated in the fifth story. It contains switchboard accommodations for 22,500 subscribers. The fourth story is laid out for accumulators and dynamos, while the third story is taken up with the cloak-rooms for the employés. The second floor contains dining rooms, library, reading rooms, etc. The offices are situated in the second and first floors, while the basement serves for the storehouses, workshops and boiler rooms. The building is steam heated throughout. The construction of the new telephone exchange cost more than $100,000. Upon the opening of the new station, all the telephones of the subscribers will be replaced by a new apparatus of special design. In the new telephones, simply lifting up the receiver serves to call up the central station. At the same time a red light appears on the switchboard, produced by a small incandescent lamp. On the appearance of the signal light the employé connects with the subscriber without using a call bell, and after asking the name he wishes to have, the employé makes the proper connection. When he is through talking, the subscriber puts his receiver back in place, and this causes the red light to be changed to white light by means of another lamp beside the first. By this new system the method of making connections is greatly simplified.



NEW VIBRATING DEVICE FOR INDUCTION COILS, DESIGNED BY M. CARPENTIER.

It is reported from Germany that a severe storm which took place recently caused great damage to the telegraph and telephone lines in different parts of the country. Several days were needed to replace the broken wires and establish the direct communication with Holland, Belgium, France, Italy and Switzerland.

M. Carpentier, the well-known electric constructor of Paris, has lately brought out a new vibrating device for induction coils. In a make-and-break device of this kind it is recognized that the break should be made as quickly as possible, hence the adoption of different outside mechanical devices for accomplishing this. It was found that with an armature which is attracted by the core of the induction coil itself, the break occurs at the beginning of the stroke and consequently at the point where the armature is moving the slowest. This is the contrary of what should happen. When the break is made to occur at a point where the armature is moving rapidly, a quick break is secured which gives a much better effect in the coil, and this is noticed in the better quality of the spark. In the diagram, the armature P vibrates in front of the core, and is drawn back by the spring R; it rests normally against the screw B. The electrical contact for the coil is made between the platinum piece *a* carried on the spring L, and the platinum end *b* of the screw C. The core attracts P and when it is moving rapidly it strikes against the end of L, thus breaking contact between *a* and *b*. The break at *a b* is thus much more rapid than in the ordinary case, and gives a better spark in the coil. This device is now used very successfully on different forms of induction coil.

Telephoning to the shores of the Arctic ocean has now been made possible, according to the Swedish journals, by the extension of a line running from Stockholm to the north. The small village of Narosk, which forms the terminal point of the most northern line of railroad in the world, has been connected recently with Stockholm. The length of the new line which extends to the Arctic ocean is about 600 miles.

A series of experiments has been carried on in Germany by H. Ebert and P. Ewers,

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which seems to prove that the air coming from the lower strata of the earth contains an emanation which is similar in effect to the emanation given off by radium. One of the principal phenomena produced by the emanation is the discharge of a pair of electrified plates which are exposed to its action. In the present experiments an iron tube having 1.2 centimetres bore was sunk in the ground to a depth of 140 centimetres. The upper end of the tube which projected from the surface was connected to a gasometer, so that the air could be drawn up through the tube and the gasometer filled with it. From the latter the air was passed into a bell-glass where the tests were made. Under the bell-jar was placed an Elster-Geitel indicating apparatus, consisting of a pair of plates whose loss of charge could be measured by an instrument placed on the outside. When the air coming from the ground was passed in the bell-glass, the conductivity between the plates was found to be increased in a large proportion, no less than twenty-two to one. This condition holds good for several days. It is supposed that the effect is due to the ionizing action of the air. No action is produced in similar circumstances by water vapor or carbon dioxide. The air coming from the ground is found to have an induced radioactivity, and this property diminishes less rapidly than in other cases. Gases and water vapor were removed from the air to prove that they did not cause the phenomenon. In such case the air still keeps its ionizing action, showing that it is not due to the presence of electrons, but to an emanation which transforms the neutral molecules of a gas in repose to electrified particles. When ordinary air is substituted in the bell-jar, the effect disappears.

Accumulators have been used with great success on the new submarine boat which the Russian Navy has built at the docks of the Baltic Company. The submarine, which made a cruise not long ago in the Gulf of Finland, with Captain Beklemischeff in charge, measures eighty feet long and has a displacement of 100 tons. It is found that the submarine can remain under water for five consecutive days, while traveling at a speed of eight or nine miles an hour. The equipage is composed of twelve men. The accumulators and motors were found to work very satisfactorily on these trials. When running at the surface of the water, the boat can reach a speed of twelve miles an hour.

The electric railway which is to pass through the Pyrenees region will form another connecting link between the French and Spanish railroad systems, and shorten up the distance from Paris to Madrid. A decision has been lately taken by the two governments as to the construction of a line of standard gauge electric road. The proposed line is to run between Ax-les-Thermes in France and Puycerda on the other side of the frontier, connecting at this point with the Spanish railway system. Another electric railroad to be installed in the Pyrenees region before long is the extension of the line of standard gauge road which now ends at Olette. From the latter point a new section of road is to be run as far as Puy. This part of the country, which possesses extensive mines and forests, will thus be opened up to the industries. Owing to the lack of transportation facilities it could not be easily reached. It is expected to complete these two electric railway lines within the next five years, as the work of drawing up the plans is now being carried on under the supervision of both governments.

One of the German plants which now uses electrically operated mine pumps is that of the Helios mines, in Gneisenau. The dynamo plant is located at the surface and the main cable passes down the mine shaft to an underground chamber which has been fitted up for the motors and pumping outfit. The station above ground contains two three-phase alternators of 7,000 kilowatts each, driven by steam engines. These alternators work at eighty-three revolutions per minute and deliver three-phase current at 2,600 volts. The machines are excited on starting by an independent exciter group formed of a generator direct-coupled to a steam engine. When the alternator comes up to full load, the fields are supplied by a motor-generator set. The pump room is located at a depth of 1,200 feet in the mine. Two cables take the current down to the motors. At present one motor is installed, having a capacity of 670 horse-power. It operates the pumps at sixty revolutions per minute.

At the International Exposition of Alcohol, which is to be held at Vienna next spring, will be seen different types of motor and dynamo groups in which the motors use alcohol as fuel. The exposition is to be held from April 16 to May 31. It is intended to bring out the recent progress of the production and methods of utilizing alcohol, and among the most interesting features will be the display of motors in which alcohol is used to form the explosive mixture. Such motors have been very successful in Europe for several years past, and many of the alcohol motors are used in direct-coupled dynamo sets, thus forming a compact and portable group which has many uses. Among other exhibits will be the new alcohol lamp, which uses an alcohol flame in connection with the Welsbach burner. This form of lamp is economical and gives an intense light. It will no doubt prove to be one of the competitors of electric light in the near future. The promotors of the exposition are taking measures to have apparatus introduced for the show free of duty. C. L. DURAND.

Paris, December 5.

The Operation of a Commutator in Oil.

In a recent issue of the *Zeitschrift für Electrotechnik,* Herr Osnos suggests the construction of a commutator to operate in oil. The form of the commutator should be that of a cylinder containing the oil, with the brushes rubbing on the interior. The presence of the oil gives, according to the author, the following advantages: the commutator operates well without causing short-circuits of the sections due to the brush spanning two segments, and for this purpose the armature has two distinct windings connected to alternate segments of the commutator. The oil prevents sparking, even when the voltage between adjacent segments of the commutator attains a value which, without the use of oil, could not be allowed. It will thus be feasible to construct commutators with few segments, while the coils on the armature may contain many turns. Oil also allows metallic brushes to be used, and this will decrease the surface contact which would be required by carbon brushes. At the same time, oil reduces friction and contact resistance losses. A commutator thus constructed may be so small that a series armature winding can be used, so that but two brushes will be necessary. The author lays stress upon the advantage which this arrangement will possess in the construction of alternating-current motors, and he believes that it will make possible the use of high voltages directly upon the windings, and do away with the necessity for transformers.

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British Institution of Electrical Engineers.

The inaugural address of President Robert Kaye Gray, delivered at the opening meeting of the British Institution of Electrical Engineers, dealt fully with matters of local importance and gave a review of the year's progress. The following are some of the interesting points discussed:

Many opinions have been advanced as to the scope and aim of an Institution such as ours; as to what it should do and what it should not do, and as to its relations with kindred societies. In early days the institution was the only association or body which could voice the views of electrical men, and therefore everything touching their interests was fit matter for discussion. To-day the necessity is not so imperative, as, owing to the great development of the electrical industry, other bodies are springing up who can more properly deal with a variety of questions which affect, but only indirectly affect the Institution as an institution of electrical engineers. As time goes on this necessity will become less and less, and the Institution will fall back into its proper function as an institution of electrical engineers, and will not fill the part of an association of electrical engineers, which it has often been obliged to do in the past. The word "institution" in this connection bears in my mind the meaning of a body for dealing with technical interests, while "association" implies a corporation whose functions are related to everything affecting general interests.

It is interesting in this investigation to note that modern tendencies in England are decidedly in favor of the direct-current system with a three-wire distribution. The number of direct-current undertakings increased from 139 in 1901 to 214 in 1902 and 260 in 1903. For these three years the alternating-current stations numbered sixty-seven, sixty-eight, and sixty-nine respectively. There are now established in Great Britain thirteen two-phase and five three-phase stations, exclusive of power transmission stations. In twenty-nine cases supply is given on two or even more systems. Many of the alternating-current stations have taken up the supply of direct current, others have added two-phase or three-phase supply to their single-phase service, or have changed over completely to one of these. The direct-current system appears to be in no immediate danger of supersession, in part owing to the raising of the voltage, and the consequent possible extension of the service area. The number of voltages in use is somewhat confusing, and presents to the standards committee a difficult problem to solve. These voltages now amount to about sixteen, and out of 289 samples of pressures nearly one-third are declared at 230, more than one-sixth are given as 220, while voltages of 240, 200 and 100 claim about one-eighth each. There are between fifty and sixty stations which revel in more than one declared pressure. The extent to which the change from one voltage to another has taken place may be judged from the fact that in 234 cases the pressure is upward of 200 volts; sixty-four supply current both above and below 200, and there are only twenty-nine whose supply is entirely under 200 volts.

Among the remarkable things of the year may be mentioned as in course of construction four turbo-generators of the Parsons type, each rated at 5,500 kilowatts to 8,280 kilowatts, and occupying a space measuring only fifty-one and three-quarters feet by fourteen feet by twelve feet. A 6,500-kilowatt turbo-generating set is being built by Brown, Boveri & Company, which measures fifty-nine feet by ten feet by ten feet. A Curtis turbine of 5,000 kilowatts is running in Chicago; this turbine is a combination of the Parsons and De Laval systems, and is arranged with a vertical shaft, a somewhat inadvisable design. In shape it is cylindrical, and, including turbine and generator, stands twenty-five feet high, with a diameter of fourteen feet. It may be interesting to note that there are over half a million horse-power of turbines in use or on order, and twenty-four stations in England use the turbine more or less. While referring to large units, it may be of value to state that the Société Cockerill, of Seraing, is expected to show at the St. Louis exhibition next year a gas engine of 3,000 horse-power; this engine will have two cylinders, each of fifty-one inches diameter, and will run at eighty-five revolutions per minute. It is said that the Gasmotoren Fabrik Deutz is designing a 6,000-horse-power engine.

Since the establishing of the Portrush electric tramway in 1883 the electrical engineer has encroached on the field of the tramway engineer, and consequently the purely tramway work, as apart from the electrical work, has often shown the mark of the active, clever, but untrained mind, impossible curves and grades being attempted, and unnecessarily expensive work being done. There has been some advantage in this no doubt, as the experience gained by these works, although expensive, has tended to improvements in practice. There is an American manner in this mode of procedure which leads to a free use of the scrap heap. We have been toiling up a steep hill for many years, and the time has now arrived when we should stop and survey the landscape as a whole, instead of narrowing our views to the particular point toward which we happen at the moment to be ascending. Already many of the paymasters are questioning the scrap-heap theory, as they know by experience that this is often evolved from nothing but a craving for change and a want of appreciation of the true value of money on the part of their advisers.

The application of electric traction to our railways is progressing. At present the sections which are being dealt with are those which have a great traffic density or a frequent service. This policy is doubtless a wise one, as the railway companies limit the application of a considerable capital expenditure to the best paying division of their lines, and to those portions where the benefits to be derived are the most apparent. During the current year the first section of the Metropolitan District Railway conversion has been made, and it is expected before March of next year that the Moorgate street, Drayton Park and Drayton Park-Finsbury Park sections of the Great Northern & City Railway Company will be in operation. The Mersey Tunnel Railway has been completed, and the conversion of the Wirral Railway is under consideration. The North-Eastern Railway has had trial runs along Tyneside, and good progress is being made with the Liverpool-Southport line. The Central London Railway is completing the change from locomotive to motorcar driving. The motorcar system is generally accepted as the best form for passenger traffic for many reasons which I need not recapitulate. The direct-current system at 500 to 700 volts appears to remain as a standard for railway work of this class, as well as for tramway work, but there are signs that single-phase alternating current may prove a rival. The three-wire system of feeding tramways and railways, though not without examples abroad, has not been adopted in England save on the City & South London Railway, where it seems to have proved satisfactory.

The advantages of electricity as a motive power seems to be readily appreciated. Among some of the large schemes in project is the electrification of the national railways of Sweden, the original power being derived from water pressure or the

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combustion of peat. Estimates are being drawn for 2,700 miles of railway, calling for over 100,000 horse-power. The official estimate shows that there will result a saving of fifty per cent in the present working expenses, which amounts to about £800,000 per annum. Switzerland again speaks of a conversion of its national lines, entailing the use of 30,000 horse-power to be obtained from water pressure.

A year ago the gap in the world's telegraphic girdle was completed by the laying of the trans-Pacific cable which now unites Canada with Australia, and this year has seen completed a second line across the Pacific from San Francisco to the Philippines and China by way of the Sandwich Islands, Midway and Guam.

It is strange that during this development the improvements in the types of telegraph cable employed have not been great, nor has there been any great advance made in the design of the instruments used for the transmission of signals, but the administrative work has been vastly bettered. Messages which formerly took hours in transmission are now received from the public and delivered to the addresses in a few minutes. I am informed that a telegram announcing the result of the yacht race for the American Cup was carried, in August last, from London to South Australia in four minutes. This message, which was forwarded *via* South Africa, was handled by fifteen operators, passed through eleven stations, and traversed 14,404 nautical miles of submarine cable and 1,515 statute miles of land lines. Ordinary commercial traffic can not be dealt with at this speed, but the instance I quote shows what can be accomplished when special arrangements are made to carry news which is of peculiar interest. The manager of an American cable company has told me that the result of the American Cup Race reached London one minute after the termination of the race, having been transmitted through 3,400 nautical miles of submarine cable and some 200 statute miles of land wire. The record time between New York and London is thirty seconds, and messages have been sent and replies received in one minute and thirty seconds.

The use of the telephone continues to extend, and in addition to the greater facilities offered in Great Britain there are gradually being established international wires which place in telephonic communication the principal towns of Great Britain and several of the commercial centres on the Continent. So far as I am aware, no practical use has yet been made of Poulsen's telautograph.

In a quite different direction electricity is being used for the purification of the water supply of towns. There are two installations of this kind in Germany—Schierstein and Paderborn—where the Siemens ozonizing tubes are in use; air is charged with ozone by means of these, and is passed up dripping towers, down which the water trickles, with the result that it is completely sterilized as regards all deleterious organisms. At Schierstein the capacity of the plant is nearly 50,000 gallons per hour, and the power required is fifty horse-power, of which, however, only twenty-seven horse-power is used for ozonizing; the remainder serves for pumping, etc. The pressure used is 8,000 volts. The working cost is in all from threepence halfpenny to fourpence halfpenny per 1,000 gallons. By the Jaruti process water is electrolyzed to give pure hydrogen and oxygen, consuming 115 kilowatt-hours per 1,000 cubic feet. A solution of caustic soda is used, with a perforated iron diaphragm to separate the gases. At Stangfjorden, in Sweden, the Jebsen system is used for the manufacture of briquettes from peat. The latter is carbonized by heating with the electric current, derived from water power, and the tarry by-products are recovered. The production of nitric acid from the atmosphere has long been the subject of experimental research; it is now in active operation at Niagara Falls, where by means of electric discharges at extremely high pressures and frequencies the nitrogen and oxygen are caused to combine. The same subject has been dealt with on the Continent, where a return of fifty-two grammes to fifty-five grammes of nitric acid per kilowatt-hour has been obtained, using a current of 0.05 ampere at 50,000 volts and 6,000 to 10,000 cycles per second. As Sir William Crookes has shown, the fixation of atmospheric nitrogen may in the distant future have a most important bearing upon the existence of the vast population of the earth, when natural sources fail to furnish an adequate supply of food. In connection with this subject, the synthesis of sugars by the electrolysis of carbonic acid, ammonium, phosphate, etc., which has been accomplished by Walther, is of no little interest.

With wisdom, we in England open our arms to the skilled man of other countries, and through his skill we can, in certain directions, maintain supremacy in some of our productions. The pity of it is that we have not among our own countrymen men of equal education and skill. One may say that the electrical industry is also suffering, and that the signs of it are the large importation of American and German machinery into this country at the present time; but I venture to disagree. Americans and Germans are doubtless appearing on our markets, and in many cases owing to greater skill in manufacture; but the financial side of the question has a great deal to do with their incursion, and especially is this so with their competition in our colonies and in non-manufacturing countries. We must, as a policy, continue to welcome all comers, but while so doing we should equip ourselves so that by sheer skill and ability we may conquer in the end. The equipment we require is, everyone now admits, technical education, and thus we are developing in all directions. The electrical engineers as a class are better equipped than any other class I know of, thanks to the teaching received in our technical institutions from very capable men, some of whom we are proud to see numbered among the past-presidents of this Institution.

An Independent Telephone Directory.

The Inter-Ocean Telephone and Telegraph Company, 336 Ellicott square, Buffalo, N. Y., has issued the first edition of a combination directory of the independent telephone companies in the Buffalo-Rochester district in western New York. This directory contains all the names of subscribers to the local independent telephone exchanges which are connected directly with the Inter-Ocean Telephone and Telegraph Company's long-distance service. During the past two years there has been great activity in the central and western New York districts, in the development of independent telephone systems. It is a remarkable fact that there are now in operation in western New York 50,000 independent telephones, all of which are at present, or will soon be, connected with the Inter-Ocean company's lines.

This directory has been carefully prepared, and is an important addition to the business directories of the country. While the edition is limited, extra copies have been printed for distribution outside of the district covered by these exchanges, and the book can be secured by remitting fifty cents in stamps to the Inter-Ocean company, at Buffalo, N. Y.

General Electric Company.

It is stated that the General Electric Company anticipates fully as much business for 1904 as it has enjoyed during 1903. Recent arrangements made with large German interests, it is expected, will prove of importance in this connection.

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Conductivity of Mercury Vapor.

By Peter Cooper Hewitt.

THE electrical conductivity of gases and vapors and its relation to the conditions under which the electrical current is maintained has occupied my attention for many years. A large number of experimental data accumulated during the progress of my work—when properly arranged and coordinated, furnish an explanation of electrical conduction through gases which seems to account satisfactorily for the phenomena observed. It was thought desirable to perform additional experiments for the purpose of obtaining exact quantitative measurements upon some particular gas and for this purpose mercury vapor was selected. The results of these experiments are given in the following brief summary. I was fortunate to secure during the progress of this work, the assistance of Dr. A. P. Wills, who expects to publish in the near future a detailed account of the methods and apparatus employed in this experimental study.

A gas or vapor forming part of an electrical circuit exhibits three distinct sources of electrical reactions, namely, one at the junction of the positive electrode of the conductor with the gas or vapor; one in the gas or vapor uninfluenced by the electrode effects; and one at the junction of the gas or vapor with the negative electrode.

Difficulty was experienced in obtaining electrical measurements upon the conducting gas or vapor independent of these electrode effects; the measuring instruments require the use of terminals or electrodes in contact with the gas or vapor with the electrode resistances accompanying them; difficulty was also met with in obtaining the gas or vapor in a state of purity. The results given in the diagrams are not vitiated by terminal or electrode effects. The measurements were taken in such a way as to be subject to but little variation from the effects of the current during the time of observation.

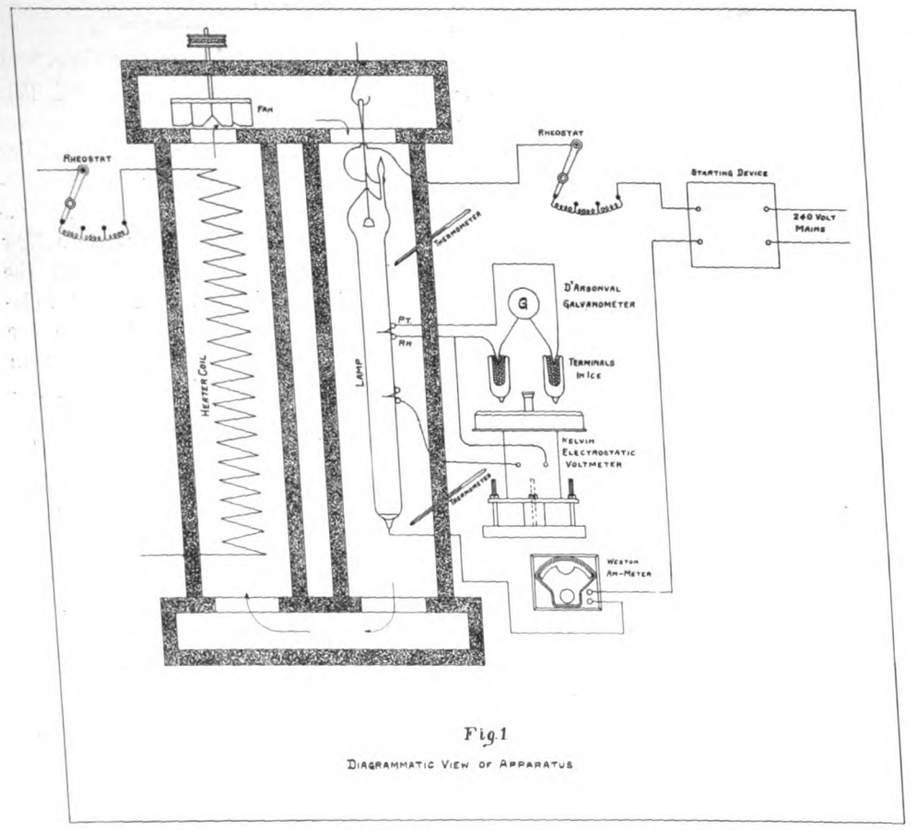
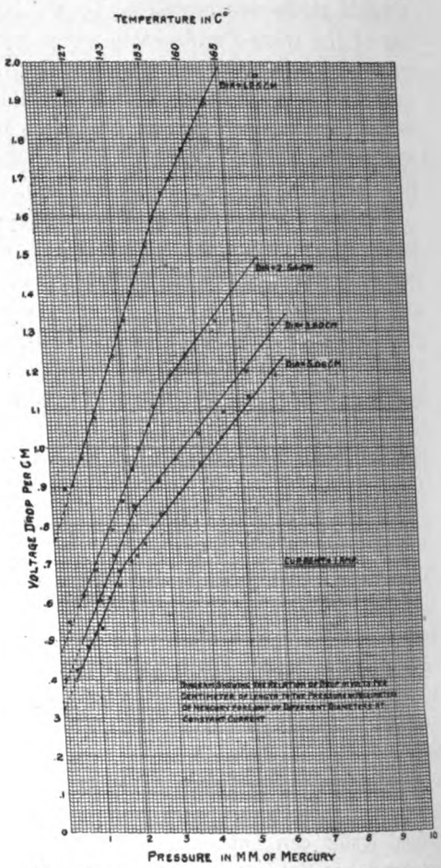


Fig. 1

DIAGRAMMATIC VIEW OF APPARATUS

DIAGRAMMATIC VIEW OF APPARATUS FOR STUDYING CONDUCTIVITY OF MERCURIAL FANS.

Fig. 1 is a diagrammatic view of the apparatus. Two upright chambers of insulating material were connected together at the top and bottom, thus forming one continuous air chamber. One chamber contained an electric heating coil, the current supply of which could be regulated externally; a centrifugal fan over this chamber produced a rapid circulation of the air contained by the two chambers for the purpose of bringing the whole to a uniform temperature which was regulated by the heating coil. In the other chamber was placed the vessel containing



RELATION OF DROP IN VOLTS PER CENTIMETRE OF LENGTH TO PRESSURE IN MILLIMETRE OF MERCURY FOR LAMP OF DIFFERENT DIAMETERS AT CONSTANT CURRENT.

the gas or vapor, marked "lamp," with the necessary electric connections. Thermometers were inserted at both ends, as shown, for determining the external temperature. Two platinum-rhodium couples were sealed in the walls of the lamp at a measured distance apart, and extended to the centre. The external terminals of the couples were immersed in ice and connected to a D'Arsonval galvanometer. The internal temperature was measured by means of these couples by observing the deflection of the galvanometer. It was possible to ascertain accurately when the internal and the external temperatures were the same. The drop in volts between the platinum-rhodium points was taken by a Kelvin electrostatic voltmeter; the couples thus served a double purpose.

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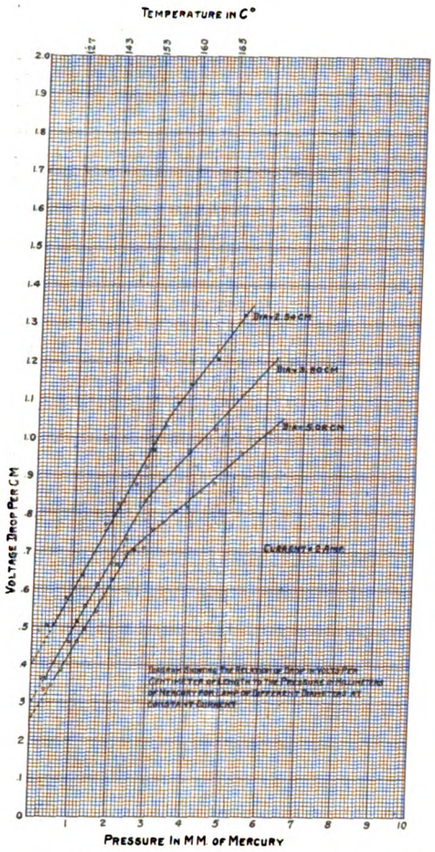
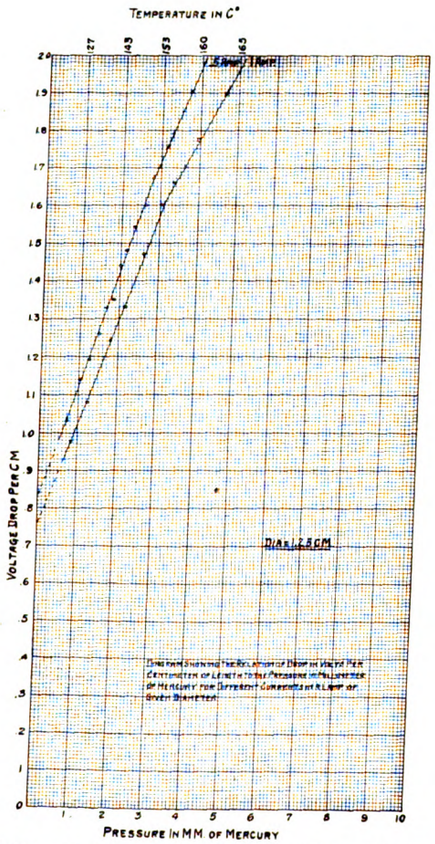


DROP IN VOLTS PER CENTIMETRE OF LENGTH TO THE PRESSURE IN MILLIMETRE OF MERCURY.



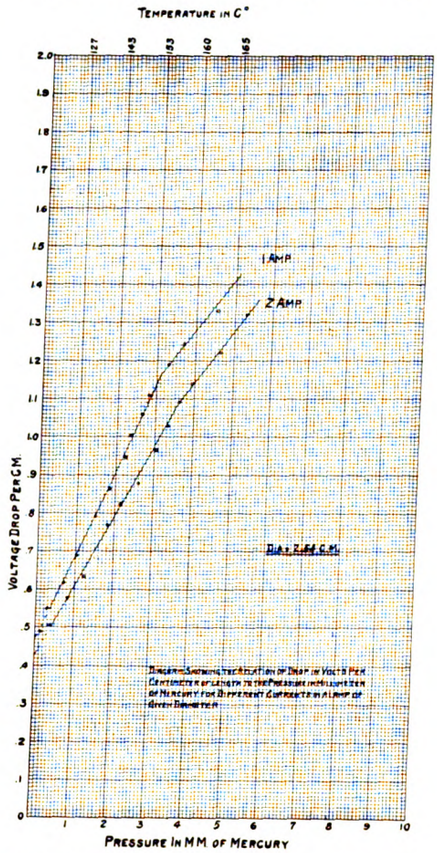
RELATION OF DROP IN VOLTS PER CENTIMETRE OF LENGTH TO THE PRESSURE IN MILLIMETRE OF MERCURY FOR DIFFERENT CURRENTS IN A LAMP OF GIVEN DIAMETER.

It was possible to obtain voltage measurements at the temperatures desired. When a required temperature was obtained internally and externally, the current was started through the lamp by the starting device, and was controlled by an external resistance and measured by a Weston ammeter. Immediately after starting the current, the reading of the Kelvin voltmeter was taken. There was sufficient time to obtain these readings accurately before the current materially altered the vapor density.

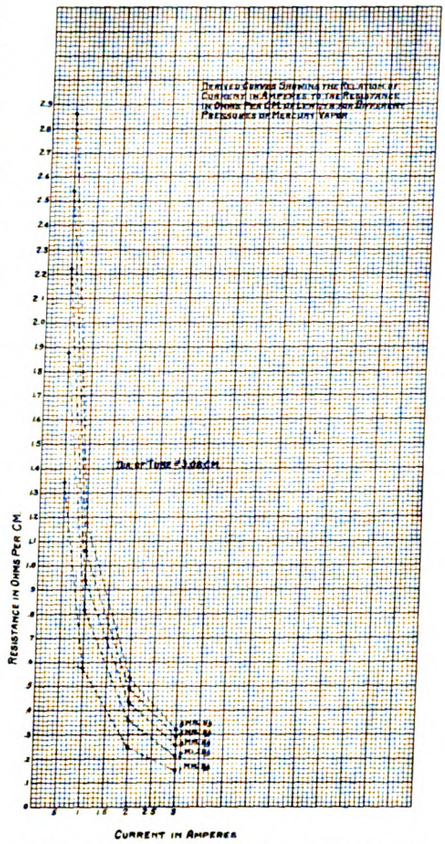
The lamps contained some mercury and were exhausted with great care until nothing but mercury and its vapor were present. The size of the tube used for the lamp limited the diameter of the conducting vapor column, and its diameter is the diameter given in the diagrams.

The relation of the pressure of the saturated vapor to the temperature was deduced from the observations of Ramsay and Young; the density is proportional to the pressure. The walls of the lamp being covered by small globules of mercury and a large amount of mercury being present at the bottom of the lamp, the vapor was considered to be in a state of saturation.

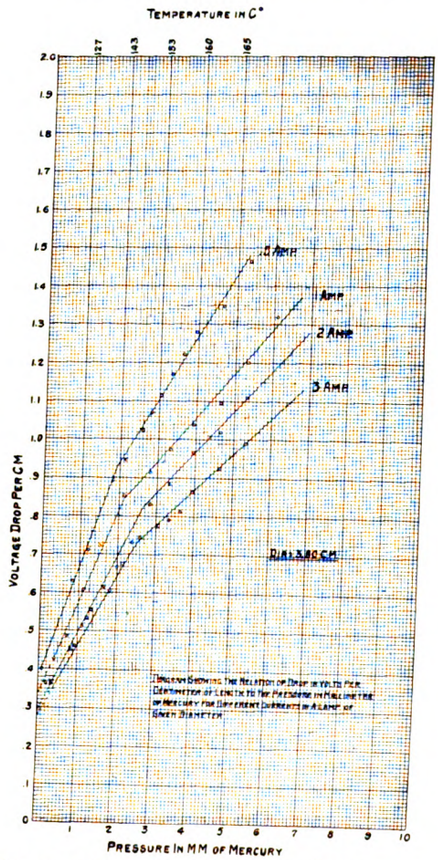
The points on the curves indicate actual readings; the drop in volts and temperature were observed. In most cases the



RELATION OF DROP IN VOLTS PER CENTIMETRE OF LENGTH TO THE PRESSURE IN MILLIMETRE OF MERCURY FOR DIFFERENT CURRENTS IN A LAMP OF GIVEN DIAMETER.



DERIVED CURVES SHOWING RELATION OF CURRENT IN AMPERES TO THE RESISTANCE IN OHMS PER CENTIMETRE OF LENGTH FOR DIFFERENT PRESSURES OF MERCURY VAPOR.



RELATION OF DROP IN VOLTS PER CENTIMETRE OF LENGTH TO THE PRESSURE IN MILLIMETRE OF MERCURY FOR DIFFERENT CURRENTS IN A LAMP OF GIVEN DIAMETER.

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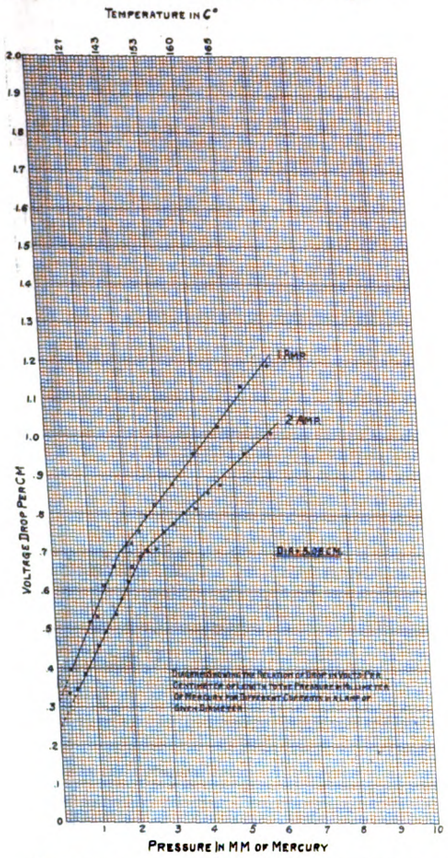
experiments were repeated many times with different lamps, and with the same lamp reexhausted in order to be certain that only mercury vapor was present in the lamp, since the presence of a small amount of another gas will cause considerable variation in the measurements. For instance, on admitting a different gas into a lamp containing a pure gas, the effect may be observed by the measuring instruments.

The diagrams show the influence of density, diameter and current on the drop in volts per unit length. From them can be deduced the resistance, as a function of the density, current and diameter. They show that the voltage required to maintain an electric current in a gas or

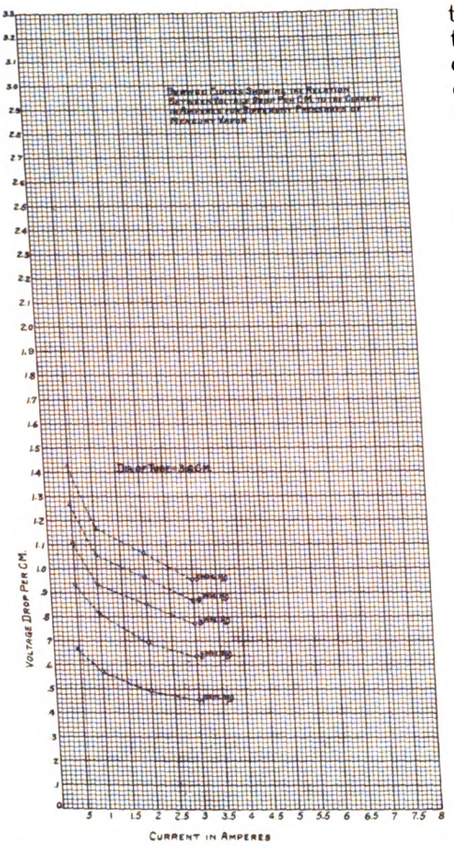


Relation in Volts per Centimetre of Length to the Pressure in Millimetre of Mercury for Different Currents in a Lamp of Given Diameter.

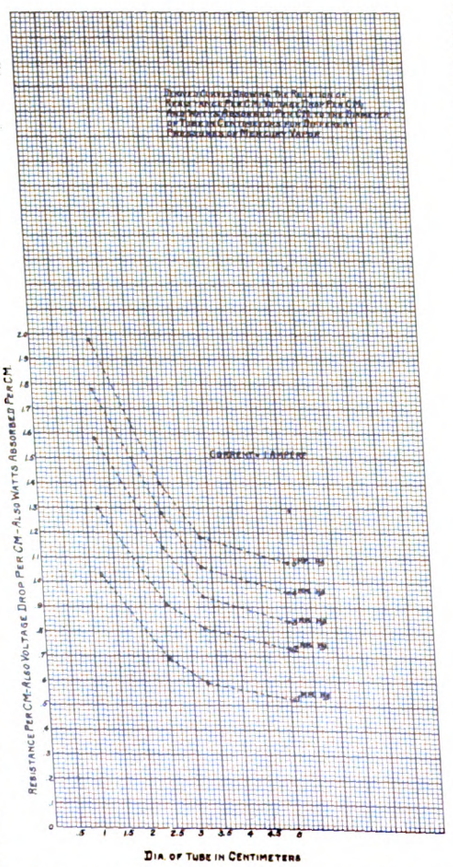
vapor is directly proportional to the density and that it decreases as the diameter of the lamp increases. The resistance decreases with increase of current. From the diagrams, relations among the diameter, density and current may be established.

The current assumes a definite cross-section for a given density and current when not restricted by the lamp; this cross-section increases with increase of current and decreases with increase of density. The angles in the curves shown may be due to these effects, but this point needs further investigation.

The light efficiency of mercury vapor varies with the density; there is a density of maximum light efficiency. On passing current at a very low density practically no light is visible and the drop in volts for the same current is less



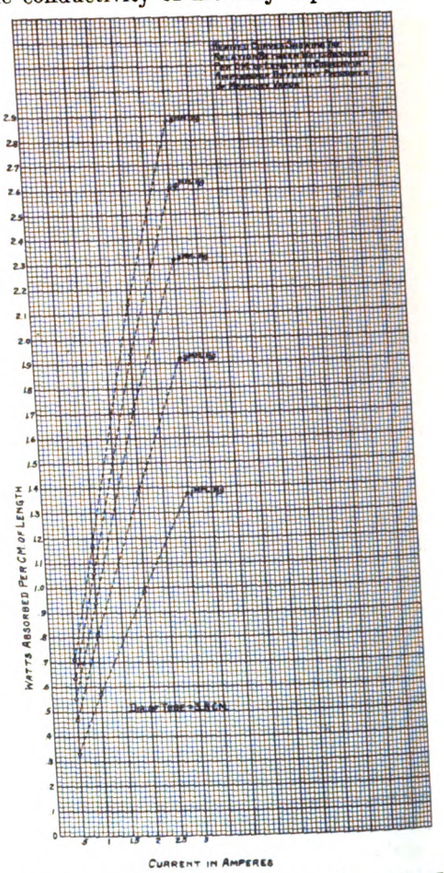
Derived Curves Showing the Relations between Voltage Drop per Centimetre to the Current in Amperes for Different Pressures of Mercury Vapor.



Derived Curves Showing Relation of Resistance per Centimetre, Voltage Drop per Centimetre, and Watts Absorbed per Centimetre.

than at greater densities. At greater than a certain limit the light efficiency decreases. If another gas is present with mercury vapor, the current is usually selective and gives the spectrum of mercury vapor, but the resistance is materially altered. The effect of magnetic force transversely applied at low densities is very marked, and is that of increasing the resistance in an extraordinary degree, while at higher densities it increases the resistance but little. Magnetic force alters the spectrum, particularly at low densities.

The experimental curves speak for themselves; the conclusions which may be drawn with respect to the relation of the conductivity of mercury vapor to the



Derived Curves Showing the Relation between Watts Absorbed per Centimetre of Length to Current in Amperes for Different Pressures of Mercury Vapor.

physical conditions under which the electrical current through the vapor is maintained appear to be, broadly speaking, generally true for all gases and vapors. It is not necessary to enumerate here all these conclusions, for they are sufficiently evident on the face of the curves, but some derived curves are given which have been deduced from the curves obtained by direct experiment. They are marked in the diagrams as derived curves. There is one conclusion, however, which from a purely technical point of view deserves special attention. It is this:

When a given vessel containing mercury vapor is to be employed as a source of light, that is as an electric lamp, the highest light efficiency will be obtained when the vapor density and the current employed have a definite and fixed relation.

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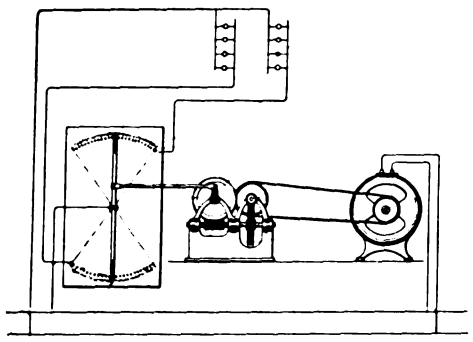
Electrical Patents.

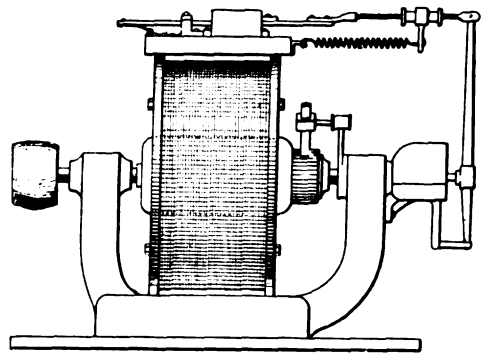
Means for operating electric signs is the subject matter of a patent granted to William Goltz, of Chicago, Ill. It is the object of Mr. Goltz in the present invention to employ means for operating the lamps without breaking the circuit, thus eliminating all injurious sparking. · Another



DIAGRAMMATIC VIEW SHOWING ARRANGEMENT EMPLOYED FOR OPERATING ELECTRIC SIGNS.

feature is the provision of means whereby the lamps of an electric sign may be suddenly fully illuminated, and remain at full illumination long enough to be read and then suddenly darkened. A motive source, preferably a motor, connects by means of a belt with a train of reduction gearing, consisting of a pulley, carrying a belt, a worm, mounted on a common shaft with the pulley and engaging a worm-wheel, a second worm on a common shaft with the worm-wheel, and another worm-wheel engaged by said second worm, all mounted in suitable bearings. A crank mounted in common with the second worm-wheel transmits oscillatory motion to a contact lever on a dimmer by means of a connecting rod. The lever is pivoted at its centre, its ends being adapted to travel over resistance terminals. The connecting rod so engages the lever that as the crank revolves said lever will oscillate between the limits of resistance terminals. The high rate of revolution of the motor may thus be reduced to any desired rate of oscillation of the lever on the dimmer, controlling the illumination of the lamps on the sign. When the lever is at the ends of oscillation, the lamps are either dark or at full candle-power, and the connecting-rod-bearing centres and the crank-shaft centre will lie in the same plane. The crank end may move a considerable distance either side of this plane without causing enough motion of the lever ends to perceptibly affect the illumination. In fact, it may be said that the lever ends have harmonic motion. If it is desired to have full candle-power illumination continue a greater length of time, the corresponding end-resistance terminal may be lengthened to give prolonged or lingering contact.

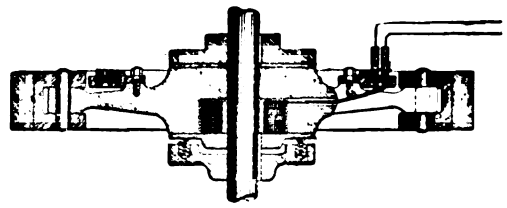
Mr. Alexander J. Churchward has obtained a patent on an alternating-current motor, the general object of which is to provide for the efficient operation and the ready control of such motors. The invention is designed especially for use with motors which have any usual direct-current armature winding and commutator and may be operated by feeding alternating currents to the commutator and field simultaneously, the field coils being preferably in series with the armature. The invention consists essentially, in the combination with the machine, of a transformer supplying alternating currents thereto and suitably wound to permit its voltage to be regulated through the medium of suitable switch devices that serve to throw in windings of the transformer to give an excess voltage at starting and afterward to throw out said windings and thereafter control the speed by preferably throwing out windings of the transformer and reducing the voltage supplied thereby when the speed rises above the normal or desired working speed and throwing in windings and increasing the voltage when the speed falls below such normal speed. The switch devices may be worked by hand or may be controlled by speed-responsive devices which act in accord with the speed of the armature. A suitable device for the purpose is a centrifugal



SHOWING A FORM OF MOTOR AND REGULATING MECHANISM.

governor. When a motor having a direct-current armature and commutator is operated by a single-phase current and run in synchronism with the alternating-current supply, the armature becomes in effect a constant field excited by the direct current flowing in the armature coils. The poles of the field magnet will act practically as a revolving field to rotate the armature. Operated under this condition there is no appreciable loss by hysteresis in the armature or by self-induction in its wires, and if this condition may be preserved the machine may be operated with high efficiency. The present invention permits this to be accomplished by varying the winding of the transformer which supplies the current to the machine, so as to increase the voltage if the speed falls below the synchronous speed and to decrease it if the speed rises above such speed.

Alexander Churchward, of New York, N. Y., has obtained a patent on an anti-hunting device, which he has assigned to the General Electric Company, of Schenectady, N. Y. The invention relates to certain improvements in anti-hunting devices for use in connection with synchronous motors, rotary converters, or in any other relation where such a device is desirable, and comprises various novel features. Mounted upon the shaft of the machine with which the anti-hunting device is to be used is a flywheel, which, against the opposition of a frictional resistance, is permitted to move relatively to the shaft. This frictional resistance, attendant upon relative motion between the shaft and flywheel, is the factor which damps out the hunting tendency of the shaft. To secure this frictional resistance to motion of the flywheel relatively to the shaft, the wheel is mounted so that its hub is yieldingly pressed between two friction discs. One of these discs, which may be of wood, fibre or the like, is held between the hub and a flange, keyed or otherwise secured to the shaft. The other disc is pressed against the hub of the flywheel by springs, placed between said disc and another flange, keyed or otherwise securely fixed to the shaft. This latter disc is splined upon the shaft, so as to be capable of a slight longitudinal movement thereon, but incapable of rotation about the shaft. Located within a recess in the hub of the flywheel is a magnetizing coil which is supplied with current from collector rings upon which bear brushes to which current is conveyed by means of leads. The friction between the flywheel and the parts between which it is yieldingly clamped is sufficient under ordinary conditions to prevent hunting of the machine to which the device is connected when the machine is running normally. When starting up the machine from a state of rest, however, this friction is insufficient to bring the flywheel up to speed as quickly as the driving machine comes up to speed. Under ordinary circumstances the flywheel requires a considerable time before it reaches a speed of rotation synchronous with the driving machine, during which interval the machine is apt to hunt or pump to a very inconvenient extent. By exciting the coil with current one of the discs, which is of magnetic material, is urged strongly against the hub of the flywheel by magnetic attraction and constitutes a stiffly yielding



SECTION OF ANTI-HUNTING DEVICE.

if not rigid connection between the flywheel and the shaft upon which it is mounted. The flywheel is thus brought up to speed as quickly as the shaft which drives it, thereby preventing the initial pumping of the driving machine. It will be evident that by adjusting the amount of current in the exciting solenoid the friction between the flywheel and the shaft may be adjusted accordingly, and this may be readily performed while the device is in normal operation in case adjustment for any reason is then desirable.

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Reviews of Current Engineering and Scientific Literature.

Electric Lighting System of Fulda, Germany.

An interesting electric lighting station, operated by a windmill, is in service at Fulda, Germany, and is here briefly described by Herr F. Schneider. The windmill is of American make, twelve feet in diameter, and drives directly a four-pole dynamo at 300 revolutions per minute. The output of the dynamo is eighteen amperes at forty volts. It is used to charge a storage battery consisting of fifteen Polak cells. The voltage of the system is thirty. The lamps are connected directly to the circuit, and are twenty in number, all of them being osmium lamps. No automatic regulator controlling the dynamo is employed, the only instruments on the switchboard being a voltmeter and an ammeter; nor is there any method of regulating by hand the voltage of the system. The osmium lamps support very well such differences of voltage as are produced by the fifteen batteries between charge and discharge. The energy consumed by the lamps is not large. In spite of the irregular operation of the windmill, the plant works satisfactorily, requires little attention and was inexpensive.—*Translated and abstracted from the Revue l'Électricité (Berne), November* 15.

Swinburne's Electric Locomotive.

A method of driving electric locomotives, relating more particularly to the use of constant-speed motors, has been developed by Mr. James Swinburne, of Westminster, England. The rotor of the motor is mounted on the driving shaft which drives the driver wheels by means of coupling rods or other mechanism. The other element of the motor, which, under normal operation would be the stator, is mounted so as to be free to rotate in the opposite direction, and in rotating works an oil water pump of variable stroke. The liquid under pressure is led to a second set of pumps or engines which work on the axle of the driving wheel, and which also have a variable stroke. By varying the strokes of the pumps, the speed of the locomotive may be varied continuously from starting up to full speed, while the motor elements move at the same speed relatively to each other. At standstill the armature of the motor is stationary, the other element rotating at full speed backwards, while at full speed the latter is stationary with respect to the car. The stroke of the pumps is varied by means of eccentrics, which in one position give no throw; and the opposite, a throw double the combined eccentricity.—*Abstracted from the Mechanical Engineer (London), November* 28.

The Heating Effect of Radium Emanation.

When Rutherford and Barnes described their experiments, in which they attempted to determine the source of the energy which radiates heat from radium salts, Mr. Arthur Schuster disagreed with their conclusion, that the energy was set free during the several stages of disintegration of radium atoms. He thought that the effect should be attributed to the secondary radiation set up by the emanation, and he has made preliminary experiments to test his view. Air charged with a radium emanation was led through a tube containing a terminal junction formed by iron and nickel wires. The junction was left charged to a high negative potential during ten minutes; then taken out and placed side by side with an unexposed junction in a metal vessel kept at a constant temperature. The two junctions seemed at first to be at the same temperature, but the exposed one began to become warmer almost immediately, and after twenty minutes, was about one-tenth of a degree above the other. The test was repeated with the same result, and it was shown that there was no accidental disturbance which could have caused it. The author draws the conclusion that it is the third or last stage of disintegration of the radium atom at which the excited activity finally disappears or becomes negative, which sets the energy free.—*Abstracted from Nature (London), November* 19.

Single-Phase Traction Experiments.

The Union Elektricitäts Gesellschaft, of Berlin, has been experimenting with a single-phase traction motor, and is now operating two trolley lines with this apparatus. The motor was designed by Herren Winter and Eichberg. On one of the lines referred to above, which runs through the company's yards, the motor is supplied with single-phase current at forty cycles per second, 600 volts. The car is equipped with two forty-horsepower motors, and the controller is similar to that used for direct current. By short-circuiting the motors, they may be used as an electric brake. The other line runs between Johannistal and Sindlersfeld, and is a part of the Prussian State Railways which was placed at the disposal of the company for the experiments. The line is 4.1 kilometres long, single track. Since August 1 last the trolley car has been in regular service. It is equipped with two 125-horse-power motors. Current is supplied at 6,000 volts, twenty-five cycles. The motors are connected permanently in parallel. The high pressure is applied only to the stationary part of the motors and to the exciting apparatus. Elsewhere pressure does not exceed 190 volts. For lighting purposes the pressure is reduced by a transformer to thirty-five volts, and the incandescent lamps used show no flicker. The characteristic curves show that the efficiency of the motor is about eighty per cent. The tractive and speed curves are very similar to those for direct-current motors, and the power-factor varies with the excitation, and can be brought nearly to unity. —*Abstracted from the Electrical Review (London), November* 27.

The Training of Apprentices in an Engineering Works.

The efficiency of any industrial enterprise is dependent upon the degree of intelligent familiarity with the nature of the product and skill of manufacture which is possessed by those employed in the operations necessary to fabricate the finished output. The methods adopted for training its employés by the Westinghouse Electric and Manufacturing Company are described here by Mr. C. E. Downton, who has had much to do with organizing and developing the system. Two classes of apprentices are recognized —the ordinary apprentice and the engineering apprentice. The first course of work is provided for young men without technical education who desire to learn the machinist's trade, the object of the course being to train the men who take this course as skilled mechanics and inspectors and foremen. This class of apprentices does not progress through the works from one section to another, for it is not intended to give them a general knowledge, but, rather, a specific training in the manufacture of a definite line of work. Each section is practically a complete machine shop, and when the young man completes his course, he is able to handle any of the machine tools

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there used. After three months of probation the apprentice is allowed to become indentured. The entire course lasts four years, and at its completion the graduate is given a gratuity of $100 and a diploma. The compensation varies according to the man's age and the time served, from five cents to fifteen cents per hour. The engineering apprenticeship provides for young men who are graduates of technical schools. This course lasts two years, sixteen cents per hour being paid for the first year, and eighteen cents for the second. A trial term of three months is required. Men who take this course are watched most carefully. Constant vigilance is being exercised to discover those who show exceptional appreciation of the work. It is not attempted to make the engineering apprentice a skilled mechanic, but to acquaint him with shop and manufacturing methods and operations. The apprentice is shifted from one department to the other, the time spent in each depending upon the man and the importance of the work.—*Abstracted from the Engineering Magazine (New York), December.*

Concerning Wireless Telegraph Transmitters.

One reason why various attempts made to approximate the resonance in wireless telegraphy have had so little practical result is due, according to Dr. Lee de Forest, to the insufficient attention that has been shown to the necessity of generating at the transmitter a long train of but slightly damped oscillations. The failure to do this has been due largely to imperfect arrangement and construction of condensers, to the spark-gap and faulty insulation in the transmitter. Rapid damping of the transmitter oscillations is due to two causes—first, losses due to radiations from the antenna, which are considered useful and necessary; and, second, losses resulting from leakage, heat and dielectric hysteresis. To prevent leakage, the antenna should be most carefully insulated from the supporting mast. A petticoat insulator giving a large and dry surface should intervene between the wire and its support. Dust and moisture are fatal to good insulation. If the air is moist, invisible brush leakage from the antenna gives the effect of a large fictitious capacity between the antenna and earth, greatly increasing its natural period of oscillation of the antenna and throwing the sending apparatus out of tune. This apparent capacity, moreover, represents a large energy loss not recoverable, and produces additional damping to the oscillation. The brush leakage, which takes place from the edge glass condensers in air, causes an apparent increase in the capacity. This leakage acts as buffers for an impulsive high-potential charging of the condenser, and thus saves the dielectric from puncture, but produces great damping, and should not be allowed. There is also an appreciable inductance in a battery of Leyden jars, when these are connected up as closely as possible. The author recommends arranging the jars in a circle, with connecting wires of equal length. This allows the battery to discharge as a unit. The heating of the spark-gap indicates that a loss of energy takes place there; and the wider the gap, the greater the loss. To reduce the gap, while maintaining the requisite high potential, a series of small gaps between balls or discs of small curvature may be used. With a one-kilowatt transmitter it is easily possible to obtain a reading on a hot-wire ammeter inserted in the antenna, of over two amperes, and five to ten times as much in the closed oscillating circuit itself. This, with 20,000 volts applied at the condenser jars, gives, roughly, a calculation of about seventy kilowatts. This nominally is explained by the fact that, during a brief hundred-thousandth of a second, the energy put into the circuit at a one-kilowatt rate is radiated at a rate enormously greater. The test is a clear and convincing demonstration of the enormous quantities of energy which a small transmitter is radiating, and of the amount which the generator would be called on to supply, could the much-desired undamped wave train be obtained. In view of the above considerations, it is not difficult to point out the fallacy of certain calculations which are often given to show the sensitiveness of a coherer or other wave detector.—*Abstracted from the Electrician (London), November 27.*

Switches for Opening High-Potential Circuits Under Load.

Several types of air-break switches have been developed in Europe for use in opening a high-potential circuit under load, without the formation of a destructive arc. When an arc is formed between two points, much heat is evolved; but if the arc can be prevented from maintaining a fixed position, the switch contacts are not heated sufficiently to be damaged. Therefore, a switch which will cause the arc to shift its position continuously until broken will not be damaged if the circuit is open while current is flowing. To accomplish this a switch may be designed upon the principles of the Siemens diverging horn lightning arrester. Thus, if two curved arms, arranged to have their upper ends diverging, are placed so that they can be brought in contact or separated, they will form a very effective high-tension switch. The simple action of separating the two arms by rotating either one or both of them about their lower extremities, opens the circuit and forms an arc, which, due to the tendency of the heated column of air to rise, is shifted upward along the diverging ends of the switch arms until it breaks. This principle has been used by Voight & Haeffner. The switch, in its final form, consists of a bell crank switch arm, having at one end a wooden operating rod, and at the other end an upwardly projecting horn. This arm is mounted upon an insulator, and, when lowered to a horizontal position, makes contact between the terminals of the line, which are supported upon two other insulators. One of these has a contact strip, which preserves contact with the arm throughout its motion, while the other has a strip extending vertically, which forms the other one of the pair of horns. Another type of switch, made by Schückert & Company, consists of two stationary diverging horns separated some distance. Contact is made between these by a metal rod bent into the form of a delta, which may be moved in a vertical direction. When it is lowered it opens the circuit on each side, forming two arcs between two pairs of diverging horns. Still another type of switch, made by Kummer & Company, consists of a pair of switch jaws, upon which are mounted two long, flexible contact pieces. When the jaws are separated by an arrangement of levers, the contact pieces are brought together and engage. As the jaws are moved apart, the two strips bend until, at a certain point, they slip by each other, making a very quick, long break.—*Translated and abstracted from the Elektrotechnischer Anzieger (Berlin), November 19.*

The Committee on Steam Turbines of the National Electric Light Association.

The National Electric Light Association's committee for investigating steam turbines, of which Mr. William C. L. Eglin, of Philadelphia, is chairman, has already accumulated a large amount of very valuable data on steam turbines, and will publish in its report a full description of the turbines manufactured in this country; it will also publish expressions of opinion from some of the leading European engineers concerning the use of the steam turbine and the field it occupies in Europe. This report will be quite voluminous, and will undoubtedly give more interesting information than has yet been published. It is the expectation of the committee that this report will be in the form of a bound volume prepared for distribution at the twenty-seventh convention of the association, to be held in Boston in May.

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INDUSTRIAL SECTION.

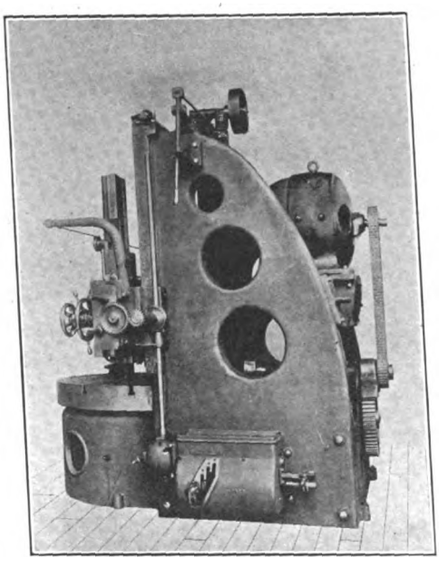
ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Fifty-one-Inch Boring and Turning Mill with Motor Drive.

Boring mills, for one reason or another, have seemed to present more difficulties in the way of a favorable application of individual motor drives that almost any other class of machine tools. Heretofore nearly all the designs that have been advanced have placed the motor outside of the machine, where it occupied useful floor space. Even when it has been mounted upon the frame it has usually been in a protruding position, or where it was not easily accessible, or was an obstruction to the accessibility of other important parts. The arrangement illustrated herewith is one of the latest and most satisfactory schemes yet devised, as it overcomes or compromises on most of the former objections.

The tool represents a fifty-one-inch boring and turning mill as built by the Baush Machine Tool Company, of Springfield, Mass., and the motor the Crocker-Wheeler fifteen-horse-power semi-enclosed form I machine. The drive is communicated to a modified cone pulley shaft through a Renold silent chain, two and one-half inches wide, with a speed reduction of 3 to 2. There are further three gear changes, the total reductions of speed for each from motor spindle to table being 14 to 1, 45 to 1 and 98 to 1, respectively. With either gear combination the motor, which is supplied with current on a four-wire multiple-voltage system, is capable of twenty-one speeds in either direction, varying from 1,065 to 106 revolutions per minute. It is not intended, however, to use motor speeds lower than those necessary to give the table the same speed that the next slower gear combination would allow at top motor speed, except on the slowest combination, as it would entail a sacrifice in power. At the highest speed of the motor the fastest speed of the table is 76.3 revolutions per minute, and the slowest, 10.9, or with the lowest motor speed the slowest possible speed of the table is one revolution per minute.

The tool has a capacity for swinging work fifty-one and one-half inches in diameter and forty inches high. The face-plate is fifty-one inches in diameter and is unusually well supported, having an outer bearing on the under side nearly equal to its diameter and another under the centre on the outer edge of the spindle. The height of the face-plate from the floor is thirty inches and the diameter of its spindle ten inches. A hole through the centre of the latter allows the chips to fall under the mill, from where they may be easily removed. In place of the face-plate, a combined independent and universal chuck may be substituted, the two being made interchangeable. The distance between the uprights is forty-six and one-half inches and the traverse of the tool is twenty-four inches. By the manipulation of the lever seen near the top of the machine, the cross-rail may be raised and lowered by power without revolving the face-plate. The cross-rail is deeply arched with double-walled back and large wearing surfaces. The saddles are



FIFTY-ONE-INCH BORING AND TURNING MILL, WITH MOTOR DRIVE.

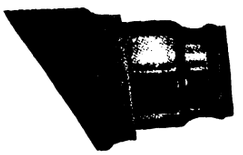
attached to steel feed screws by split nuts which can be opened and a rapid movement obtained by rack and pinion engaging a steel rack on the cross-rail. For feeding and thread cutting the saddles are arranged with Hendey-Norton gear-changing device, by means of which fifteen positive rates of feed can be obtained on each saddle, both vertical and horizontal, and the changing can be made instantly, while running.

Strength, compactness and rapid producing capacity are prominent features of the tool as equipped in the manner described. The one illustrated is installed in the Pittsburg & Lake Erie Railroad shops, at McKees Rocks, Pa., where nearly all the machine tools have individual motor drive and those requiring various speeds are supplied on the Crocker-Wheeler multiple voltage system of current supply.

Angle Wall Sockets.

The Marshall-Sanders Company, Boston, Mass., has just put upon the market a line of angle wall sockets, one of which is shown in the accompanying illustration.

These goods are made by the well-known automatic process of the Marshall-Sanders Company and embrace all the well-known forms of sockets, Edison,



ANGLE WALL SOCKET.

T.-H. and Westinghouse bases; key and keyless.

The Marshall-Sanders Company has an abundant stock on hand for immediate delivery.

The Susquehanna Development.

It is announced that Mr. Anthony N. Brady, of New York, and associates have taken over $1,000,000 stock in the United Electric Light and Power Company, of Baltimore, Md.

Plans for the power plant at Conowingo, on the Susquehanna, have been completed and routes for the cables to Baltimore, Havre de Grace, Elkton and other towns in Maryland, Pennsylvania and Delaware. This new interest is expected to assure an early completion of the power project.

BOOK REVIEW.

"Care and Handling of Electric Plants." Norman H. Schneider. New York. Spon & Chamberlain. Flexible leather. 116 pages. 4¼ by 6¾ inches. 66 original drawings. Supplied by the ELECTRICAL REVIEW at $1.

This manual is intended as a handbook of practical information for those who are called upon to operate a commercial or military electric plant without having had previous experience. It is written with the aid of notes actually obtained in handling the apparatus described. The author calls particular attention to the chapter on incandescent lamps, as this subject is fully taken up.

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High-Potential Oil Switches.

The increasing use of high potentials has presented many serious problems in switching and the protection of the generating apparatus from dangerous overloads. The oil-break type, in which the switches and all live metal parts are immersed in oil, is generally conceded to be the best form of switch for handling high voltages, and a recent development of this type, designed by the Hartman Circuit-Breaker Company, of Mansfield, Ohio, is shown in the accompanying illustration.

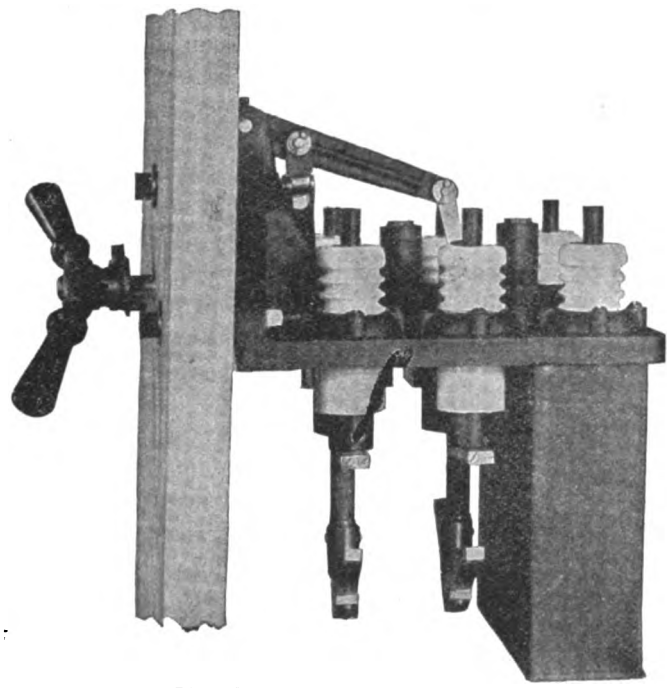
This is a view of a three-pole, double-break oil switch designed for installing on the back of the panel, and to be used on circuits up to 11,000 volts. The view shows the switches in the "off" position, with one of the switches enclosed in an oil tank. Each pole of the switch is immersed in a separate tank, which is entirely independent of the adjacent ones and can be readily removed without in any way interfering with the others. The tanks are lined with insulating material which is formed in such a way that there is just sufficient space for the free vertical movement of the switches, and the quantity of oil used is thus reduced to the minimum.

A distinct feature in this oil switch is found in the use of the laminated or brush form of contact, which greatly increases the current-carrying efficiency of the switch and also entirely prevents "freezing" or sticking at critical periods. These contacts are protected by final arcing plates, which, with the corresponding plates on the terminal blocks, are removable and can be readily replaced should they become burnt away in the course of time. The form of contact which is used and the isolation of the switches in separate compartments give the switch a very large breaking capacity.

The movable parts of the switch are controlled by means of specially treated wooden rods, which are fastened at their upper ends to a common cross-bar. They are held in normal position by means of a toggle lock. The switch is opened by giving the handle a slight turn in the direction opposite to that taken in closing. This will cause the toggle to move past the centre and the switches will then open free of the controlling handle—producing an absolutely quick break.

Another form of this switch is made with an automatic overload attachment. There are usually two tripping coils provided for a three-pole breaker, but it can be constructed with a tripping coil in each line. In all cases the operation of any one tripping coil will break all lines. The distinctive feature of this overload attachment lies in the fact that the tripping coils are energized by current from the high-potential circuit, and the use of series transformers in connection with the circuit-breaker is entirely avoided. The tripping coils instead of being located on the front of the panel, as is commonly the case, are mounted by means of special porcelain insulators on the carrying-frame itself. They are separated from each other by barriers of insulating material, and the method of insulation throughout is of the highest order. The overload attachment has other distinctive features, one of the most important of which is that it can not be held closed while an overload exists on any line.

This apparatus is also constructed with remote electrical control, to be installed apart from the switchboard and to be opened and closed from a distance. The operating current may be derived from the exciters, a storage battery or any convenient source of direct-current supply at from 110 to 500 volts. The remote control attachment is very reliable and it adds but little to the cost of the installation.

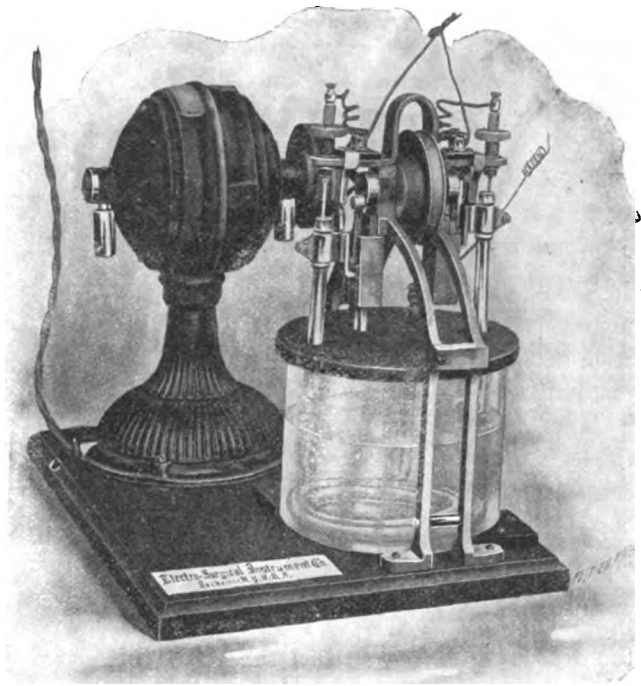


HIGH-POTENTIAL OIL SWITCH.

A New Current Interrupter.

A new current interrupter has been patented by Mr. T. A. Houghton, of Rochester, N. Y., who has assigned it to the Electro-Surgical Instrument Company, also of that city.

This interrupter is designed particularly to reduce the amount of current flowing through the coil to a minimum, giving, at the same time, heavy sparks on from one-quarter of an ampere to four or five amperes. The interrupter is double in all of its working parts, which are motor-driven, so that there is always an alternate action, the break being made at both the binding-posts and in the liquid, so that in one revolution of the shaft one wire is exposed to the liquid and another exposed to the mechanical break. The combination of the rapid mechanical and electrolytic action reduces to a minimum the current used.



A NEW CURRENT INTERRUPTER.

An important feature of this apparatus, the inventor states, is its ability to be operated very slowly, giving momentary surgings of current through X-ray tubes, and coming slowly to a maximum, then slowly receding to a minimum. For skiagraphic work it is stated that very clear negatives have been made with but five of these surges.

The interrupter can be used with other coils, and will take the place of a static machine for therapeutic work. It is also valuable in connection with transformers, making an efficient substitute for the rotary alternator used in transforming direct current into current suitable for cautery work, and providing a convenient means of regulating the current strength, taking the place of a rheostat and rotary alternator for this work.

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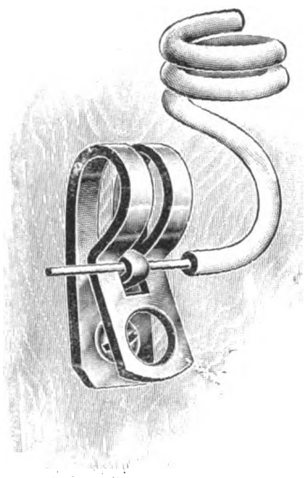
Spring Binding-Post.

The Fahnestock Transmitter Company, 74 Cortlandt street, New York city, is introducing a new form of binding-



NEW FORM OF SPRING BINDING-POST.

post, in which the set screw or screw nut is done away with and the wire is held by the action of a spring. This is shown in the accompanying illustration. The maker claims that with this construction the wire can not work or jar loose, and that contact is always ensured, because of the constant pressure exerted on the wire. The maker also claims that a wire can be connected or disconnected in one-tenth of the time it takes to set a screw-post, and that there is also no possibility of the wire being broken in the process of binding. The company is prepared to supply this post for all kinds of electrical work, including battery connections.

New Electric Lighting Specialties.

The Banner Electric Company, of Youngstown, Ohio, manufacturer of the "Banner" incandescent lamp, has recently placed on the market several new specialties. The accompanying illustrations show two of these. Fig. 1 is a new weatherproof cutout. Fig. 2 is a new floor box.

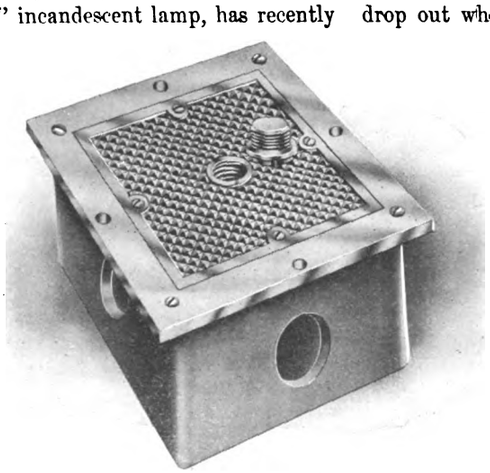


FIG. 2.—NEW FLOOR BOX.

The weatherproof cutout is an interesting device used principally in connection with alternating arc lamp service. The contact point can not be reached except by means of the fuse tubes shown, so that a heavier fuse than should be used can not be connected. In this way the lamp is protected from excessive current. The device can, however, be used in many other ways where some protection is needed and can be afforded by using fuses of fixed capacity. The base of this cutout

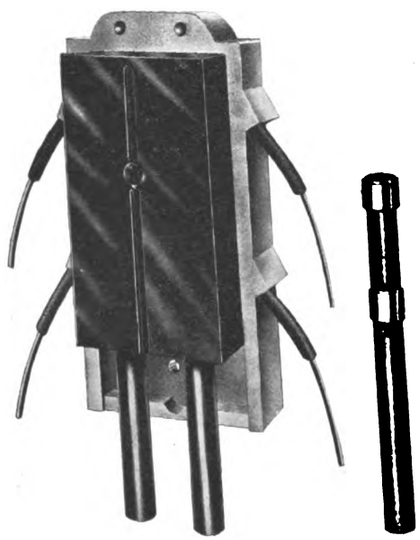


FIG. 1.—WEATHERPROOF CUTOUT.

is of glazed porcelain, and the contact points are round spring clips. The fuse tubes are of heavy hard fibre, carrying copper ferules, to which the fuses are soldered, the fuse passing through the side of the tube from one ferule to another.

The maker states that this arrangement is such that the fuse can not jar loose or drop out when inserted in the clips, and a good contact is always assured.

These cutouts are designed for 250 volts and any required capacity up to thirty amperes. The positive and negative poles are separated by a thick wall of porcelain, minimizing the possibility of short-circuit. The cover is of enameled galvanized iron bolted to the porcelain and cemented securely around the edges so as to be waterproof. The inleading wires are soldered to the spring clips.

The floor box shown is designed for conduit work, and is to be used by the new Government Bureau of Standards in its laboratory, which has recently been built at Washington. The lower part of the box is of cast iron, the cover being of polished brass. The centre field is finished in small, raised diamond-shaped figures. The centre plug screws in from the bottom of the plate, and when in place comes flush with the top side. A rubber gasket is used between the brass cover and the iron box body, so as to make it watertight.

An Elevator Alarm System.

The National Oil Burner and Equipment Company, St. Louis, Mo., is introducing a system consisting of a set of electrical alarms located on each floor of a building which are automatically sounded by a moving elevator in advance of and announcing the approach of the elevator, whether it is going up or down.

Three contact plates are fastened on or near to the guides of the elevator of such length and so placed as to sound the alarm the desired length of time and at the required intervals. The circuit is made by a roller contact with a spring on the platform of the car. The platform of the car is in connection with a thin cable, one end of which is carried on the car and the other end is stationary at a point midway between the extreme up and down position. From this point it is connected to a battery.

From the contact plates the guide wires are connected to the alarm bells. These are connected in turn to two more circuits which are alternately switched to the battery, as the car moves up or down. This switch is operated by the tiller rope, which by suitable levers throw the switch simultaneously with the reversal of the machinery. This system was designed by Mr. Joseph G. Branch, general inspector of boilers and elevators for St. Louis, Mo.

News comes from Brussels that the Belgian and the French governments have made an agreement relating to the establishment of telegraph communication between the Congo Free States and the French Congo. According to this agreement a submarine cable is to be laid at Stanley Pool which will connect the telegraph offices of Brazaville and Kinchassa. The cost of construction is to be borne equally by the two countries. It is proposed to use Morse registering apparatus in the two stations. The tariff is fixed at five cents a word with a minimum rate of twenty cents per message. The agreement stipulates that press despatches will pay only half rates.

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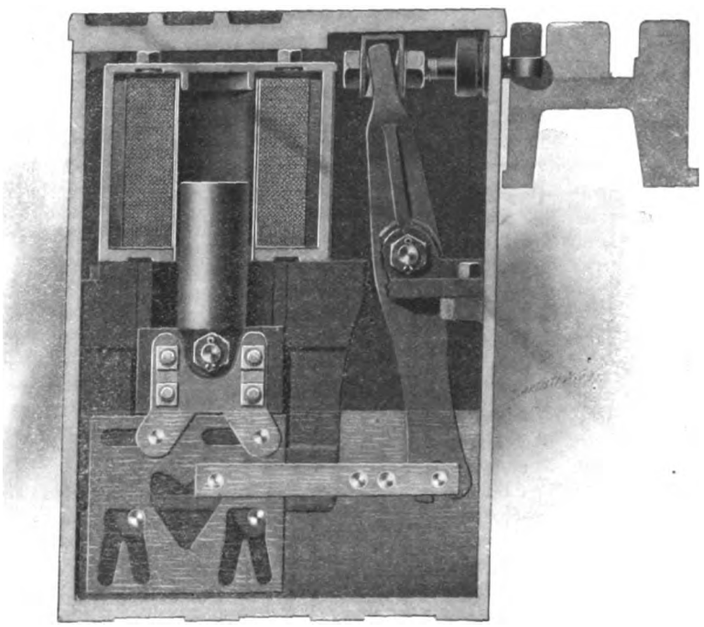
A New Automatic Track Switch for Electric Roads.

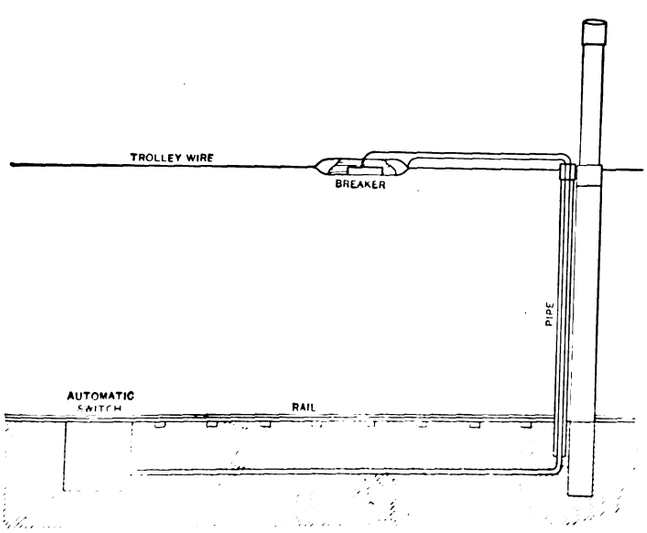
The American Automatic Switch Company, 120 and 122 Liberty street, New York city, has devised a new switch-operating mechanism for turning a railroad switch automatically. This, the company claims, is simple in construction, positive in operation, has no exposed contact points, no drainage to sewers, and no complicated mechanism. The accompanying illustrations give a good idea of the operation of the switch.



AUTOMATIC SWITCH MECHANISM.

The mechanism is enclosed in a sealed box, and the magnet is immersed in a special oil in a sealed case, giving it absolute protection from moisture.

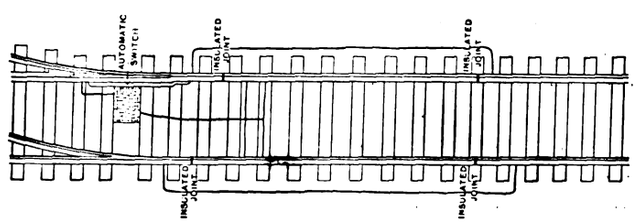
This automatic track switch is, of course, capable of being operated either with a trolley or rail installation. Where a trolley is used, a breaker is placed in the circuit, the current from the breaker actuating the electromagnet at the proper time. To operate the switch, the motorman must leave the controller at one or two points while passing over the breaker or the insulated rail, while if the switch is in proper position, the power is shut off and the car is coasted over the insulated rail or the breaker. A study of the illustration will aid in understanding the operation of the system.



TROLLEY CONNECTION FOR AUTOMATIC TRACK SWITCH.

The motorman brings his car to a point where it is possible to see whether the switch is in proper place for either continuing straight ahead or making a turnout. If the switch must be turned, he approaches the breaker with a small amount of power turned on, and this current flowing through the breaker actuates the electromagnet. The electromagnet pulls up the cam, which causes the switch to close, and the car proceeds. The next car along may wish to continue in the direction taken by the preceding car, and in this case the motorman cuts off power and passes over the breaker without actuating the electromagnet. The next car that wishes to change the direction repeats the operation of the first car, the switch being automatically opened or closed as the occasion demands.

There are no springs connected with the mechanism, the levers, cam and electromagnet being all there are to the apparatus. The manufacturer states that the switch has been in use on the system of the Metropolitan Street Railway Company, New York city, and has also been used by several other prominent roads, giving satisfaction in each case.



RAIL CONNECTION FOR AUTOMATIC TRACK SWITCH.

The Metric System.

Since the question of the metric system was discussed before the British Institution of Electrical Engineers last session, it has been debated with more or less vigor in many another assembly in different parts of the country. It is understood that a conference will be held in London at the end of the present month of representatives of local authorities who have come to a decision by resolution on the subject. The conference will be invited to appoint a representative deputation to meet the Board of Trade to discuss the question of the compulsory use of metric weights and measures in Great Britain.

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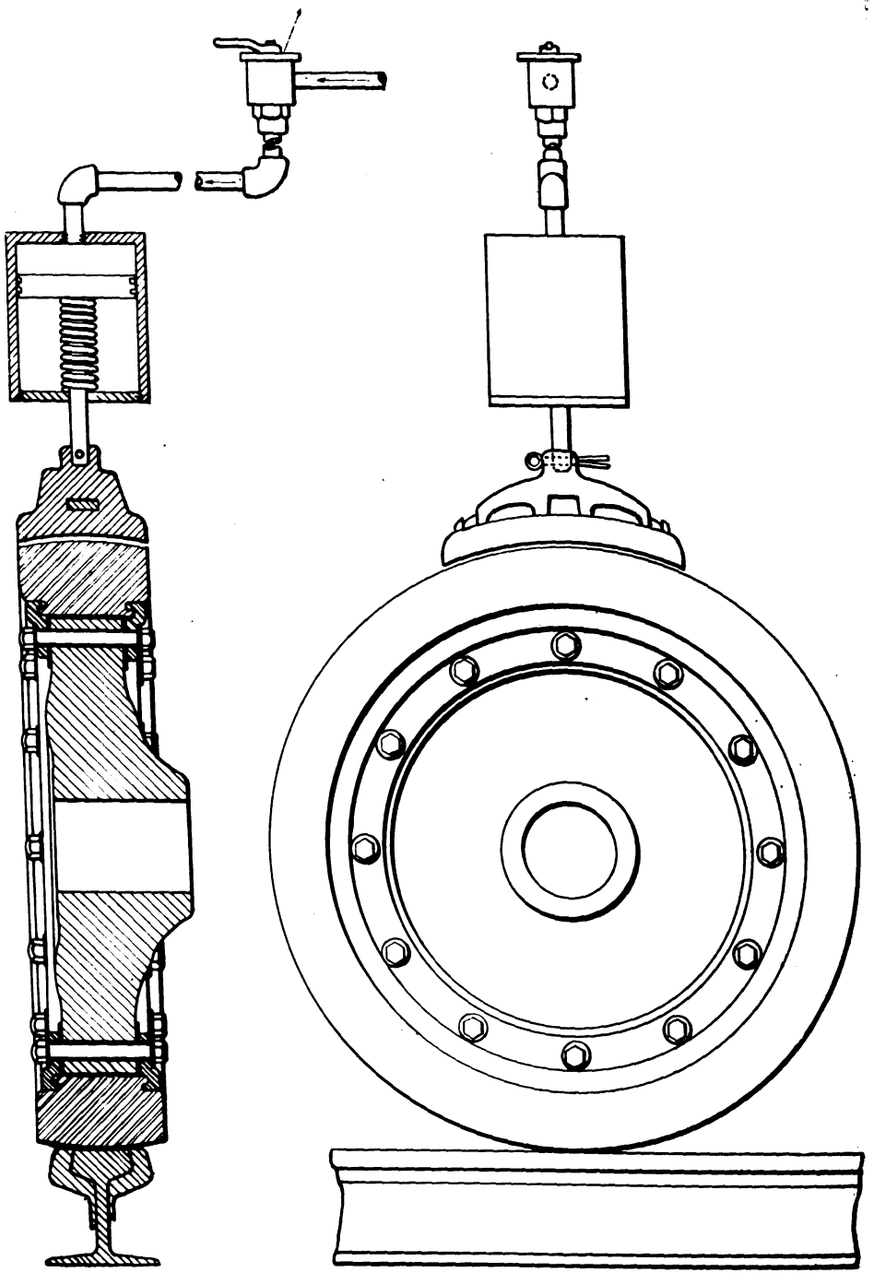
Sleet Cutter and Contact for Third-Rail Systems.

One of the difficulties in the operation of third-rail systems during the winter season has been the deposit of sleet and ice at the time of storm, this condition sometimes necessitating the tying up of the entire system under this contingency. Many efforts have been made to overcome this, and the accompanying illustration shows a device which has been placed on the market by the Kinsman Electric Railway and Supply Company, of New York city.

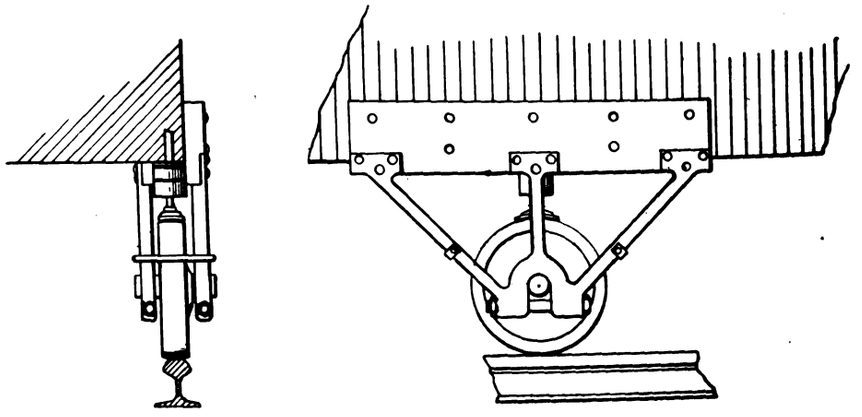
The Kinsman sleet cutter and contact for "third-rail" roads consists of an ordinary car wheel so constructed as to travel upon the "third rail" as an idler, except when under pressure from the air cylinder, controllable from the motorman's cab. The introduction of compressed air into this cylinder or electromagnetic controller forces a brake shoe carried above the wheel at the end of a piston rod (as shown in the accompanying cut) into contact with the periphery of the wheel. Upon a car traveling at ten miles an hour a given pressure from the cylinder retards the motion of the idler or contact wheel to, say, six miles an hour. The differential motion thus produced, grinds or strips the "third rail" of ice or any other obstruction, giving a clean surface for the following contact wheel or shoe. The wheel is fitted for different sizes of rail, as shown in the illustration, and has a wearing surface of three times its diameter, which in the case of a twenty-eight-inch car wheel is equivalent to something over eighty-four inches, the ordinary scraper has a wearing surface of from three to six inches, and can only be used with the pressure resulting from its own weight.

The Kinsman arrangement is very durable in that its flexible hanging and cushion effect of the air cylinder permits it to take a raised joint or other obstruction without injury.

Where the wheel is used only as a scraper a solid second-hand car wheel serves the purpose. Where it is used as a contact wheel as well as a scraper it needs to be insulated as shown in the accompanying illustration. Where it is found undesirable to put the responsibility for the pressure upon the motorman, it is regulated automatically by the amount of current the shoe is taking, as, for instance, a limited quantity of current allows the air valve to open, bringing full pressure upon the wheel. The amount of air entering the cylinder is decreased by a stronger current, partially closing the inlet, and at the same time permitting of a certain amount of escape. A substantial advantage is found in the absence of danger from flying pieces of metal as from other forms of cleaners.



SECTION AND ELEVATION, SHOWING METHOD OF APPLYING INSULATED RIM SLEET CUTTER.



A NEW THIRD-RAIL SLEET CUTTER.

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CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

HONOLULU RAPID TRANSIT—The Honolulu Rapid Transit Company, which operates an extensive electric traction system in Honolulu, Hawaiian Islands, has acquired the horse car lines hitherto operated by the Hawaiian Tramways Company—a British capitalized concern—and will convert a large portion of the road into electric motive power.

SOUTH AMERICAN POWER PLANT—The Ytu Light and Power Company is to construct a transmission plant for the purpose of supplying electric energy to Ytu, a small city in the state of Sao Paulo, Brazil, and surrounding districts. Contracts have just been placed in the market for various equipments. The plant will be located at a place called Cachveria das Larvas, about half a mile from Ytu.

LIGHT AND POWER MERGER—A merger of the electric lighting and power plants in the coke regions, and the Pittsburg, McKeesport & Connellsville Railway system, has been effected, and an application for a charter for the combined interests will be made at Harrisburg, December 31. It is said that the capitalization will be considerably over $5,000,000. The new company, which will be known as the Western Pennsylvania Railways Company, will be in control of the entire lighting, power and street railway systems of Westmoreland and Fayette counties, as well as part of the trolley system of Allegheny County.

LONG ELECTRIC RAILWAY IN MEXICO—An electric railway is to be built by an American syndicate between the cities of Guaymas and Chihuahua, a distance of 270 miles. It will commence at Guaymas and pass through the towns of Misa, San Marcial, Pesquerin, Ononas, Tuluaca and Temosachio, terminating at Chihuahua. It will cross three rivers, the Metape at San Marcial, the Rio Yaqui close to the city of Ononas and the El Rosario at Tuluaca. The object of building the road is to do away with the expense of mule trains. G. A. Albert, a former banker of Utica, N. Y., is chiefly concerned in the scheme. He is now on his way to Guaymas.

IMPORTANT TELEPHONE OPINION—All telephone companies doing business in Chicago can be compelled by the council to enclose in boxes or booths all public telephones in the city limits, even if the telephones are used for talks with persons outside of the city or state limits. The city has the right to pass an ordinance requiring the Chicago Telephone Company to return coins dropped in the slot unless the person calling succeeds in conversing with the person called for. These principles are laid down in an opinion drawn up by Assistant Corporation Counsel Maclay Hoyne, and approved by Corporation Counsel Tolman, for the judiciary committee. As to the nickel dropped into the slot, however, the law department advises the committee that the passing of a returning ordinance might end the city's right to further compensation from the company. This amounted last year to $85,000.

BIG SYSTEM OF TELEPHONES—One of the most extensive private telephone systems of the country has about been completed by the Carnegie Steel Company. This company for years has had all of its plants connected with the general offices in Pittsburg by its own telephones, and by this means has been able to keep all department heads in instant touch with the works. As the company passed to the control of the United States Steel Corporation and other companies, such as the National Steel Company, the American Steel Hoop Company and portions of the Union Steel Company were merged with it, the telephone system became purely local in its service and failed to give the heads of the various departments that same facility for directing that was had before. The recent arrangement of the company calls for the extending of the telephone wires not only to all local plants, but to all of the plants of the merged companies, and, in all cases, with a direct connection in the main telephone room in the Carnegie Building. This gives the company telephones of its own, extending through the Mahoning and Shenango valleys and to Sharon. Every plant, furnace and other feature of the big underlying corporation will be taken into the general service. Altogether there are over 1,000 telephones to be in the completed service, and miles of special wires have had to be strung for the system.

NEW TRACTION COMPANY IN INDIANA—The Vincennes, West Baden & Louisville Traction Company has filed articles of incorporation with the secretary of state. This is one of the most important traction ventures ever undertaken in Indiana. The plan is to build an electric and steam railroad from Vincennes to Jasper, Dubois County; from there to West Baden and ultimately to Louisville, Ky. The directors of the company are John L. Griffiths, of Indianapolis; A. Norvale, of Cincinnati; Bomar Traylor, of Jasper; Robert M. Gray, of Otwell, Pike County; John O. Davis, of Petersburg; George W. H. Roush, Edwin P. Millett and Thomas H. Adams, of Vincennes, and Elmore F. Cox, of Worthington. The company is capitalized at $1,500,000 and has been financed by the Municipal Bond and Securities Company, of Cincinnati, which firm is the fiscal agent of the enterprise. Eugene Calhoun, an expert traction engineer of Buffalo, has surveyed the proposed route of the road, and has made a fifty-page report to the promoters. In his report he says the scheme "presents the most attractive traction proposition in the country." The promoters of the line say it will open up 250,000 acres of coal lands in southern Indiana, and it is stated that three companies are ready to open mines as soon as the road is built. It is understood that a right of way has been secured between Vincennes and Jasper, a distance of about forty-three miles, and that work on the construction will be completed within ninety days. It is the purpose to build a track that will accommodate a steam locomotive, and one of the plans of the company is to some day haul freight trains over the line by steam. The directors of the company have organized at Vincennes.

LEGAL NOTE.

PENNSYLVANIA-WESTERN UNION DISPUTE GOES TO FEDERAL COURT—Way has been opened for the taking of the dispute between the Pennsylvania Railroad and the Western Union Telegraph Company to the United States Circuit Court of Appeals, and it is announced that this will be done immediately. This action has been made possible through an agreement of counsel for both sides, that there will be no more destruction of lines until the case has been decided. The Western Union company filed in the United States Circuit Court at Pittsburg an amended bill of complaint against the Pennsylvania company, in regard to its notice of termination of contract, given June 2, 1902, and expiring June 2, 1903. This bill complains particularly of the contract between the Western Union and the Pennsylvania companies for rights along the line of the Cleveland & Pittsburg Railroad. A demurrer to this amended bill was filed on December 2, and was sustained by Judge Buffington. A decree was also entered by Judge Buffington, dismissing the complaint. This placed the matter in regard to the Cleveland & Pittsburg Railroad and other of the Pennsylvania lines west in the same condition as the decision of Judge Acheson some time ago placed it in the suit of the Western Union company against the Pennsylvania Railroad Company, when all the poles of the telegraph company along the railroad's right of way were cut down. By the agreement of counsel, however, there was no radical action taken by the railroad, as it is desired by both sides to get a decision on the matter from the United States Court of Appeals. The decree entered by Judge Buffington places the matter in position to be taken to the higher court.

AUTOMOBILE NOTE.

ANNUAL BANQUET OF THE AUTOMOBILE CLUB OF AMERICA—On Saturday evening, January 23, 1904, the Automobile Club of America will hold its fifth annual banquet at the Waldorf-Astoria, New York city. The governors are in receipt of acceptances to invitations sent to several well-known speakers, and it is expected that all of the members will give their hearty support to this most important of the club's dinners. Mr. Homer W. Hedge is chairman of the house committee.

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ELECTRIC RAILWAYS.

ROANOKE, VA.—The Roanoke Railway and Electric Company and others are reported to be considering a plan to build an incline railway to the top of Mill mountain.

EVANSVILLE, IND.—A move is on foot to build a traction line from Tell City to Cannelton, a distance of four miles. Cannelton and Tell City capitalists are said to be back of this plan.

VINELAND, N. J.—It is said that a trolley line direct from this place to Bridgeton will be built in the spring. The line will connect Norma, Alliance, Rosenhayn and Carmel with Bridgeton and Vineland.

MARSHALL, MO.—Steps have been taken for the construction of a line of electric railroad from Sedalia to Miami by way of Marshall, a distance of fifty miles. The proposed road will traverse the best agricultural country in Missouri.

ATLANTA, GA.—The Birmingham Railway, Light and Power Company has put into operation its addition to the Powderly line, making a new electric route between this city and Bessemer and establishing a loop twenty-five miles around.

PENN YAN, N. Y.—The towns of Urbana and Pulteney have granted the franchise asked for by the promoters of the proposed electric railroad that is to run from Savona to Hammondsport, and thence along the west coast of Lake Keuka to Branchport.

VIRGINIA, MONT.—Eastern capitalists are said to be interested in a plan to construct an electric railway connecting this city and the Ruby valley with Dillon and the Oregon Short Line Railway. The cost of the project is estimated at $150,000, and it is said that work will begin in the spring.

SPRINGFIELD, ILL.—The secretary of state has licensed the incorporation of the Decatur Railway and Light Company, capitalized at $1,500,000, to operate a street railway, heat, light and power plant. This is said to be merely a reorganization of the Decatur properties owned by the McKinley syndicate.

SEA ISLE CITY, N. J.—Philadelphia capitalists are said to be interested in the construction of a line of electric railroad to run from Beesley's Point to Cape May City along the Seashore road, a distance of thirty miles. Another road will be built from this city to Millville, a distance of twenty-eight miles.

GLENS FALLS, N. Y.—The Hudson Valley Railway Company is about to install a new storage battery station at Caldwell. The building will be twenty-five by sixty-eight feet, and 267 cells will be included in the battery, with a storage capacity of 700 kilowatts. The cost of the plant will be approximately $20,000.

NORFOLK, VA.—At a meeting of the stockholders of the Chesapeake Transit Company, the capital stock was increased from $623,000 to $1,000,000. The company operates a trolley line from here to Lynn Haven Inlet, Cape Henry and Virginia Beach, and proposes to double-track the entire distance of twenty-four miles.

CONNERSVILLE, IND.—Local capitalists and business men are interested in the formation of a company for the purpose of promoting an electric belt line to include the towns of Laurel, Metamora, Brookville, Fairfield, Lyons Station, Milton, Bentonville, Glenwood and Orange, with the central station and power-house at Connersville.

SEYMOUR, IND.—The townships of Brownston and Driftwood have voted in favor of a two per cent subsidy for the Indiana Central Electric Railroad Company. The tax in the two townships will amount to about $30,000. In Vernon township, Jennings County, it was also voted to donate a two per cent tax aid to the Hubbard Yoder-Rominger interurban line from Columbus to Madison.

CHAMPAIGN, ILL.—Contracts have been let for the construction of the interurban line between Decatur and Springfield. The firm having the contract has just completed the work at Carlinville, on that part of the line between Springfield and St. Louis, and will move its men to a point near Decatur. Enough material is on hand to complete the road to Springfield, and work will continue all winter.

WASHINGTON, D. C.—About $80,000 has been subscribed for the new electric railway through Rappahannock and Culpepper counties, in Virginia, and it is now stated that the line will surely be built. It will start at Washington, the county seat of Rappahannock County, and will run to Culpepper, where it will connect with the Southern and Chesapeake & Ohio railways for this city. The line will eventually be extended along the Rappahannock river.

LITTLE ROCK, ARK.—The state railway incorporation board has granted the application of the Little Rock Nothern Railway Company for a charter, under which it purposes to build a railroad from Little Rock, Ark., to Springfield, Mo., a distance of 280 miles. The board of directors consists of Andrew Johnson, W. W. Dickinson, John M. Rose, Charles T. Coleman and H. M. Armistead, of Little Rock, and the company's authorized capital is $11,000,000.

WILMINGTON, DEL.—Officials of the Middletown & Odessa Railway Company state that the company will build a line down the state in the spring. The new line, as proposed, will pass through Townsend, Blackbird, Clayton and Smyrna, and later may run to points further south. After this extension is completed it is likely that the road will be connected with the New Castle & Delaware City line, making a continuous trolley road from Wilmington to Smyrna.

MOLINE, ILL.—A trust deed in favor of the Illinois Trust and Savings Bank, of Chicago, has been filed in the office of the circuit clerk by the Mississippi Valley Traction Company, to cover an issue of bonds in the sum of $600,000. The filing of the deed represents one of the early transactions of the new company in taking over the property of the Moline, East Moline & Watertown interurban road. The bonds are issued to cover the transfer and to provide a fund with which to carry on the plans of the new company to extend the present line of the Watertown interurban.

MIDDLEBORO, MASS.—The first corporation meeting of the Plymouth, Carver & Wareham Street Railway Company resulted in the election of the following officers: president, Henry S. Griffith, Carver; vice-president, William S. Kyle, Plymouth; secretary and treasurer, James B. Collingwood, Plymouth. The route of the proposed road is from the Tremont station of the New York, New Haven & Hartford Railroad, in West Wareham, through South Carver, Centre Carver, Wenham and Darby to Plymouth, a distance of about fourteen miles. It is proposed to have the line in operation early next spring.

GOSHEN, IND.—Local capitalists are organizing a company for the purpose of completing the last connecting link that will give South Bend, Mishawaka, Elkhart and Goshen, now closely united by the Indiana Railway Company's electric line, direct railway connection with Indianapolis. Marion capitalists are now building a line to Wabash, and a company composed of Wabash, North Manchester and Warsaw citizens have the right of way secured between Wabash and Warsaw. The twenty-four miles from Warsaw to Goshen will complete one of the best paying traction lines in Indiana, giving connection with the resorts of Winona and lake Wawasee.

WAYNESBORO, PA.—A charter has been granted to the Valley Traction Company, a company organized to combine the trolley interests in Cumberland County and Franklin County now under the control of the Cumberland Valley Railroad. The company has control of the Harrisburg & Mechanicsburg, the West Fairview & Marysville, and the White Hill & Mechanicsburg lines. It is the intention of the company to build a line from Mechanicsburg to Carlisle, connecting there with the Carlisle & Mount Holly line. A central power-house for these lines will be erected at Bridgeport. The directors of the new company are M. C. Kennedy, Chambersburg; George H. Stewwart, Chambersburg; Lyman D. Gilbert and Spencer D. Gilbert, both of Harrisburg, and Lewis S. Sadler, Carlisle.

INDIANAPOLIS, IND.—Stockholders of the new Columbus, Greensburg & Richmond Traction Company have elected the following directors: August M. Kuhn, A. K. Hollowell, of Indianapolis; M. O. Reeves, Columbus; Walter McConahy, Richmond; William P. Meyer, C. N. Wilson and H. M. Holland. The electric interurban system planned by the new company contemplates a line from Richmond to Louisville by way of Greensburg and Columbus. Connections with Indianapolis are also planned, and the company will also probably build extensions to meet the Appleyard system in Ohio. When the system has been worked out completely it is said there will be eight connections into Indianapolis. The estimated expense of the system contemplated by the company is $2,500,000. The financing of the first line from Richmond to Columbus has been practically accomplished, and it is announced that work will begin early in the spring. A power-house is to be erected at Greensburg.

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ELECTRIC LIGHTING.

READING, PA.—The electric light plant at Bernville has been placed in operation.

MEMPHIS, MO.—There is some talk of installing an electric light plant at Downing.

NORWAY, IOWA—L. J. Norland and others contemplate installing an electric light plant.

NORFOLK, VA.—The Portsmouth Electric and Gas Company has been awarded a contract for street lighting.

WALNUT, IOWA—The electric light proposition voted on recently resulted in favor of a municipal plant.

GALVESTON, TEX.—San Antonio is to vote on a $200,000 bond proposition for a municipal electric light plant.

ATHENS, OHIO—The Athens board of public service has contracted for the erection of a municipal light plant, to cost $13,740.

FRESNO, CAL.—The San Joaquin Power Company has completed its new auxiliary plant, which will give it approximately 800 additional horse-power.

EATON RAPIDS, MICH.—At a special election the proposition of the city bonding for $12,000 to build an electric light plant was carried by 113 majority.

ST. LOUIS, MO.—The St. Charles Electric Light and Power Company will increase the capacity of its plant by the addition of two 500-horse-power engines.

BLOOMER, WIS.—The electric light plant has been put in operation. Power for the plant is furnished from a dam at Eagle Point, about seven miles from Bloomer.

ATLANTIC, N. J.—The Atlantic Electric Light and Power Company is making additions to its system which will provide for the increase of business during the next five years.

HARRISBURG, PA.—Notice has been filed at the state department by the Philadelphia Electric Light Company, that it has increased its capital stock from $100,000 to $2,500,000.

CAPAC, MICH.—The contract for the construction of an electric light plant for this village has been awarded. The plant is to cost $5,913, and is to be run in connection with the waterworks system.

NEVADA, MO.—The Missouri Water, Light and Traction Company has sold all of its plants and property in Nevada to the Union Water, Light and Traction Company, with headquarters at Jerseyville, Ill.

PORT HURON, MICH.—The Port Huron Light and Power Company is supplying a large amount of power to various concerns at South Park, and has decided to erect a substation and furnish the power direct from there to consumers.

WAREHOUSE POINT, CT.—The street lighting committee has made a contract with the Windsor Locks Electric Light Company to light the streets of this village and Broad Brook for a period of ten years, at a cost of $14.88 per light.

READING, PA.—The Allentown & Reading Traction Company is now running its wires from Kutztown to Lyons and Fleetwood, for the purpose of supplying these towns with electric lighting. They may be extended to Blandon during the winter.

WESSON, LA.—The city council has closed a contract with W. H. Harvey, of Memphis, to install an electric plant. The system is to consist entirely of arc lights and to be first class in all its appointments. Work is to commence as soon as possible, and is to be completed by spring.

HANNIBAL, MO.—The special committee appointed by the mayor to consider the plan of rebuilding the electric light plant will make a report to the council recommending that a proposition to issue bonds in the sum of $100,000 to rebuild the plant be submitted to a vote of the people.

LITTLE ROCK, ARK.—The contract for the power-house of the Walnut Ridge & Hoxie Light, Power and Transit Company, at Walnut Ridge, is to be let. The main building will be 48 by 105 feet, with twenty-two-foot ceiling. There will be two engines of 225 and 300 horse-power, respectively.

PATERSON, N. J.—The Plainfield Gas and Electric Company and the Somerville Lighting Company have filed an agreement merging the two concerns. The officers of the new company are H. G. Runkle, president; secretary, A. M. Young, of Bramford, Ct.; treasurer, James C. Pope, of Paterson, N. J.

PORTLAND, CT.—The Middletown Electric Light Company has decided to extend its service across the river to this town. It is said that enough subscribers have been secured to warrant the success of the venture, and the service will be gradually extended. The company is also running a line to Cromwell.

LEE, MASS.—The annual report to the state board of gas and electric light commissioners shows the Lee Electric Light Company's assets to be $64,980.94, and its liabilities $60,066.25, leaving a balance of $4,914.69. The operating expenses amounted to $6,241.45, while the income from the sale of light was $10,826.67.

JOHNSTOWN, PA.—It is expected that the plant of the Dunlo Light, Heat and Power Company will be ready for operation about the middle of January. The plant is to be a model one in every way, and will have a capacity of from 1,200 to 1,400 lights. M. G. Ashley is president of the company and John Quinn is secretary.

HACKENSACK, N. J.—The lighting plant of the Hackensack Electric Light Company, on the Hackensack river, has been destroyed by fire. The loss is not definitely known, but it is thought it amounts to more than $50,000. The building was of brick and contained much valuable machinery, which was entirely destroyed.

MACON, GA.—The new contract between the city and the Macon Railway and Light Company for lighting the city has become operative, the former five years' contract having expired. Under the former contract, the price paid by the city was $100 per lamp per year. The price under the new contract is $75 per year. The present number of lamps is 153, amounting to $15,000 per annum, exclusive of the incandescent lights used in the public buildings.

MOLINE, ILL.—At the annual meeting of the stockholders of the People's Power Company, the following officers were elected: president, C. O. Nason, Moline; vice-president, Philip Mitchell, Rock Island; secretary and manager, S. S. Davis, Rock Island; treasurer, W. L. Velie, Moline. The board of directors is now as follows: C. O. Nason, C. H. Deere, W. L. Velie, Moline; S. S. Davis, Philip Mitchell, T. B. Davis, Rock Island; A. W. Vanderveer, Davenport.

ALBANY, GA.—Charles E. Garner and Smith D. Pickett, representing the Florida capitalists who recently purchased the water power on Muckafonee creek, two miles above the city, have made a proposition to the city to furnish it with power for its water and power plants. This water power is said to be one of the finest in the state, and if the committee appointed to look into the matter awards the contract asked for, its development will be assured.

SAN FRANCISCO, CAL.—A complete transfer has been made to the San Francisco Gas and Electric Company of all the properties, including stocks, bonds, machinery and appurtenances, of the Independent Electric Light and Power Company and the Independent Gas and Power Company. This transfer consummated the sale under the terms of an agreement entered into July 2, 1903. Cash and bonds to the amount of $6,210,000 were paid to John D. and A. B. Spreckels.

NIAGARA FALLS, N. Y.—It is stated that the Electrical Development Company, one of the companies now engaged in power development work on the Canadian side of the river, will erect one of the largest power-houses on the continent. The building will be 425 feet long and 200 feet wide. It will be constructed of solid granite. Plans and specifications are now being prepared, and tenders will be called for within a short time. The building, as proposed, will cost $400,000.

SPRINGFIELD, TENN.—The Springfield Electric Light and Water Company has been organized here, the following citizens being the promoters and stockholders: William McMurry, A. B. Porter, G. S. Moore, Frank Bell, H. L. Dulin, H. Fatham, H. T. Stratton, Jr., E. B. Long, W. B. England and C. T. Tanner. The company has made a proposition to the town to furnish its water free and lights at a nominal cost, provided the town will erect a standpipe and lay water mains; also to give the town one-third of the annual gross receipts of the water plant. The company asks for a twenty-year franchise and proposes to sell its plants to the town at their actual cost if the town desires to purchase them between the date of erection and July 1, 1905.

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TELEPHONE AND TELEGRAPH.

RAWLINS, WYO.—A telephone line is to be built from Walton to Kaycee.

MOLINE, MINN.—The Central Union Telephone Company has opened an exchange at East Moline.

PITTSBURG, PA.—The Huntingdon & Clearfield Telephone Company has installed an exchange at Winburn.

NEW YORK MILLS, N. Y.—The Utica Home Telephone Company has installed its system in this village.

HOKAH, MINN.—The Hokah Mound Prairie Telephone Company has been organized to build a farmers' line into Hokah.

LA CROSSE, WIS.—The Wisconsin Telephone Company will install a complete telephone system in Sparta, work to commence soon.

DES MOINES, IOWA—The Farmers' Mutual Telephone Company has been incorporated at Voorhies. J. Conroy is president and J. H. Dunn secretary.

PHILADELPHIA, PA.—A new telephone line will be built in the vicinity of Steinsville, taking in a large number of rural towns in both Berks and Lehigh counties.

DES MOINES, IOWA—The American Telegraph and Telephone Company, recently incorporated for $100,000, is now constructing a line from Waterloo to Des Moines.

SHAWNEE, O. T.—The Independent Telephone Company has completed a metallic circuit to Denison and Sherman, Tex., connecting with its main line in this city.

GREEN BAY, WIS.—The Wausauke Telephone Company is constructing a line through the town of Brazean, to extend to Oconto Falls and Gillett and then to Green Bay.

LOUISIANA, MO.—The Baffum Telephone Company, of this city, announces the completion of its new copper wire line to St. Louis, where it connects with the Kinloch system.

WILMINGTON, N. C.—The Columbia Telephone Company has been organized with the following officers: J. W. Harrelson, of Clarendon, chairman; L. Goodman, secretary.

WENONAH, N. J.—The People's Rural Telephone Company, which has been organized, expects to have its system in operation by next July. Its headquarters will be in this town.

WHEELING, W. VA.—The Belmont Telephone Company has decided to make quite extensive improvements to its system, as a result of the growth which has taken place in its business.

PATCHOGUE, N. Y.—At a meeting of the highway commissioners, the North Shore Telephone Company was granted permission to use the streets of the town for its poles and wires.

ANN ARBOR, MICH.—The Washtenaw Home Telephone Company has given a trust mortgage of $25,000 to the Luzerne County Trust Company, to secure the issue of bonds to that amount.

PORTSMOUTH, OHIO—The Portsmouth Telephone Company contemplates some extensive additions to its plant in the immediate future, in order to accommodate the large increase in business.

UNITIA, TENN.—The route for the new telephone line from here to Greenback has been surveyed and will be built shortly. Another new line has also been surveyed from here *via* Antioch to Lenoir City.

SMITHVILLE, TEX.—The Smithville Telephone Company has been organized with the following officers: H. C. Schumacker, president; V. S. Robb, vice-president, and J. M. Moore, secretary and treasurer.

HART, MICH.—At a meeting of the directors of the Oceana Telephone Company it was voted to change the name of the organization to the Lake Shore Telephone Company, and to increase the capital stock to $200,000.

PROVINCETOWN, MASS.—The Hyannis circuit and the Cotuit circuit of the Cape Cod Telephone Company's lines have been brought together, giving all the subscribers connection with Hyannis, Hyannisport, Centerville, Osterville, Marstons Mills, Cotuit and Santuit.

EXETER, N. H.—The Exeter Telephone Company's lines have been extended to Haverhill, Mass., making connection with Powpow River, Carterville, Newton, Newton Junction, Plaistow and Westville. Connection can now be had with the People's Telephone Company.

CATAWISSA, PA.—The Columbia County Telephone Company has completed traffic arrangements with the Pennsylvania Telephone Company. This is a new company which is backed by John G. McHenry, of Benton; William Masters, of Millville, and George Hummer, of Elk Grove.

AMITYVILLE, L. I.—The New York & Long Island Telephone Company, which for the past six months has been erecting a telephone line between this place and Freeport, has completed the work and established service between the two points. The work of extending the line to Babylon has reached a point near Lindenhurst.

SAN ANTONIO, TEX.—At the annual meeting of the stockholders of the San Antonio Telephone Company, all the officers and directors were reelected, as follows: H. M. Daugherty, Columbus, Ohio, president; H. M. Aubrey, San Antonio, vice-president; D. A. Walker, Columbus, Ohio, secretary and general manager; A. L. Beze, San Antonio, superintendent; Ferdinand Herff, Jr., San Antonio, treasurer; Cyrus Huling, Columbus, Ohio, member of the board of directors. At the next meeting of the board of directors the matter of extensions will be taken up.

SCHENECTADY, N. Y.—The new telephone line between this city and Amsterdam, which will be under the control of the Home Telephone Company, has been placed in operation. The line also connects Pattersonville with the city, and in order to do this it was necessary to have a span across the Mohawk 750 feet long. The company has a gang of men on the new line it is building to Utica, and it is hoped to have this completed within three months. The opening of the Amsterdam line gives Schenectady service with Fonda, Johnstown and Gloversville over the Home company's lines.

TOLEDO, OHIO—The Wabash Railroad is about to install long-distance telephones along its entire system. The old road from Toledo to St. Louis has been wired, and operating forces are now at work between Detroit and Montpelier and on the Chicago division. Construction will be pushed as rapidly as possible, and it is said that the new method will do away with about fifty per cent of telegraphing on the Wabash road. An operator will be located at each town and station where the telephone is installed. The scheme of wiring will allow one wire to be used at the same time for telephoning and telegraphing, without interference of any kind.

OBITUARY NOTICES.

MR. ALBERT A. HONEY died on December 5, at Chicago, Ill., in the Chicago Union Hospital. Mr. Honey was an old-time telegrapher, beginning when twelve years old with the old Illinois Telegraph Company. He was one of the first of three operators employed by the Associated Press in Chicago. Later on he entered the employ of the Union Pacific Railroad Company, and afterward superintended the construction of the lines of the Northern Pacific from Bismarck to the Pacific coast. Mr. Honey settled in Chicago in 1901, and until within the last two months was president of the Magnetic Equipment Company. He was one of the organizers of the Old-Time Telegraphers' Association.

MR. ALBERT J. WISE, of the law firm of Quackenbush & Wise and president of J. H. Bunnell & Company, manufacturer of electrical supplies, died at his home, 533 West 162d street, New York, December 13, 1903. His death was due to bronchitis following internal injuries received a week before, when he slipped and fell near his home while alighting from a trolley car. Mr. Wise was born in Lima, Ohio, September 24, 1869. He took the degree of LL. B. at Yale and afterward at Columbia University. After his graduation Mr. Wise practised law for some time in his native town, but removed to New York in 1891. He was interested in yachting, owning the steam yacht Chetolah, and was a member of the New York Yacht, Atlantic Yacht and Sea Cliff Yacht clubs. He was also inspector of public schools for the boroughs of Manhattan and the Bronx.

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PERSONAL MENTION.

DR. HORACE CLARK RICHARDS, instructor in physics in the University of Pennsylvania, has been made assistant professor of physics.

MR. A. A. ANDERSON has accepted the position of general superintendent of the Indianapolis-Cincinnati Traction Company, with headquarters at Indianapolis, Ind.

MR. WILLIAM C. ANDREWS, of New York, has just accepted the position of engineer of the sales department of the Stanley Instrument Company, Great Barrington, Mass.

MR. JOHN B. McCLARY has resigned as manager of the street railway department of the Birmingham Railway, Light and Power Company, Birmingham, Ala., to take effect January 1.

MR. W. J. CAMP, superintendent of the eastern division of the Canadian Pacific Railroad Company's telegraphs, has been appointed chief electrical engineer to the whole telegraph system of that company.

MR. THOMAS M. JENKINS, formerly general manager of the St. Louis & Suburban Railway Company, has been elected president and general manager of the Imperial Transit Company, of St. Louis, Mo.

MR. WM. M. DYATT has resigned as superintendent of the Lehigh-Northampton Gas and Electric Company, Allentown, Pa., to engage in business as an electrical contractor. He will open an office in the Willoughby Building, Catasaqua, Pa.

MR. C. O. HARRIS, formerly superintendent and engineer of the Rochester Telephone Company, Rochester, N. Y., has associated himself with the sales department of the Stromberg-Carlson Telephone Manufacturing Company, and is now located at Chicago, Ill.

MR. RANDOLPH G. SHARPE, for a number of years confidential employé of the Sterling Electric Company, La Fayette, Ind., has resigned to take charge of the collecting department of the Bell Telephone Company for Indiana, Ohio and Illinois, with headquarters at Indianapolis.

MR. JAMES W. CROSBY, chief electrician of the Halifax Electric Tramway Company, Halifax, N. S., has been appointed general manager of the company to succeed Mr. F. A. Huntress, who resigned from the company to become general manager of the Worcester Consolidated Street Railway Company, Worcester, Mass.

MR. EUGENIO DAVERI, who has been constructing superintendent of the Italian Edison Company, Milan, Italy, for the past ten years, has tendered his resignation in that capacity and on January 1 will act as representative for foreign manufacturers of vehicles of all kinds, such as cars for steam and street railways, automobiles, etc., and also for car supplies. The Italian Edison Company, with which Mr. Daveri has been connected, operates all of the electric street railway lines in Milan.

MR. THOMAS J. JOHNSTON and MR. GEORGE C. DEAN announce that their offices are now located at No. 11 Pine street, New York city. Mr. Johnston has had wide experience in the United States courts, especially in equity, and will continue to give attention to patent cases, proceedings in admiralty, removal of cases from state to federal courts, bankruptcy and other federal cases. Mr. Dean is a graduate of Amherst College, and studied law at Harvard. He has been a member of the bar for nine years, and as principal examiner in the electrical, metal-working, woodworking and other divisions of the Patent Office, has acquired an intimate knowledge of these arts and of the most recent advances in telephony, wave transmission, wireless telegraphy, mercury vapor lamps, Nernst lamps, etc. He will make a specialty of expert legal opinions on patentability, validity and infringement.

MR. WALTER H. WHITESIDE, manager of the detail and supply department of the Westinghouse Electric and Manufacturing Company, Pittsburg, Pa., has been made the general manager of the Sawyer-Man Electric Company, and has added the duties of this new office to his former ones. Mr. Whiteside is well known in the electrical field, as he has been connected with this interest for nearly twenty years, extending his acquaintanceship to every part of the country. Mr. Whiteside became a special salesman for the Westinghouse Electric and Manufacturing Company in Chicago in 1898. A year later he was sent to Washington, D. C., to take charge of sales to the government. This led, in 1900, to his being made manager of the company's office for that district, then having its headquarters in Washington. From the Washington office Mr. Whiteside was promoted to the management of the detail and supply department of the company, with headquarters at Pittsburg. Under his management the business of the department has increased greatly.

ELECTRICAL SECURITIES.

The closing prices on Saturday showed a good rally, but were not the highest for the week, there being a slight falling off in the last day's buying. In spite of this rally, however, there is not so much confidence as existed a week ago, the disturbing factor in the immediate speculative situation being the opening of the Northern Securities case in the Supreme Court. Brooklyn Rapid Transit and the electrical securities in general were freely dealt in, maintaining the advances of the previous week.

The preliminary November statement of export trade is good, and trade reports and economic conditions in general are expected to provoke a very hopeful sentiment.

ELECTRICAL SECURITIES FOR THE WEEK ENDING DECEMBER 12.

New York:	*Closing.*
Brooklyn Rapid Transit	48
Consolidated Gas	182¾
General Electric	164
Kings County Electric	180
Manhattan Elevated	140½
Metropolitan Street Railway	121
New York & New Jersey Telephone	145
Westinghouse Manufacturing Company	180

At the annual meeting of the stockholders of the Metropolitan Street Railway Company retiring directors were reelected.

A quarterly dividend of 1½ per cent on the capital stock of the Manhattan Railway Company will be paid on and after January 1, 1904, to stockholders of record at the closing of the transfer books on Friday, December 11, 1903, at 3 o'clock P. M. The transfer books will reopen on Tuesday, December 22, at 10 o'clock A. M.

The board of directors of the Western Union Telegraph Company has declared a quarterly dividend of 1¼ per cent upon the capital stock of this company, payable at the office of the treasurer on and after the fifteenth day of January next, to shareholders of record at the close of the transfer books on the nineteenth day of December inst. The transfer books will be closed at 3 o'clock on the afternoon of December 19 inst., and reopen on the morning of January 2 next.

A dividend of $2 per share will be paid on January 15, 1904, to holders of stock of the General Electric Company of record at the close of business hours on Saturday, December 19, 1903.

Boston:	*Closing.*
American Telephone and Telegraph	124½
Edison Electric Illuminating	230
Massachusetts Electric	76
New England Telephone	122
Western Telephone and Telegraph preferred	81

At a directors' meeting of the Edison Electric Illuminating Company, directors recommended stockholders to authorize an issue of 95,000 shares of new stock, to be subscribed for early next year. The new stock is to partly capitalize recent purchases of suburban properties.

The annual report of the Massachusetts Electric Companies for the year ending September 30 shows a surplus after dividends of only $6,622, which compares with $195,167 in the previous year. The income account is as follows: gross earnings, $6,333,911; operating expenses, $4,155,909, leaving net earnings of $2,178,002; paid for interest, rent, taxes and dividends, $2,171,380, leaving a balance of $6,622. During the fiscal year there was expended $2,570,000 for cars, track reconstruction, power stations, and lands and buildings, while for new roadway and new tracks there was spent only $460,000. It is stated that the large falling off above noted is due to the general rise in the price of all supplies and the increase in wages, while the gross earnings were greatly reduced by the unfavorable weather conditions which prevailed during the summer months.

Philadelphia:	*Closing.*
Electric Company of America	7⅞
Electric Storage Battery common	53
Electric Storage Battery preferred	53
Philadelphia Electric	6⅛
Union Traction	45⅜
United Gas Improvement	82⅝

The directors of the United Gas Improvement Company have declared a quarterly dividend of 2 per cent, payable January 15, 1904, to stockholders of record at the close of business December 31, 1903.

Chicago:	*Closing.*
Chicago Telephone	123
Chicago Edison Light	144½
Metropolitan Elevated preferred	51
National Carbon common	17½
National Carbon preferred	89
Union Traction common	6
Union Traction preferred	29

It is stated that Chicago Union Traction will issue capital to raise at least $3,000,000, to be spent on improvements. The plans contemplated will, it is expected, increase earnings about 35 per cent.

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INDUSTRIAL ITEMS.

THE SPRAGUE ELECTRIC COMPANY, New York city, is sending out instruction book No. 104. This gives definite instructions for the installation and care of direct-current "M. L." type generators.

THE ELECTRIC APPLIANCE COMPANY, Chicago, Ill., sales agent for Packard lamps, Zenith "intermediate" lamps and Adams-Bagnall arc lamps, is distributing a complete line of new lamp literature. This will be sent to any one interested upon request.

THE MARSHALL-SANDERS COMPANY, Boston, Mass., reports a very gratifying increase in its socket business, which it attributes to the appreciation by the electrical trade of its automatically produced sockets, which are very uniform and cost little to install.

THE CROUSE-HINDS COMPANY, Syracuse, N. Y., has been incorporated with the secretary of state, to take over the property and rights of the Crouse-Hinds Electric Company. The capital is $450,000. The directors are Huntington B. Crouse, Jesse L. Hinds and David B. Costello, of Syracuse.

THE BULLOCK ELECTRIC MANUFACTURING COMPANY, Cincinnati, Ohio, announces that its claim to the exclusive rights under the Ward Leonard patents to install the multiple voltage system of electric drive for operating machines has been sustained. This decision was rendered by Judge Kirkpatrick, of the Circuit Court, December 2, 1903.

THE PITTSBURG TRANSFORMER COMPANY, Pittsburg, Pa., has issued a neat folder illustrating several types of Pittsburg transformers. The transformers illustrated are made with fluted sheet-steel cases, with cast-iron base and top, finished in black japan, in sizes from 30 to 250 kilowatts, and voltages from 2,000 to 25,000. This circular will be sent on request.

THE EDISON STORAGE BATTERY COMPANY, Orange, N. J., has published a catalogue describing the Edison storage battery. This gives a number of excellent half-tone engravings, showing the assembly and construction of the battery, and a technical description of it. This catalogue also presents an engraving showing the mechanical works at Glen Ridge, N. J., and the chemical works at Silver Lake, N. J.

THE EWING-MERKLE ELECTRIC COMPANY, St. Louis, Mo., will be pleased to send to any one interested an illustrated catalogue descriptive of electrical novelties and appliances for boys. This includes miniature electric locomotives, electric trolley cars, derrick trailers, suspension bridges, battery fans, medical batteries, Morse outfits, private line battery call telephones, battery motors, battery lamps and electrical heating apparatus.

THE CENTRAL ELECTRIC COMPANY, Chicago, Ill., is sending out a circular calling attention to "D. & W." panel fuses and their adaptability for use with Adams-Bagnall and other makes of arc lamps. A connector is shown, by the use of which "D. & W." fuses can be fitted to any arc lamp without the necessity of a fuse block. The members of the firm are enthusiastic over the increased volume of business they are doing on "D. & W." material generally.

THE FARR TELEPHONE AND CONSTRUCTION SUPPLY COMPANY, Chicago, Ill., has adopted a novel method of presenting prospective buyers of telephone apparatus with ready reference sheets of specifications and prices. A recent folder contains illustrated descriptions and data concerning batteries, linemen's tools, transmitters and receivers, line supplies, telephones, toll line switchboards and express switchboards. This literature will be sent on request.

THE JEFFREY MANUFACTURING COMPANY, Columbus, Ohio, in its catalogue No. 52 describes and illustrates a complete line of Jeffrey coal-washing machinery. This catalogue also includes a number of testimonials from prominent users of the Jeffrey apparatus. The Jeffrey company also manufactures elevating, conveying, power transmission, screening, crushing, coal-cutting, drilling and hauling machinery. Catalogue No. 52, or any of the other catalogues which this company distributes, will be sent upon request.

THE MONTAUK FIRE-DETECTING WIRE COMPANY, 100 Broadway, New York city, is in receipt of a letter from Thomas Oakes & Company, manufacturer of woolen goods, Bloomfield, N. J., commendatory of its fire-detecting wire. Several months ago this company fitted a 160-degree fire-detecting wire to its main head shaft bearing. On the morning of December 1 this gave an alarm of an overheated bearing, and the low temperature at which this was given enabled correction of the trouble without any serious result.

THE STARK TELEPHONE, LIGHT AND POWER SYSTEM, LIMITED, with a capital of $1,000,000, has been formed in Toronto, Canada, to take over the Humber Light and Power Company, at Toronto Junction. The new company will operate the Stark patents, whereby telephone, telegraph, light and power service is furnished from the one plant and over the same circuit. The company will greatly increase the Humber Light and Power Company's plant, and will immediately commence installing a telephone service in Toronto Junction, for which town it has secured a franchise.

THE WAGNER ELECTRIC MANUFACTURING COMPANY, St. Louis, Mo., will be pleased to send bulletin No. 65 to any one interested in lighting and motor transformers. This bulletin illustrates the back view of a standard transformer, showing pocket for hanger lugs and full set of twenty-kilowatt coils, depicting the method of assembling and the standard construction for both motor and lighting transformers. There is also illustrated the construction for the twelve, twenty and thirty-light sizes and a horizontal section through a twenty-kilowatt type "M" transformer, showing the provision for oil circulation.

THE HENRY R. WORTHINGTON COMPANY, New York city, has issued a pamphlet entitled "Water-meters," describing its new disc meter and illustrating the internal construction. The pamphlet also describes the standard duplex piston meter, which is well known to engineers. There is also a description of the Worthington hot-water meter, which has wide use in checking up the evaporative values of different grades of coal, the efficiency of firemen, etc. The typography and makeup of the pamphlet are good, and it is of a convenient size for quick reference. This is worth asking for, and the company will be pleased to mail on request.

THE TRACTION DEVELOPMENT AND SECURITIES COMPANY, 74 Cortlandt street, New York city, has been incorporated under the laws of the state of New York. This company purposes aiding in the formation of syndicates, the underwriting of securities, the promotion of consolidations and construction, and the financing of steam and electric roads, gas, water and electric light plants. Expert reports and opinions will be furnished concerning properties and enterprises of any kind in contemplation. Besides technical conditions, the company will cover a study of the market supply and demand, and a full account of economic and commercial details. Financial agents are stationed in all of the principal cities. The corporation will look into various enterprises and have these thoroughly examined by experts of national repute. The directors of the company are well known in railroad and financial interests.

THE GENERAL ELECTRIC COMPANY, Schenectady, N. Y., is distributing several price lists and bulletins, and also several illustrated articles on engineering apparatus. This literature includes descriptions of single-wire porcelain cleats, electric lighting outfits for ready decorations, the GE-74 motor, type CR feeder regulators, and induction motors. A booklet entitled "Multiple Enclosed Arc Light Systems" shows forth the advantages of interior lighting by long-burning multiple enclosed arc lamps. The statement is made that there are at present in use for interior lighting in the United States 550,000 multiple lamps, of which the General Electric Company has furnished about 325,000. During the past five years there have been marked changes in the design and manufacture of enclosed arc lamps, and the General Electric Company has taken a leading part in these improvements. This booklet tells concisely of the installation, mechanism and operation of these lamps. A booklet entitled "Fifteen Years' Experience in Transformer Manufacture" gives a most instructive and interesting review of transformer history. It takes up briefly the work of Faraday, Ruhmkorff, Varley and Ferranti, and illustrates the development of transformer construction. A number of the illustrations used have already become familiar to engineers, but the work loses none of its attractiveness or importance because of this, as these illustrations are necessary to show the high degree of excellence to which transformer construction has been raised.

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CHARLES W. PRICE . . . . . PRESIDENT AND EDITOR
STEPHEN H. GODDARD . . . . . SECRETARY AND MANAGER
WM. HAND BROWNE, JR. . . . . TECHNICAL EDITOR
AINSLIE A. GRAY . . . . . ASSISTANT EDITOR

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TO ADVERTISERS

CHANGES for advertisements should be in this office by *Friday noon* for the following week's issue.

NEW ADVERTISEMENTS should be in the office not later than *Monday noon* to assure publication in that week's issue.

CONTENTS.

EDITORIALS:
New Phenomena of Invisible Radiations..... 919
Weatherproof Insulation or Bare Conductors..... 920
The Edison Portland Cement Company..... 920
Metallic Oxides as Conductors of Electricity..... 920
Commutating Alternating-Current Motors..... 920
Situation of the Electrical Industries..... 921
The Exchange of the Frontier Telephone Company, Buffalo, N. Y., by Virgil Hayden..... 922
Industrial Electrochemistry and Electrometallurgy—IV., by John B. C. Kershaw..... 925
Mountain Climbing Railways, by George E. Walsh..... 926
Anniversary of the Death of William Gilbert..... 927
An Electric Baker's Oven..... 927
The Pacific Coast Transmission Association..... 927
New York Electrical Society..... 928
The Edison Portland Cement Company..... 929
Overhead High-Tension Distributing Systems in Suburban Districts, by George H. Lukes..... 934
Mr. Westinghouse on "The Third-Rail Danger"..... 935
Standardization of Apparatus, by J. C. Kelsey..... 936
A New Submarine Cable Plant..... 937
The Opening of the New Bridge Between the Boroughs of Manhattan and Brooklyn, New York City..... 937
Electric Lighting on the Welland Canal..... 937
Electric Club Journal..... 937
The American Institute of Electrical Engineers..... 938
Eighth Annual Dinner of the Brooklyn Engineers' Club..... 940
Magnetic Iron Sand in Java..... 940
Electrical Patents..... 941
Review of Current Engineering and Scientific Literature..... 942
Meeting of the Philadelphia Branch of the American Institute of Electrical Engineers..... 943
The American Association for the Advancement of Science..... 943
INDUSTRIAL SECTION:
A 30,000,000 Candle-Power Beacon..... 944
The Wireless Railway Company..... 944
A New Lock Push Switch..... 945
The New "G. I." Floor Outlet Box..... 946
New Types of Voltage Regulators for Generators..... 946
Automatic Block Signals for Electric Railways..... 948
A New Key Push-Button Switch..... 949
CURRENT ELECTRICAL NEWS..... 950

NEW PHENOMENA OF INVISIBLE RADIATIONS.

There seems to be no lag in the interest manifested in the invisible forms of radiation, either on the part of the scientific world or the general public. In fact any tendency on the part of the latter to forget that there is such a substance as radium is very quickly checked by some new and perhaps startling discovery. Thus, the announcement made by Curie, that radium acts as a continuous generator of heat, is followed up by Wien, in a paper appearing in the *Physikalische Zeitschrift,* which states that the same mysterious substance can be used to produce continuously an electric current. Wien enclosed radium bromide in a glass tube, into which a platinum wire was fused. This tube was suspended by a glass thread in a larger tube, into which a second platinum wire was melted. The current was obtained of the order of 3×10^{-12} ampere. The explanation of this action is that, according to Rutherford, both positively and negatively charged particles or electrons are thrown off by the radium. The positive electron is many times larger than the negative, and, by means of a proper sieve, can be separated from the latter. In the apparatus just described, the inner glass tube acts as the sieve, retaining the positive electrons and letting the negative pass more or less freely.

The current obtained in this way by Wien, while exceedingly small, allowed a computation to be made of the mass of radiated particles. The figures obtained show that this is far too small to be detected by weighing. The energy, according to the Rutherford and Soddy disintegration theory, of course is due to the breaking up of the radium atoms, and, on account of the high velocity of the particles, is considerable. Four milligrammes of radium give off sixty ergs per second in the positive electrons, and 8.7 ergs in the negative.

New Observations with N-Rays.

Another group of rays, discovered by Blondlot, and called by him N-rays, have received less general attention, as the phenomena observed are not so startling as others connected with radioactivity. It will be remembered that these rays were discovered by the effect which they exert on the small electric spark, rendering it more luminous. They exert the same effect upon the luminous flame; and now M. Blondlot announces that it is not essential for these rays to fall upon an object to render it more visible, but the same effect is obtained if they penetrate the eye. These rays are given out from various luminous objects as well as from objects which have been exposed to sunlight. He happened to have his eye fixed on a small, feebly illuminated band of paper. A brick which had been exposed to sunlight was brought near his face, with the exposed surface toward him. He at once saw the band of paper brighten up, and the effect disappeared upon removing the brick or turning its unexposed side toward his face. It was not affected by enclosing the brick in a box closed with black paper.

Effect Not Entirely Physiological.

A simple experiment is to darken a room until the face of a clock on the wall is only feebly visible. By bringing a solarized brick or pebble near the eye, the face of the clock becomes sharply outlined, and possibly the hands are seen. No explanation is offered of this curious phenomenon. It can not be assumed to be entirely physiological, as in the earlier experiments photography was made use of in studying the action of these rays on sparks. These rays are absorbed by moisture, but Blondlot has found that saline solutions allow them to pass freely in all directions, and that such solutions, particularly hyposulphite of soda, may be used to store up the rays, and may thus take the place of the Nernst lamp as a source.

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WEATHERPROOF INSULATION OR BARE CONDUCTORS.

At the recent meeting of the American Institute of Electrical Engineers, attention was called to the false feeling of security which is inspired by the use of weatherproof insulation on outside conductors. As an insulator, the usual coating of braid and compound can not be compared with rubber, and after continued exposure, particularly when wet, it loses much of its insulating property, so that a wire thus protected is little better than a bare conductor. Indeed, it may be more dangerous, as due to carelessness or ignorance, an attempt may be made to handle wires covered in this way while they are alive. Another objection to this insulation is, much of it will not stand the weather, and, sooner or later, hangs in festoons along the whole line. Where a company owns its right of way, it would seem better to use bare wires and to spend the money which would otherwise have gone into insulation, in securing better line construction. When the line runs on a public highway, there are, of course, other considerations that enter into the matter, and the company may not be allowed to erect bare wire, yet it is such lines that are most likely to be handled by wiremen who are careless or ignorant of the voltage of the circuit.

The use of rubber gloves was also criticised at the meeting, for the same reason. Such gloves, while apparently in good condition, may be far from it, and the feeling of security which they give to the wearer may lead him to careless handling of wires. Defects in these gloves may not be noticeable at low voltages, while a breakdown at a high voltage might be discovered only after an accident. These warnings are timely, as all of us would rather recognize the dangers and act accordingly, than rely upon protective devices which are anything but perfect.

THE EDISON PORTLAND CEMENT COMPANY.

At New Village, N. J., there has been developed one of the most complete plants in the world for the manufacture of high-grade Portland cement. This plant has been designed entirely by Thomas A. Edison. The company is fortunate in having a good acreage of land which abounds in cement rock and limestone of the best quality for making good cement, and also in having the use of machinery which has been developed to a state of perfection for this class of work.

The machinery used in this plant is not new, but is the result of the experimental work which was done at Edison, N. J., in the iron ore plant Mr. Edison designed. This, of course, does not include the roasters, which were designed solely for the cement mill. Although heavy engines are required for driving the giant and smaller rolls used in crushing the rock and clinkers, electricity is made use of almost exclusively where it is at all possible. Miles of belt and bucket conveyors are driven by electric motors, as well as exhaust fans in the several departments. The enormous roasters are operated electrically, and it is a remarkable sight to see these giant shells being revolved by the relatively insignificant twenty-five-horse-power motor.

From a popular point of view the Edison cement works is remarkable in every way, and from a technical point of view the working out of the several engineering propositions has been eminently satisfactory.

METALLIC OXIDES AS CONDUCTORS OF ELECTRICITY.

At a recent meeting of the German Bunsen Society for applied physical chemistry, Dr. O. Frölich presented a paper giving a description of a new resistance furnace which he has devised. Electric furnaces usually depend for their action upon heat developed in arcs, by the passage of a heavy current through the material which is to be treated, or through resistances arranged either in the material to be treated or in the walls of the furnace. In this new type, the walls of the furnace are themselves made use of as the high-resistance conductors through which the current is passed. There is thus no need of introducing carbon cores, which are sometimes undesirable. The material to be treated need not be a conductor of electricity, and the temperature of the furnace can be controlled by regulating the current.

High Temperatures Obtainable.

In his paper, the author stated that he had discovered a material of which the furnace walls might be made, and which has sixteen times the resistivity of carbon when hot, and twenty-five times its resistivity when cold. He surrounds his furnace with a jacket of refractory material which is also a poor heat conductor, an air space being left between the furnace and its cover. Tests of a small furnace demonstrated that, when heated by means of two vertical electrodes, the temperature reached was about 1,200 degrees centigrade; but when current was passed through the sides of the furnace, the temperature rose to 1,600 degrees centigrade, and could be pushed still higher, as the material does not melt until above 2,000 degrees centigrade.

Pure Oxides Not Conductors.

Some important facts were brought out in the discussion of this paper. It was stated that refractory materials, like metallic oxides, become better conductors as they are more impure; that impurities in the shape of strongly acid oxides are particularly beneficial in promoting conductivity at low temperatures. Dr. Nernst stated that at temperatures of about 1,700 degrees centigrade, pure metallic oxides are non-conductors, but when mixed with other oxides, become conductors at that temperature. Thus, neither pure magnesia nor pure thoria is a conductor when used alone, but a mixture of the two is. This is analogous to the behavior of aqueous solutions, as neither pure water nor a pure sulphuric acid is a good conductor alone, although a mixture is. These observations will, no doubt, have an important bearing on the theory of electrolytic conduction as applied to metallic oxides.

COMMUTATING ALTERNATING-CURRENT MOTORS.

Since the paper describing an alternating-current motor suitable for traction, presented before the American Institute of Electrical Engineers something over a year ago, a number of motors have been constructed by other companies, and tested with a view to determining their practicability for such work. The greater number of these belong to the series type, but we have also the repulsion motor and another type which may be considered as a cross between the series motor and the single-phase induction motor. All of these motors make use of com-

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mutators for their operation. Several of them have been tried, not only on experimental tracks, but under actual operating conditions; and in practically all cases favorable reports have been made.

Return to Primitive Type.

It is interesting to note here the return to a primitive type. The first type of alternating-current motors to be put out was the series motor; then the repulsion motor was proposed, this also using a commutator. At that time, motor designers were not able to get rid of the very disastrous sparking, and the development of the beautiful induction machines filled the need for a stationary alternating-current motor, so that neither of the commutator type of motors came to anything, being used only as fan motors for a while and as starting devices. On the other hand, the development of the electric railway concentrated attention on the series direct-current motor, and this type was highly developed. Designers learned how to produce a motor which would run in either direction and under very variable loads, without necessitating shifting of the brushes to prevent sparking. The study of these machines and of other direct-current commutating machines led to an understanding of the cause of the sparking, and the proper means of avoiding it, and the knowledge here gained has now been made use of in converting the old commutating alternating-current motor into a practical machine.

An Analogous Case in Steam Engineering.

We have thus completed a cycle in motor design analogous to that which has been followed in steam engineering. Here the earliest type of steam motor was a turbine, but as then constructed it was naturally extremely wasteful and could hardly be considered a practical machine. Then the reciprocating engine was invented and perfected, and along with it the science of thermodynamics was developed. This science not only showed along what lines the reciprocating engine could be improved, and the limitations of this type, but it has finally carried us back to the primitive type—the steam turbine, which, in principle, is far simpler and which promises a higher efficiency than the highly developed reciprocating engine. It is true that other conditions have influenced both of these developments. Thus, the demand for an electric railway system which can be extended long distances, without requiring substations where constant attendance is necessary, has made the design of an alternating-current traction motor imperative. And as regards the steam turbine, it was not until there was a demand for a prime mover having a high and uniform speed to drive the electric generator that the turbine received the study it deserved and was brought to a practical point. It is interesting to note that the series alternating-current motor, while it loses on some points when compared with the direct-current motor, still is more flexible. A good series alternating-current motor, if provided with the proper controlling apparatus, can be run on the existing direct-current circuit in cities. A minor advantage is that on an alternating-current circuit, voltage control may be adopted and the wasteful rheostatic control avoided.

Cost of the Alternating-Current System.

An important question is, of course, that of the cost of the alternating-current system, as compared with the direct-current. Such a comparison was made recently by Mr. P. M. Lincoln before the electrical section of the Canadian Society of Civil Engineers. His paper appeared in a recent issue of the ELECTRICAL REVIEW. The author reaches the conclusion that, in addition to its other advantages, the alternating-current system would be cheaper than the direct-current system for a road sixty miles long, such as that considered, not only as regards first cost, but with respect to the cost of operation. It therefore seems not unlikely that although the railroad field has been one of the most active of the electrical developments, there will be no falling off in the building of new roads and the electrification of the smaller steam roads.

SITUATION OF THE ELECTRICAL INDUSTRIES.

While there has been a general feeling of uneasiness and much talk of a coming business depression, the indications now are that the electrical industries will not be much affected by these influences during the coming year, if the reported business prospects of the large electrical manufacturing companies have any significance. Thus, at a recent meeting of the district managers of one of the leading companies, encouraging reports were made. Out of nineteen managers present, whose districts cover all parts of the country, eight managers from the Central West, Pacific Coast and the South, reported that their sales for the year 1904 would be considerably larger than during the year just closing; nine managers from New England and New York, declared that their business would be fully as large as during 1903; and but two managers—and these representing unimportant districts—reported that business was likely to be smaller during the next year than it had been this year. These reports are based upon carefully gathered information, and are, doubtless, to be relied upon. It is also reported that another of the leading electrical manufacturing companies expects its business during the coming year to be fully as large as it was during that just closing.

Prospect for Coming Year Good.

It may properly be inferred from these reports that the business of other electrical manufacturers and supply companies will also show no falling off during 1904. It would seem, therefore, that the business depression which was so much dreaded a short while ago, is, at any rate, not likely materially to affect the electrical industries. While there may be a temporary depression in certain sections, due to the present financial condition, this will have little or no effect upon the total amount of work done during the year. There is a good deal of work which must be done to meet the increasing demands of consumers and to improve public utilities which depend upon electricity, such as the telephone, electric light and electric railways. Other lines of electrical application are also becoming important and, in some cases, essential. In fact, electrical methods are so closely identified with improvements and advances in nearly all other industries, that, though the electrical industry itself may suffer temporarily in some lines, on the whole it must advance.

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Vol. 43—No. 26

The Exchange of the Frontier Telephone Company, Buffalo, N. Y.

By Virgil Hayden.

THE Frontier Telephone Company, of Buffalo, N. Y., was granted a franchise to construct a telephone system in the city of Buffalo on December 13, 1901. Under this franchise the telephone company was required to furnish the city with 100 telephones free of charge and also pay the city three per cent of its gross receipts annually. A guaranty, protected by a bond, was given requiring the company to maintain competition with the Bell system during the life of the franchise or forty years. Service rates were fixed as follows: $48, $40, $36 and $24 for direct line, two, three and four-party business lines, respectively, and $36, $24, $20 and $15 for direct line, two, three and four-party residence lines, respectively. These rates are for unlimited service.

It was during the month of February, in the year 1902, that the plans for the necessary construction work were started. A complete common battery exchange of 35,000 lines was taken as a basis and the office building site, which corresponded closely to the theoretical telephone centre, was located at 332 Ellicott street.

The building is built of stone and brick and has a frontage of sixty-five feet and a depth of 132 feet. There are three stories. The offices are located on the main floor, stock and storage rooms being at the rear and in the basement. The operating rooms are on the second and third floors at the rear, the front of the second floor being used for a terminal and wire chief's room as well as a storage battery room. The kitchen, hospital, locker, recreation and dining rooms are situated in front of the operating room on the third floor.

The present switchboard, which is of the common battery cutoff relay type, is located on the second floor and is in the shape of a U, the third floor above being in reserve for future growth and is merely a gallery to the second floor, light being furnished by windows at the side and a skylight in the roof. Twenty-three sections, three positions and ten panels to a section of the switchboard have been installed. The answering-jack capacity per position is 160 and the multiple-jack capacity of the board is 18,000. The complete switchboard will consist of fifty-six sections. The finish is mahogany and each section five feet seven and one-half inches long and seven feet high. The present multiple-jack equipment is for 8,000 lines. Numbered lamp caps are used in front of the line lamps and each line lamp is immediately below its corresponding answering-jack. The multiple and answering-jacks are of the two-point

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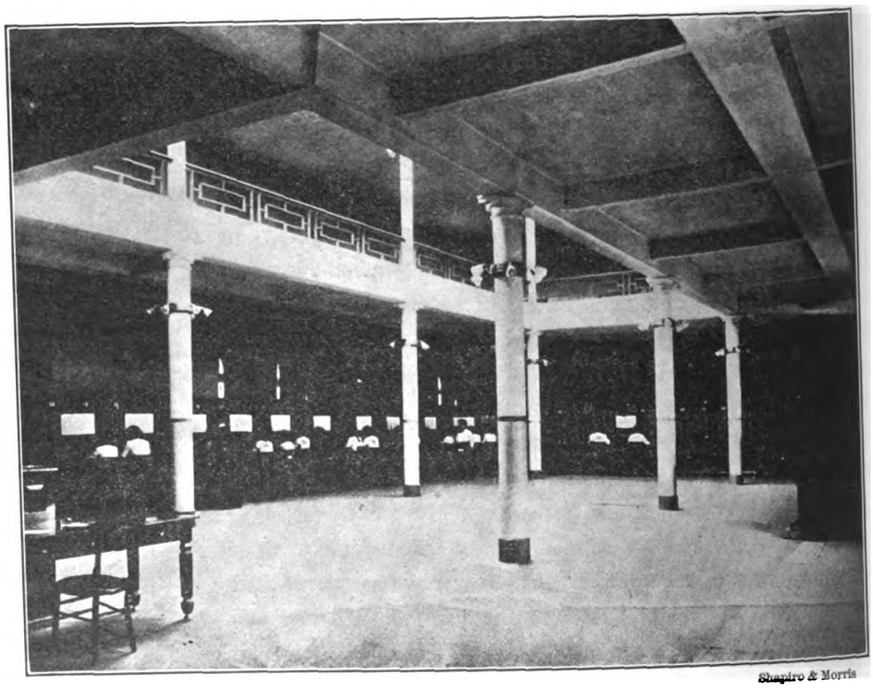
EX-SENATOR H. H. PERSONS, VICE-PRESIDENT AND GENERAL MANAGER FRONTIER TELEPHONE COMPANY.

type with a cutoff relay bridged from the sleeve side to ground. The usual numbering of stile strips and jacks is used in addition to the numbered lamp caps. The first position is used as a wire chief's test position, the second and third positions as toll trunk positions, the fourth position as a private branch exchange for the company, and the remaining positions as regular subscribers' positions. Each position is equipped with fifteen pairs of plugs and cords with double supervision and individual listening and four-party line ringing keys, also with a suitable number of order wire buttons. The key-shelf of this board is on the slant to enable the operation to be as close as possible to the face of the board. Breast transmitters, with the usual head band and watchcase ear receiver, are used. Each position is lighted by an incandescent electric light in addition to the electric lights placed on columns about the room.

A two-position chief operators' desk with the usual equipment is situated in the front of the room and in such a position that the monitors can have full supervision of the operators.

An information desk with four positions is located in a room adjoining the main operating room. Here are kept records of all subscribers and all questions are answered from this desk.

The supervisory relays and all condensers are located in the rear of the board and here are also suitable runways for the various connecting cables. The answering-jacks and line lamps are cabled directly to the answering-jack side of the intermediate distributing frame which is situated in the terminal room, and the multiple-jacks are cabled directly to the opposite side of this same frame. The intermediate frame has forty-triple lug-connecting strips arranged vertically. The relay rack is cabled directly to the multiple-jack side of the intermediate frame



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SWITCHBOARDS, FRONTIER TELEPHONE COMPANY, BUFFALO, N. Y.

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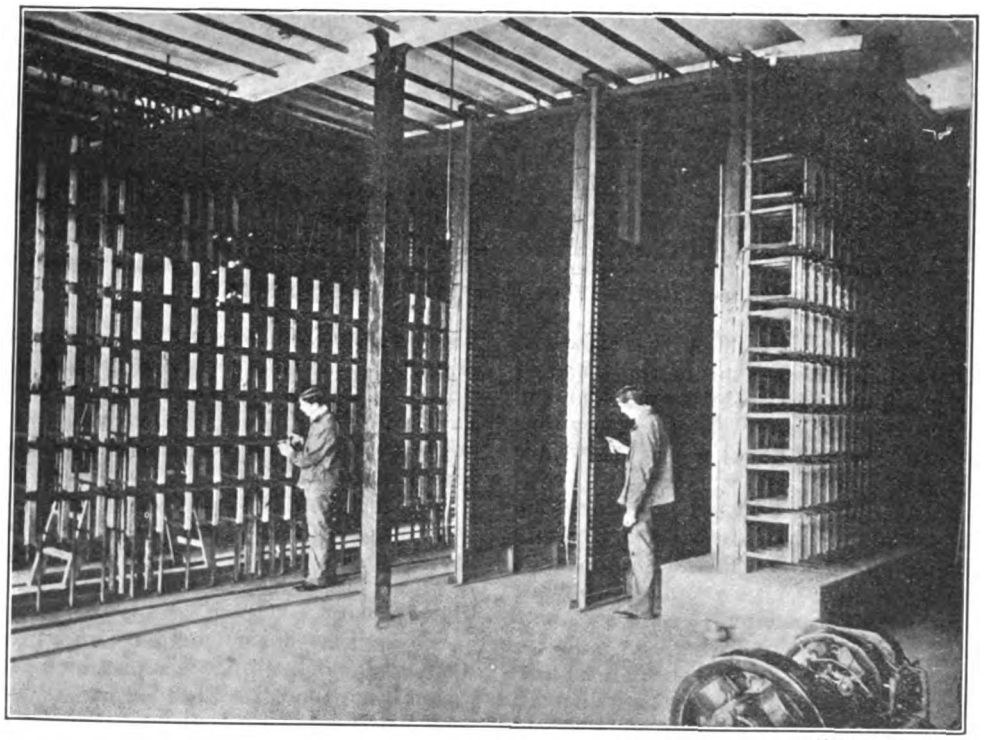
and the relays, a cutoff and line relay being mounted in the same case, are arranged in bays. This rack is located just to the rear of the intermediate frame. The switchboard side of the main frame is cabled directly to the relay rack. The switchboard side of the main frame is made up of fifty-pair lug-connecting strips arranged vertically. On the opposite side of the main frame are located the heat coils and lightning arresters, and here enter the outside cables. The usual method of running jumpers is used both at the main frame and the intermediate frame. The frames are made up of angle iron entirely.

The power plant is also located in the terminal room and consists of the following: a three-panel power-board, with a three-volt scale voltmeter, individual battery-reading switches, motor switches and starting rheostats on the first panel; on the second panel is a fifty-volt scale voltmeter and fuse panels for trunks, line lamps, line relays, answering cords, answering supervisaries, and transmitters; on the third panel are a 250-ampere scale ammeter, battery charging switches and circuit-breakers. Two ten-horse-power motor-generators for charging the storage batteries, the motors being of the Holtzer-Cabot make, as are all the machines, and type MP four-pole and running off the



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WIRE CHIEF'S DEPARTMENT, SHOWING MAIN AND INTERMEDIATE DISTRIBUTING BOARDS, RELAY RACKS AND CABINET FOR UNDERGROUND CONDUCTORS, 24,000 PAIRS, FRONTIER TELEPHONE COMPANY.

220-volt direct-current circuit, taking thirty-eight amperes at a speed of 900 revolutions per minute. The generators are of the type MP four-pole and deliver 175 amperes at thirty volts and at a speed of 900 revolutions per minute. Two four-party line ringing machines with motor in centre and two ringing generators on either end and on the same shaft, one machine to run off the 220-volt direct-current circuit and the other to run off the twenty-four-volt storage battery. The motors are of the type MP four-pole and at a speed of 1,000 revolutions per minute, the 220-volt motor draws four amperes and the twenty-four-volt motor draws 36.5 amperes. The four ringing generators on the one machine are duplicates of those on the other and are of the type MR and will deliver 1.5 amperes

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BEHIND THE BOARD, FRONTIER TELEPHONE COMPANY.

at 100 volts. The No. 4 generator has two poles and delivers a current of 16.6 cycles; the No. 1 generator is four-pole and delivers a current of 33.3 cycles; the No. 2 generator is six-pole and delivers a current of fifty cycles; the No. 3 generator is eight-pole and delivers a current of 66.6 cycles. By the use of these different frequency ringing machines and ringers having armatures differently tuned any one of four bells can be rung on a metallic line without the other bells on the same line being disturbed. Each of the four ringing buttons with each calling plug corresponds with the ringing current of the proper frequency. A ten-horse-power Westinghouse twin-cylinder gas engine connected by a chain drive to a charging generator of the same type as those used on the charging motor-generators. Two sets of eleven cells of the National Battery Company's storage batteries placed in a room just to the rear of the charging machines. Each cell at present contains nine plates fifteen and one-half inches square and has a capacity of 600 ampere-hours. The capacity of each cell can be doubled by addition of more plates for which there is ample room in the present tanks.

The Niagara Falls power is used both for power and lighting and is supplied by the Buffalo General Electric Company after being transformed to a three-wire 220-volt direct-current circuit. A gas en-

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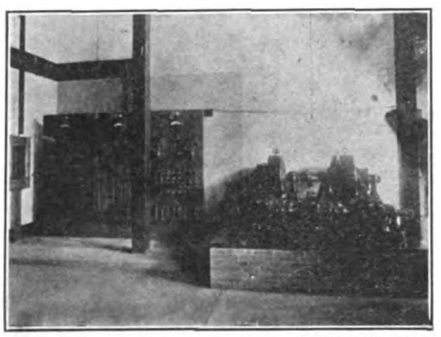
gine is now being installed in the basement to drive an eight and one-quarter kilowatt Crocker-Wheeler generator for lighting purposes, in case the Falls power is shut off at any time.

A two-position wire chief's desk is in-



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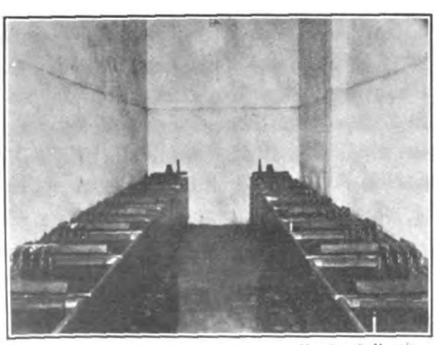
WIRE CHIEF'S DEPARTMENT, POWER SWITCHBOARD AND RINGING AND BATTERY CHARGING GENERATORS, FRONTIER TELEPHONE COMPANY.

stalled in the front of the terminal room and has voltmeters and all necessary switches for testing out subscribers' lines.

The Kellogg Switchboard and Supply Company, of Chicago, furnished and installed the apparatus above described, as did it also furnish the subscribers' instruments which are of the usual type aside from the party line instruments which differ only in the ringer mechanism.

The principal part of the city is fed by an underground cable distribution and there are some thirty-five miles of main conduit trench and over a million feet of conduit ducts. In the business section a main line of ducts leads from the exchange north and south along Ellicott street and from these main ducts and crossing at right angles lead branch ducts on alternate streets, thus touching each block on at least one side. From these ducts, where buildings adjoin each other, lead laterals into basements and office buildings, where basement and office building cable boxes are placed, three or four terminals being placed in each block, and in office buildings from one to four



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STORAGE BATTERY ROOM, SMALL CELLS ARE ON TELEGRAPH CIRCUITS, FRONTIER TELEPHONE COMPANY.

terminals are placed on each floor. In places where the buildings are more scattered, laterals run to poles in the backyards where terminal boxes are placed. In the more compact residence districts conduits are run along the principal streets and laterals are run from these to terminal poles in the backyards. Sometimes in long blocks a pole line is built and aerial cable strung in the backyards or an alley, alternate poles which are several feet higher than the standard being used for terminal poles. Ringtop distribution is used on these poles. In the more scattered residence districts pole lines have been built in the streets and aerial cable strung, terminal boxes being placed quite close together. Idaho cedar has been used for poles throughout the city.

Several toll line leads have been built and long-distance communication already established with Rochester and the East as well as surrounding towns. Other toll lines are now being built.

For underground work 400-pair No. 22 B. & S. gauge paper lead-sheathed cables are used which are brought from various distributing centres to the exchange. Here

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INSTRUMENT REPAIR SHOP, FRONTIER TELEPHONE COMPANY.

they are brought through the basement and up ducts at the side of the building to a point just below the second floor and underneath the main frame, where four 100-pair No. 22 B. & S. gauge, double silk and single cotton, insulated lead-sheathed cables are spliced into each 400-pair cable. These 100-pair cables are brought up to the cable side of the main frame and there fanned out and soldered to the proper line clips. At various manholes branch cables are spliced into the main cables, and these are used for distribution to buildings and terminal poles. In underground work cables of 400, 200, 100, 50 and 25 pairs are used, but in aerial work only cables of fifty and twenty-five pairs are used.

On pole lines where arms are used, the use of more than two arms to a pole is prohibited. When it is necessary to increase the line capacity, cable is strung and more pole terminal boxes placed. This has been found to present a much neater appearance as well as to be far more convenient.

In running open aerial lines bare copper wire is used, except in sections where trees are encountered and here No. 14 B. W. G. weatherproof iron wire is used. For subscribers' drops single No. 14 B. W. G. weatherproof iron wire is used and placed on glass insulators screwed to two-point universal irons instead of wood brackets. Where lightning arresters are necessary at the subscribers' station an outside arrester is placed near the point of entrance to the building. Pencil fuses are also used at this point. Fuses and arresters are placed at each terminal pole.

All inside wiring is done according to specifications, and differs but little from the usual standards used elsewhere.

Although the Frontier Telephone Company only began cutting lines into service in February of this year, it now has over 6,000 subscribers connected to the exchange. Over thirty private branch exchanges have already been installed, varying in size from 5 to 150 lines each. Also many special equipment private lines have been installed.

The complete installation of the system has been under the personal supervision of Wilbur H. Johnston, superintendent and assistant general manager of the company.

The officers of the company are: president, E. C. Lufkin; vice-president and general manager, the Hon. Henry H. Persons; secretary and treasurer, Charles B. Hill; assistant general manager, Wilbur H. Johnston.

The directors are as follows: Irving Stearns, Henry H. Persons, John B. Weber, H. D. Kirkover, Alvan Markle, E. C. Lufkin, Arthur Scranton, Charles B. Hill, W. A. Douglas, James M. Thomas, Charles E. Austin, Martin Carey, F. R. Green and Charles W. Goodyear.

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INDUSTRIAL ELECTROCHEMISTRY AND ELECTROMETALLURGY—IV.

NOTES ON PROGRESS IN EUROPE AND AMERICA.

BY JOHN B. C. KERSHAW.

Electrolytic Chlorates.

The industrial situation in the electrolytic chlorate industry was so fully dealt with in the special illustrated article contributed by the writer to the ELECTRICAL REVIEW on October 4 and 11, 1902, that little can be added to the information there given. A letter giving some interesting dates relating to the development of the industry in Switzerland and France has, however, recently been received from M. Gall, who, with M. Montlaur, acted as pioneer in this industry. The Gall and Montlaur process was first tried on an industrial scale at Villers-St.-Sepulchre in 1886; and this factory was operated until 1891. The Valorbes factory was started in 1890, and the St. Michel factory in 1892, and both of these factories are still in operation. The writer has also recently received a letter from the director of the Vereinigte Chem. Fabriken zu Leopoldschall in which it is stated that although this company carried out experiments upon the electrolytic production of chlorates, and patented a cell and process in the names of Spilker and Loewe, the same was not developed industrially, and the Leopoldschall company is not now producing chlorates by electrolysis. The patents of Spilker and Loewe for chlorate production are dated 1887, 1888 and 1892 while those of MM. Gall and Montlaur are dated 1886 and 1894.

As evidence that the fall in the price of potassium chlorate which is now selling at twopence three farthings per pound in England, as compared with sixpence per pound only twelve years ago, has seriously affected the prosperity of some of the electrolytic works, we have the lack of expansion shown by this branch of electrochemical industry. No new chlorate works have now been erected for four years; and the factory built at Niagara for operation of the Blumenberg process in 1896 has not been restarted, since the fire which occurred there three years ago. As pointed out by the writer in the note on this industry published in the ELECTRICAL REVIEW of February 7, 1903, the electrolytic chlorate industry has been suffering from overproduction and low prices; and only those factories which are working good processes under very scientific management can make profits under the existing market conditions for their product. At present there seems no hope of any marked change for the better in the selling price of chlorates.

Zinc.

The electrolytic or electrothermal extraction of zinc from its ores has lately been receiving much attention, and several important communications to the technical press have recently been made on this subject. Swinburne in a paper read before the Faraday Society (the new English society of electrochemists) has given further details of the experimental trials at Weston Point with the Swinburne-Ashcroft process of extraction. This process is one of chlorination, followed by chemical or electrolytic separation of the various metals contained in the fused mixture of chlorides obtained from the first operation. The zinc is recovered by electrolysis of the fused zinc chloride. The inventors have great faith in the future of their process for treating mixed sulphide ores, and the slow course of its industrial development is perhaps a feature that is to be commended. Electrochemical and electrometallurgical processes that are developed too quickly are apt to collapse with startling rapidity. (See note in ELECTRICAL REVIEW of February 14, 1903). It is now nearly six years since the Swinburne-Ashcroft process was first subjected to laboratory trial; and the scientific data and experience that must have been gained in the trials during this period have no doubt yielded most valuable insight into the practical conduct of the process.

In France, the Salgués process for treatment of zinc ores in the electric furnace is being tried at the carbide works at Crampagna, in the Pyrenees. The ores used for this process contain the zinc, either as oxide or sulphide, and are smelted with fluxes, which yield a slag carrying all the impurities of the ore. This sounds well on paper, but may be difficult in actual practice. The zinc may either be obtained as metal, adhering to the slag, or it may be volatilized and condensed as zinc dust. With ores containing forty per cent of Zn, and furnaces of 100-kilowatt capacity, the output of Zn is reported to be nearly five kilogrammes per kilowatt-day. At present the process is being used at Crampagna for production of zinc-white (blanc de zinc); but it is not stated how this compound is obtained from the zinc dust or metallic zinc.

Strzoda has recently published some instructions for obtaining good cathode deposits of zinc by electrolysis. He advocates the use of sodium zincate solution, with agitation of sand, or other inert finely divided material in the electrolyte to prevent the formation of zinc sponge. The zinc can also be extracted from calamine by this process, if the ore be first crushed and suspended in the electrolyte. In both cases carbon anodes are used, with copper as cathode material.

Barium and Its Compounds.

Some details were given in the ELECTRICAL REVIEW of February 28, 1903, concerning the production of barium hydrate at Niagara Falls, by the Bradley & Jacob's process. This process depends upon the treatment in the electric furnace of a mixture of barium sulphate and coke, portion of the sulphate being first reduced to sulphide, and the two salts then reacting at the temperature employed to yield oxide and sulphurous acid gas, in accordance with the equation—

$$3BaSO_4 + BaS = 4BaO + 4SO_2$$

The writer pointed out in the note referred to above, that this reaction could be carried out in ordinary furnaces heated with coal, and that only in exceptional cases could electrical energy be profitably utilized for this manufacture. The conditions for success, were stated to be: cheap power, and a market for the products in the vicinity of the works. These conditions do not appear to have been found at Niagara, for the United Barium Company is stated to be in liquidation, and a deficiency of $30,000 exists in the accounts; the assets being valued at $90,000 and the liabilities being $120,000. The collapse of this company comes rather as a surprise, for as recently as the autumn of last year, it was stated that the manufacture was a success and that the factory at Niagara was to be greatly extended. The cause of the failure is said to have been the small demand for barium hydrate in the sugar industry in the United States; and possibly the objection to use barium salts (which are all poisonous) in the preparation of a foodstuff, may have had some influence upon the result. In England, this objection to the use of barium salts for sugar refining is very much in evidence.

As regards the other process, to which reference was made in the earlier note, the writer has recently received a further communication from the agent of the Brussels firm which is exploiting the patents. In this, it is stated that the plant at Brussels is only an experimental one; that the process has been improved, and that it is now worked without the aid of an electric current. Barium and its salts must therefore be removed from the list of chemicals now being produced industrially by aid of electricity.

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MOUNTAIN CLIMBING RAILWAYS.

BY GEORGE E. WALSH.

The opening this winter of the new electric railway which is to climb to the summit of the Jungfrau practically inaugurates a new era in mountain climbing railroading. Some of the most difficult engineering problems in railroading of the past have been overcome in constructing railroads to the summits of famous mountain peaks to accommodate the summer visitors who wish to ascend to the high altitudes for their health or pleasure. The most noted of these railroads in this country are those which wind up the sides of Mount Washington and Pike's Peak.

The Mount Washington railroad is the pioneer mountain climbing railroad of this country, and for upward of a quarter of a century it has been one of the famous attractions of the summer resorts of New England. The Pike's Peak railroad reaches a higher altitude than that of the former, and it required greater engineering difficulties to construct it. During a good part of the time the construction engineers were forced to cut their way through solid rock in the face of heavy snowstorms. The grades of both roads are steep at places, and the cost of operating the two lines has made their financial success much lower than the builders expected. The railroad up Mount Pilatus represented the most important mountain climbing railroad in Europe until the new Jungfrau railway was projected and opened to the public.

The equipment of the mountain railroads with electric power was experimented with a dozen years ago, but little success attended these efforts. Electrical railway developments have within the past few years brought the matter up again for consideration. The question of changing the motive power of the two important American mountain climbing railroads to electricity is now in the charge of engineers, who in the past year have been making estimates on the cost of installation and operation.

The Jungfrau railway offered in every respect most difficult electrical engineering features that had to be overcome in order to demonstrate the feasibility of climbing mountains by electric cars. The Eigerwand station of the Jungfrau, which has just been opened, is the highest point of any electric railway in the world. The total height of the mountain to its accessible summit is 13,670 feet, and to this extreme altitude it is proposed to carry the new road if possible. The early projectors of the railway did not anticipate reaching the summit, but merely to connect some of the few important lower levels with Scheidegg, where the steam railroad running from Lauterbrunnen and Grindewald ended. This is the highest point of the western Alp level of this district, and is 6,160 feet above the sea level. To start at this altitude and run an electric railway to the summit of the Jungfrau was a daring undertaking.

From this starting point the engineers ran the line to the Eiger glacier, which has an altitude of 7,645 feet, where a magnificent view of the mountain and valley is obtained. To complete this first part of the road a tunnel 322 feet long had to be cut through the solid mountain. There is probably no station in the world which affords such an extensive view of glaciers as this electric railway station at Eiger. Although the altitude of the station is only 873 feet higher than the starting point of the road, it requires a ride of a mile and a quarter to reach it, so winding and irregular is the route.

The first section of the road proved so popular to tourists that work was immediately begun on the second section, which extends to Rothstock, and enjoys an altitude of 8,270 feet, and is two miles from the starting point. The third station was established at Eigerwand, and is 9,405 feet altitude. The fourth station is Eismeer, or sea of ice, with a total altitude of 10,355 feet. This station is completed, and the line to this point is nearly ready for operation.

From this point the line will run in time to Jungfraujoch, 11,090 feet, and eventually to Jungfrau, a total height of 13,488 feet. This is as close to the summit as any line can come, but the remaining few feet will not count. A winding staircase or an electric elevator may eventually be built to carry those who wish to reach the very pinnacle of the mountain peak.

To reach this great altitude with an electric railway, the engineers were forced to cut their way through the solid mountain rocks for nearly one-half the distance. There was no side spurs or galleries over which the road could be built. Through different portions of the tunnels windows have been cut to give the passengers views of the valleys and mountain peaks.

The difficulties experienced in cutting through the mountain at several points was so great that only electrical drills and boring machines could be used. These had to be chained to the sloping sides of the mountain, while the workmen were lashed to suspended platforms from above. The electric boring machines were worked by American-made motors, and when the section beyond the present highest station is started even more difficult engineering feats will be required to place the machines in working position. The line of eternal snow and ice will then be reached, and the work must be carried on under difficulties of the most surprising kind. Frequent snowstorms and blizzards enshroud the summit of the mountain, and it is expected that work can be conducted only in summer time.

The gradient of the new road in its first four sections runs from fifteen to twenty-five per cent, but this maximum may be further increased in the final stretch. Another obstacle in the way of the engineers was that of securing proper workmen who could toil in such rarefied atmosphere. At 10,000 feet altitude comparatively few workmen can do hard work for more than a few hours a day; but the selected north of Italy men appear able to respond to the demands of the climate better than was expected. Mountain sickness frequently decimates the ranks of the workmen, and new shifts have to be obtained from below; but these new men have to be accustomed to the high altitudes by degrees. At 13,000 feet, the workmen may have to work in shifts of two hours at a time, and then return to lower levels for rest and recuperation.

The company constructing the road give the best hygienic care to their workmen, and they are housed and fed with as much attention to little details of comfort as though they were a part of the company's board of directors. As the road is pushed skyward a completely equipped plant goes with the men, including a bakery, smithy, infirmary, and good houses for sleeping and eating. It has been found, however, that many of the rugged mountaineers can not only live at the summit of the Jungfrau all the time, but they maintain an amount of health and strength that is surprising to those who have heretofore concluded that an altitude above 10,000 feet was destructive to the tissues of the heart and lungs.

The gauge of this new mountain climbing electrical railway is thirty-nine inches, and the rails weigh forty-two pounds to the yard. They are laid on sleepers of steel, to which they are bolted and clamped securely. As the rack system is used, the rails have teeth cut into them. The electric locomotives employed for the new railway are built so that the working parts will be amply protected from extreme weather conditions, being enclosed

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so that all parts can be kept warm. They are operated by two three-phase motors of either the Brown, Boveri or Oerlikon type. These have from 120 to 150 horse-power, with 750 revolutions per minute.

The motive power for operating the road is obtained from the waterfalls on the White Lutschine, a distance of nearly six miles from the nearest railway station. The power for the road can be increased at comparatively little expense. The three sets of turbines can furnish 2,650 horse-power; but at present only about 1,650 horse-power is installed. There are two Girard turbines of 500 horse-power each; two Francis turbines of 800 horse-power each, and two small auxiliary turbines of twenty-five horse-power each. These six turbines are directly coupled to three-phase alternators which generate 7,000 volts. The electric current is carried to the substations in conduits of pipes made of steel sheeting, and the high pressure transformed in 200-kilowatt transformers. At the stations small transformers take the high-pressure current down for lighting and heating purposes.

The wooden poles for carrying the transmission line are placed 100 feet apart where topographical conditions will permit, but through the tunnels the wires are attached to wooden side brackets, or carried through conduits built for them in the solid rock. The construction of the supports for the transmission wires was as much a problem in places as that of building a place for the track. In fact, at almost every step of the way some unique engineering obstacle had to be overcome.

Four trolley poles collect the current, two for each phase. The brake on the engine and cars was of necessity important, and this is applied by the tension of a strong spring resting on the axles of the motors. The trains are made up of a small locomotive and two trailers coupled on behind. Complete this train weighs about twenty-eight tons, and the two trailers will accommodate eighty passengers. The speed of the train is not great, nor is it desirable that it should be, as passengers ascending the mountain frequently desire to study the scenery at different points as they advance. It is intended that the trip up to the summit shall consume about one hour and forty minutes. This gives the passengers the opportunity to accustom themselves to the change of atmosphere. A sudden rise to the top of such a mountain is dangerous to many people, but with a slow rise it is estimated that not one per cent of tourists will be unpleasantly affected by the air. The train runs on the maximum gradients of twenty-five per cent at a speed of 8.5 kilometres per hour, but even this speed will not be maintained at all seasons of the year. Those suffering from mountain sickness can be let off at almost any place along the line where medical attendance can be obtained.

In the winter season it will probably be impossible to run the cars on account of the severe snowstorms, and the road will practically be snowbound and the summit station cut off from the rest of the world from October to April. There will, however, be maintained at the summit all the year round a small colony of workmen, including electricians, engineers, hotel-keepers and physicians. Ample accommodations will be provided for them in the way of shelter and refreshments. Many mountain climbers visit the summit in the dead of winter, and those who follow the line of the new road will be sure to find shelter and food at the different stations.

Unique in the annals of railroading as this line will be, the cost of operation is placed so much lower than that required to run cars up and down Mount Washington, Pike's Peak and Mount Pilatus, that the enterprise is assured of success at the beginning. It practically opens a new era in mountain climbing railroads. There are a dozen mountains in this country where similar electrical roads will be built with advantage to tourists seeking health and recreation. The wonderful curative effects of mountain air at certain seasons of the year is spreading the demand for accommodations at high altitudes. The question of reaching the summits of the mountains has always been the most insurmountable obstacle, and the experiments with steam railroads and cable roads have not been altogether satisfactory. Electricity in entering this new field of endeavor may soon convert our mountain summits into great health resorts and sanatoriums.

Anniversary of the Death of William Gilbert.

Thursday, December 10, was the three hundredth anniversary of the death of William Gilbert. In commemoration of this, the mayor and other representatives of the borough of Colchester, England, attended a meeting of the British Institution of Electrical Engineers, and received, on behalf of the borough, an historical picture representing Dr. Gilbert in the act of showing his electrical experiments to Queen Elizabeth and her court. William Gilbert was born in the borough of Colchester in 1544, and died in 1603.

An Electric Baker's Oven.

An electrically heated oven for a bakery has been put in service at Montauban, France. This draws its power from the local distributing system, and the oven has not been changed in carrying out the installation. In case of an interruption to the electrical supply, it can be heated with wood. The oven is circular, 3.2 metres in diameter, with a spherical arched roof fifty centimetres maximum height. It is completely enclosed, with no other opening except the oven door.

The electrical installation consists of twenty heating elements using 700 watts each. They are connected in parallel across the 110-volt circuit and are distributed in four hearths—two taking 37.5 amperes at the centre, and two twenty-five amperes at the sides, a total of 125 amperes. The heating elements are placed on a rack, and can be raised or lowered in the oven, as desired. It is raised when introducing the bread and lowered toward the end of the baking, with two hearths operating simultaneously at a rate of 125 amperes, 110 volts, a consumption of 13.75 kilowatts; the desired temperature is reached in ninety minutes, the energy consumed being 20.625 kilowatt-hours. After this point has been reached, the power required is reduced to 5.5 kilowatts and the bread is introduced. The baking is then continued without interruption.

The Pacific Coast Electric Transmission Association.

The transactions of the Pacific Coast Electric Transmission Association, just issued, contain the proceedings of the seventh annual convention, held in San Rafael, Cal., June, 1903. The following is a list of the papers which were read and discussed: "After the Ions—What?" by Alexander G. McAdie; "The Electric Automobile as an Income Producer," A. E. Brooke Ridley; "Electric Power for Mining Purposes," George Scarfe; "A Coming Problem for the Pacific Coast Engineer," W. F. Lamme; "Local Distribution for Transmitted Power," George C. Holberton; "Single-Phase Motors for Multi-Phase Plants," H. A. Bullard; "Organization of the Operative Forces of a Transmission Plant," L. M. Hancock; "Some Notes on Alternating and Direct-Current Arcs," P. C. Butte; "Electric Railway Service as Supplied by Long-Distance Power Transmission," Allen H. Babcock; "Tangential Water-Wheel Efficiencies," George J. Henry, Jr.

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New York Electrical Society.

The New York Electrical Society held a most interesting meeting on the evening of December 16, when Mr. S. T. Dodd, of the Stanley Electric and Manufacturing Company, of Pittsfield, Mass., gave a comprehensive lecture on "The Evolution of the Electric Railway Motor." Mr. Dodd said:

The early investigators of the electric railway problem, Edison, Field and others, made the mistake of attacking it from the locomotive standpoint and consequently their efforts contributed little or nothing to the solution of the problem. The first electric car to be driven by a motor placed under the car floor was put into operation in 1884 in Cleveland, Ohio, by the Bentley-Knight company.

In '85 and '86 various experiments were made by Messrs. Daft, Sprague, Vanderpool and Short. Mr. Short attempted to develop a series railway system and built a road in Denver which was soon abandoned. To Mr. Short should be given the credit of seeing that for motors of the normal speed of that date, double-reduction spur gearing should be used. By '87 or '88 both the Bentley-Knight and the Sprague companies had developed bipolar, series-wound motors, especially for railway service, and it was about this time also that public attention began to be attracted to the work.

The years '88 and '89 were very eventful; the Sprague and Edison interests consolidated, the Bentley-Knight interests were acquired by the Thomson-Houston company, and there appeared on the market a Westinghouse double-reduction motor and a Short double-reduction motor. We might say that the standard railway motor at this date was bipolar, running at a normal speed of 1,000 to 1,500 revolutions per minute. It was connected to the axle by double-reduction gearing, it was series-wound and with the exception of the Short motor was of the smooth core drum type. The high speed of these motors was a serious disadvantage. The railway managers were bitterly complaining of the expense of maintaining gears and pinions. It was seen that the electric railway motor could not be a final and permanent success until some method was found of obviating this difficulty.

The Wenstrom motor of 1890 offered the solution of this difficulty. The Wenstrom motor was a multi-polar designed with slotted armature, thereby making possible the reduction of motor speed and the change to the single-reduction type of motor. The Westinghouse company then introduced what might be called the first of our modern motors, its No. 3, which with the minor modifications introduced in its No. 12 and No. 38 remains to-day the standard Westinghouse type.

The G. E.-800 motor of 1893 was an attempt to make an absolutely enclosed and waterproof motor. With the appearance of the enclosed motor, a new problem was introduced; namely, ventilation, a factor which had previously received but little attention and which even to-day is not always given the consideration which its importance deserves. In 1894 appeared the G. E.-1000, wherein it followed the lead of the Westinghouse No. 3 and had four poles, abandoning the consequent pole design. In 1895 the Walker company brought out its No. 3, which marked a decided advance in that better provision was made for ventilation than in any previous type of motor. In 1899 the Westinghouse No. 38 introduced laminated poles. In 1896 there was a change in the character of the service demanded of railway equipments brought about by the beginning of interurban roads and by the extension of city roads into the suburban districts, the new conditions calling for continuous service at moderate loads. In order to meet the new requirements the General Electric company brought out its No. 52, the feature of which was the ventilated armature which has since become standard. The Walker 15-L, a 100-horse-power motor which was built for the Brooklyn elevated, and the G. E. No. 51 illustrate the limitation imposed upon motors of the standard type when built in large sizes. This limitation called for a change in motor construction which was met by such motors as the G. E. No. 50 and particularly the G. E. No. 55 built for the Nantaskett Beach line and the Metropolitan and Westside elevated. The latter had a solid box frame with waste packed bearings from which the armature could be removed by sliding it out through one end. This type has since become popular for very heavy service.

The S. K. C. type of motor represents a still further development of the principle of motor ventilation. For the first time in a street railway motor, both ends of the armature are left open for the entrance of air into the armature and there are ducts in the pole-pieces and through the frame of the motor which register with the ducts in the armature perpendicular to the shaft. As a result of this unusually good ventilation the all-day load of this motor is about fifty per cent of its hour rating (with the same heating) as compared with an all-day capacity of but thirty-five per cent of the hour rating for other motors of the same grade.

In the G. E. No. 74 motor is preserved the compactness of the G. E. No. 55 with the added advantage of increased accessibility of the armature. The G. E. No. 69 for the New York subway and the two makes of German motors used upon the Berlin-Zossen line are the most modern types of motor for heavy service, and in each of them it should be noted increased attention is being paid to ventilation. As is well known, the Berlin-Zossen motors are alternating-current motors and mark a reversion to the gearless type discarded ten years ago.

I have attempted to show you how our present type of motor grew from the stationary motor of twenty years ago. It is a series motor, a characteristic which it inherited from the Brush motor used by the Bentley-Knight people in 1884. It is hinged upon the axle and geared to it by spur gearing, for which we are indebted to Messrs. Sprague and Short in 1886; it is a multi-polar motor, with slotted armature which is derived from the Wenstrom motor of 1890; it has concentric fields, with salient poles, projecting inwardly from the surrounding case and the armature is series connected so that one pair of brushes suffice for a multi-polar motor, characteristics which are derived from the Westinghouse No. 3 of 1891. It has machine-wound coils and a barrel armature, which are due to a development through the Westinghouse No. 3, the G. E.-800, and the Walker. It has laminated fields, which were introduced by the Westinghouse No. 38 in 1895; it has a ventilated armature for which we are indebted to the G. E. No. 52 of 1896.

At the present time, increased attention is being paid to disposing of the heated air from the interior of the motor and the ventilation of the motor for long-time service. This means that the motors of the future will have reduced weight of electrical parts, magnetic iron and conductors, and more attention will be paid to the bearings, gears and other mechanical parts.

The history of the art was illustrated by an admirable series of lantern slides. The following members were elected: Mr. R. P. Bache, Central Electric Company, Bound Brook, N. J.; Mr. John C. McGibney, 364 West Twenty-fifth street, New York city; Mr. Jas. Stuart Patrich, 125 West 133d street, New York city; Mr. Wm. J. Moore, Stevens Technical Institute, Hoboken, N. J.; Mr. Henry Abbey, Marine Engine and Machine Company, Harrison, N. J.; Mr. Carl Behn, Buffalo Refrigerating Machine Company, Harrison, N. J.

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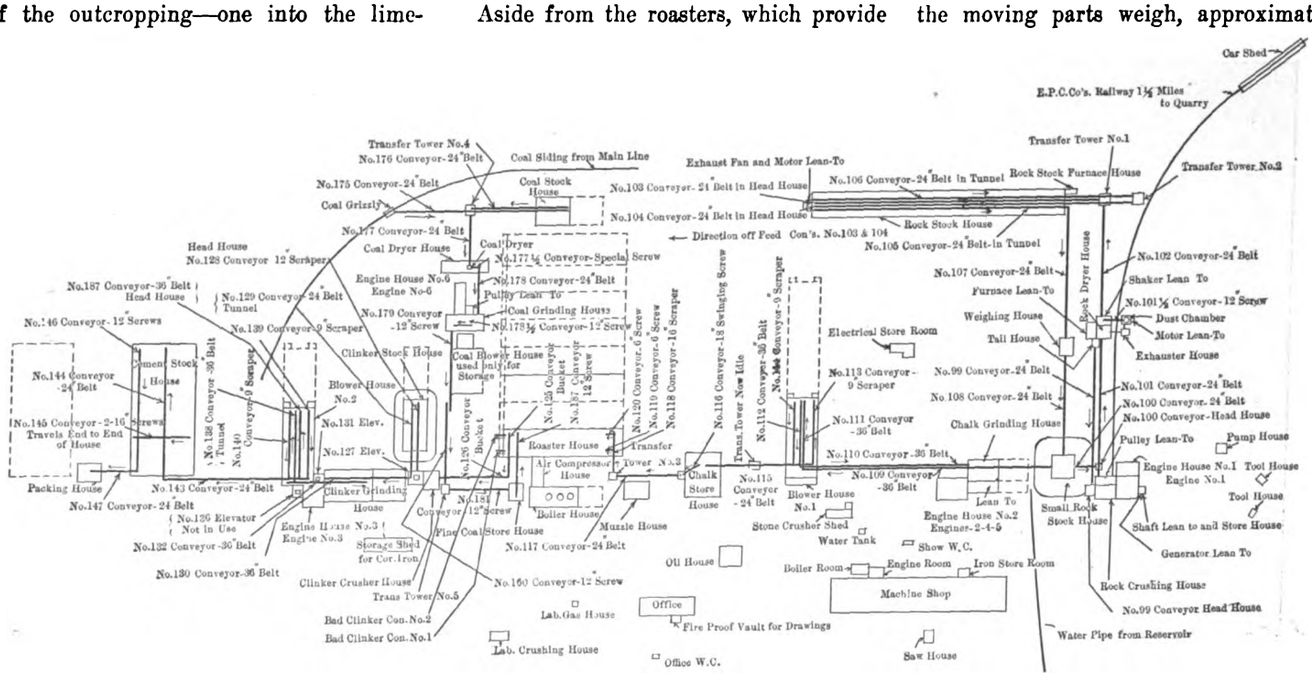
The Edison Portland Cement Company.

A General Description of the Process and the Works at New Village, N. J.

THE works of the Edison Portland Cement Company are located at New Village, N. J., adjacent to the main line of the Delaware, Lackawanna & Western Railroad. The Edison company has some 600 acres of land in and about New Village and Stewartsville, N. J., the greater portion of which contain limestone and cement rock. The buildings stretch out in a continuous line for about a half mile, and a study of the accompanying drawing will give a good idea of the general layout of the plant.

Two cuts have been made into the face of the outcropping—one into the limestone and the other into the cement rock—each cut in at a slight angle to the other. The rock strata is composed of carbonate of lime and cement rock, the carbonate of lime lying next to the dolomite. The Edison company has what is probably one of the most fortunately situated quarries in the world, in that the cement rock found in this territory and the limestone both are of the best quality for the making of good cement.



GENERAL PLAN OF THE WORKS OF THE EDISON PORTLAND CEMENT COMPANY, NEW VILLAGE, N. J.—THE DOTTED LINES SHOW INTENDED EXTENSION.

The accompanying photograph shows a general view of the cutting in the quarry as it stands to-day. The outcropping has been penetrated to a depth of probably 200 yards, and the walls of the quarry are now about fifty feet high.

The rock is first drilled and blasted, and then picked up by a ninety-ton Vulcan steam shovel and loaded upon skips, a standard gauge railway running into the heading in each cut. These ninety-ton steam shovels are the most powerful of their kind ever constructed. Huge boulders weighing upward of five to six tons are easily picked up and deposited upon the skips. After each skip is loaded, it is hauled by a horse to a siding, where a train of flat cars is made up, and the rock is then hauled from the quarry, a distance of nearly a mile, to a shed located about 100 yards from the crusher. It is here that the actual process of cement-making begins.

Aside from the roasters, which provide the spectacular element of the plant, the crushers are, of course, the most interesting from a popular and technical point of view. After the locomotive has hauled its train of flat cars to the shed, the train is broken up into sections of three cars apiece. There is a slight decline from the car-shed for about 500 feet, where the bottom of an incline reaching into the crusher house is met. The three cars travel by gravity along the tracks and partly up the incline, where they butt into a "dolly" car, which is provided with an automatic coupler. By means of this car the three flats are then hauled up the incline to the top of the rock-crushing house.

In this rock-crushing house are situated the giant crushing rolls, and beneath these, the smaller rolls for crushing the broken rock. At the top of the rock-crushing house is a very interesting application of the motor drive.

It might be well at this point to explain that the skips are laid loosely upon the flat cars, and are of the form of an exaggerated dustpan. At the back of each is a heavy ring bolt. A large hook on the end of a flat steel belt automatically engages with this ring bolt and drags the skip from off the flat into adjustment at the edge of the hopper just above the giant rolls. These giant rolls are each five feet in diameter by five feet long, and the moving parts weigh, approximately, twenty-five tons each. They are capable of crushing any size of stone weighing five tons or less. The two rolls rotate in opposite directions, and are made up of chilled iron plates fitted on to a mandrel.

The motor which operates the skip dump—as the hook apparatus is termed—is enclosed in a gunny chamber which is absolutely dustproof. This is a chamber which is made up of a skeleton framework, and the housing of which is composed of gunny cloth. It is a feature of all of the electric motors used in the Edison works that they are enclosed entirely in these dustproof gunny chambers, and all of the gears are also enclosed in gear cases, to prevent their being interfered with by the dust which is prevalent in all parts of the mill.

Immediately in front of the hopper,

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and directly under the edge of the skip as it is placed in position for dumping, is a feed roll operated by an enclosed electric motor, and which throws the rock directly between the crushing faces of the giant rolls. This feed roll, together with the skip dump and the drum for hoisting the three cars up the incline to the rock-crushing house, is controlled from a platform to one side of the main hopper. On this platform are the two controllers. The cable drum which winds the cable for pulling up the cars to the crusher is operated by a 500-volt, 110-horse-power, General Electric motor. This is equipped with a solenoid brake for lowering the cars, and the resistance is disposed along the roof of the building. The three cars which are brought up at each time contain about fifteen tons, and a trip is made once every four minutes, the crusher taking care of the stone as fast as it can be brought up.

After the rock has been deposited in the hopper and passed through the giant rolls, it drops to a smaller hopper with a capacity of ten tons, and is fed out over a roller feed to the first set of thirty-six-inch rolls on the floor below. Then it passes by gravity through a second and third set of thirty-six-inch rolls. These thirty-six-inch rolls are thirty-six inches in diameter and thirty-six inches long, with a crushing face of twenty-eight inches. The first thirty-six-inch rolls have flywheels to enable them to crush the large pieces passed by the giant rolls. Both the first and second rolls are set rigidly at a fixed distance between the crushing faces, but the third set of thirty-six-inch rolls is held together by a set of coiled springs. This latter set of rolls also receives the spalls from the rock-drying house, which matter will be taken up in detail a little further on.

After passing through the first set of thirty-six-inch rolls, the rock has been broken up into cubes of about three inches cross-section. Passing through the second set; it is broken into pieces of about one-half this dimension; and, on passing through the third, it comes down to about one-half inch in cross-section and finer. From the third set of thirty-six-inch rolls the broken rock passes on to conveyor belt No. 100 to the rock-drying house.

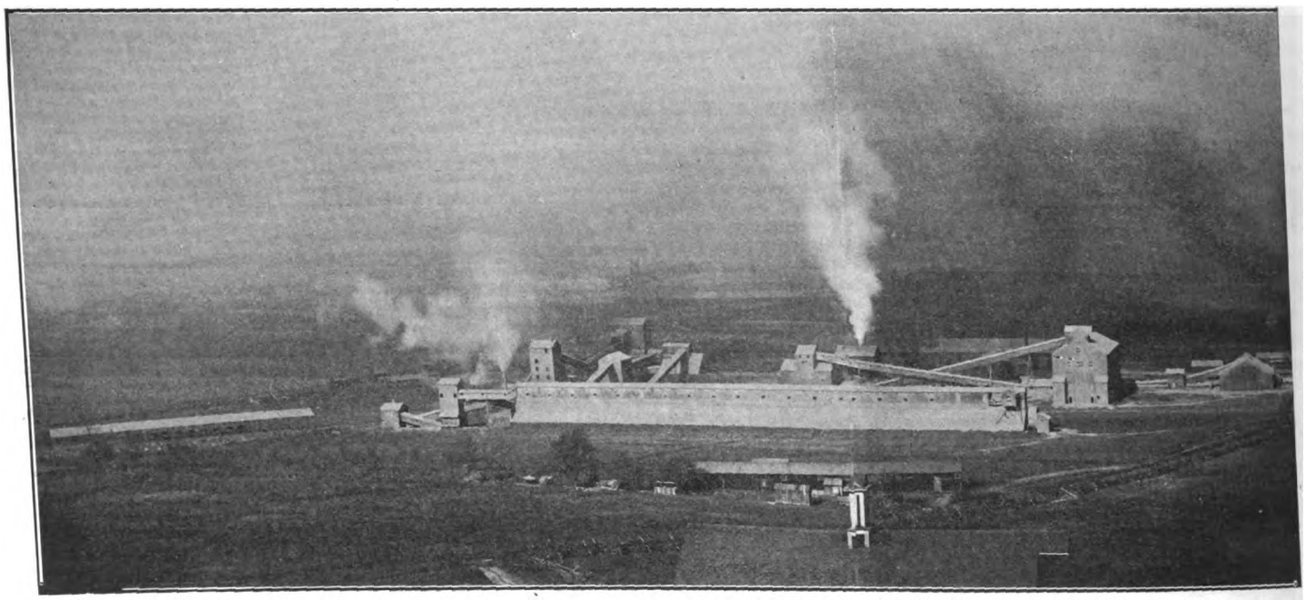
The crushing rolls in the rock-crushing house are driven from the engine room on the first floor by a 500-horse-power E. P. Allis vertical cross-compound condensing engine. This runs at 100 revolutions per minute, and drives directly on a jack-shaft. On this shaft is one pulley with a seven-foot face, upon which are three belts driving the three sets of thirty-six-inch rolls. On the same shaft another pulley drives the giant rolls. Three generators are also driven from a pulley on the same shaft.

The broken rock, after being carried on the conveyor belt from the bottom of the rock-crushing house to the top of the rock-drying house, is allowed to fall by gravity through a series of grates and baffle plates, which are continuously heated by hot gases. On the first floor of the rock-drying house are three furnaces, and the heat enters the drying flues in three places. A shaker engine draws the baffle plates in and out, and allows the broken material to fall through. These furnaces are equipped with blowers for forced draft, when this becomes necessary. After the material has passed through these three stages, the rock has been thoroughly dried.

The hot gases from the furnaces are exhausted from the top of the dryer by an eighty-inch exhauster, and delivered in a dust separator. The dust from the separator is delivered to conveyor belt No. 102, by screw conveyor No. 101½. The rock-drying plant is driven by a fifty-horse-power motor.

After the rock has passed through the drying house it is conveyed by conveyor belt No. 102, to transfer tower No. 1. At transfer tower No. 1 the rock is deposited on conveyor belt No. 103, by which it is taken to the rock stockhouse. This rock stockhouse is 462 feet long and has seven bins, each with a capacity of 1,500 tons. Four of these bins are used for cement rock, and two for carbonate of lime, the extra bin being used for mixing purposes. Belt conveyor No. 104, on the top of the rock stockhouse, and belt conveyor No. 106, on the bottom of the rock stockhouse, are used for mixing only, and the material may be taken from, and delivered to, any of the bins by these two conveyors. This mixing process is necessary for the reason that sometimes the rock, as quarried, runs high in lime, and at other times runs comparatively low. By carrying the cement rock back and forth through transfer tower No. 2, it is thoroughly mixed and ensures a uniform product.

After the material has been thoroughly mixed it is fed out from the different hoppers over a feed roll, and delivered on belt conveyor No. 105, at the bottom of the rock stockhouse, and transferred to



BIRD'S-EYE VIEW OF EDISON PORTLAND CEMENT COMPANY'S PLANT AT NEW VILLAGE, N. J. CRUSHER HOUSE IS AT IN THE BOILER HOUSE AND THE TWO

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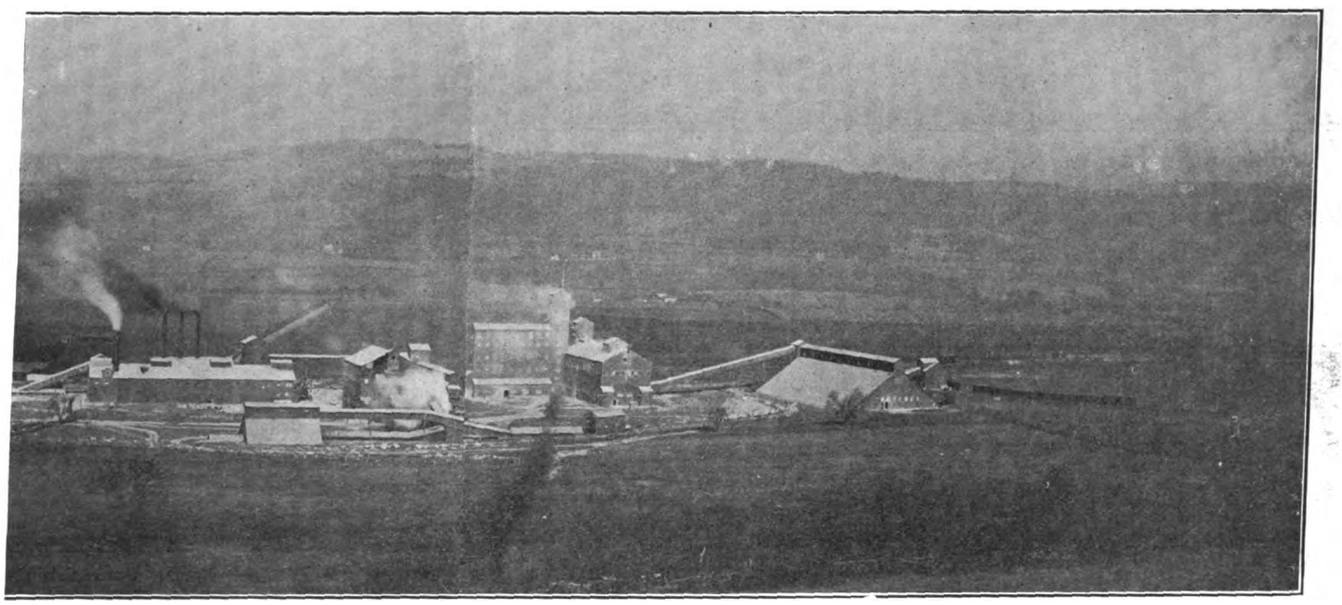
belt conveyor No. 107. On this belt it is carried to the weighing house. In the top of the weighing house there are two bins, one for limestone and one for cement rock, each having a capacity of sixty tons. From these bins the material, which is up to this point separated, is delivered into weighing bins. This is a very interesting stage in the process. After the chemist has laid out his formulæ for the value of the several elements, a certain proportion of each is delivered to the weighing bins. The scales are set so that, after the proper proportion has been deposited on the weighing pan, the scale beam closes an electrical circuit which cuts off any further supply. The cement rock and limestone, in the proper quantities, are then delivered through chutes going to a feed roll, which mixes them thoroughly, delivering the mixed material to conveyor belt No. 108, this belt, in turn, delivering it to the small rock stockhouse or "bijou." This "bijou" has a capacity of 1,000 tons of material ready for grinding. From this point the mixed material is fed out by a feed roll on belt conveyor No. 109, where it passes under the chalk-grinding rolls and is delivered on belt conveyor No. 111 at the top of blower house No. 1. This conveyor has two "S" dumps, each of which dumps feeds eight blowers. The material, after passing through the blowers, falls through a set of baffle plates, while a current of air is passing through it. The air carries the dust into a large settling chamber, where the dust settles to the bottom on account of the reduced velocity of the air. The air is taken from the top of the bins and returned to the blowers by means of pipes, while the dust is removed from the bins by scraper conveyors Nos. 113 and 114, and delivered on belt conveyor No. 115, which takes it to the chalk stockhouse. The coarser material, which is rejected by the blowers, is carried by chutes to belt conveyor No. 112, which transfers it to belt conveyor No. 110, and this belt takes it back to the feed rolls over the chalk-grinding rolls.

The chalk-grinding rolls are twenty-eight inches in diameter and have an eight-inch face. One roll is driven from a main shaft, and the other two rolls are driven by friction from the direct-driven roll. The pressure between these rolls—which varies from 14,000 to 18,000 pounds per square inch—is obtained by having a set of loose sheaves on the ends of the two outside rolls, with an endless wire rope weaved over them, similar to a block and fall rig. There is a sheave in the bight of this rope which is connected to a cylinder to which compressed air may be admitted at any pressure. By this means there is no pressure on the bearings of the rolls when crushing, except that due to the weight of the rolls themselves.

Adjoining the chalk-grinding house is engine house No. 2. This contains an E. P. Allis vertical cross-compound condensing engine of 750 horse-power, this engine driving the main shaft, which, in turn, drives the chalk-grinding rolls. There are also in this engine room two Armington & Sims horizontal engines of 300 horse-power, each driving lighting generators. In addition to this equipment there is a motor-generator set used as an equalizer. Each of the latter engines has a flywheel on both ends of the shaft, and one engine drives two General Electric direct-current generators at 250 volts, 800 amperes, 425 revolutions per minute. The other engine has a flywheel on each end of the shaft, with two belts on each flywheel, driving one General Electric 250-volt 220-ampere generator, one General Electric 250-volt 260-ampere generator, and two old-style Edison bipolar lighting machines. In this engine room these is a handsome black slate switchboard, equipped with switches, measuring instruments and regulators. The apparatus now installed is temporary, and ultimately will be replaced by a general power station with direct-connected compound engines.



THE LEFT TO THE REAR. THE DIFFERENCE IN DEGREE OF COMBUSTION IS NOTICEABLE IN THE THREE SMOKESTACKS STACKS IN THE ROASTER HOUSE.

The capacity of the chalk stockhouse is 1,000 tons of material, and this is moved from the building by screw conveyor No. 116. This conveyor is pivoted at one end and travels on a track at the other. It delivers the material to belt conveyor No. 117, which transfers the same to scraper conveyor No. 118, and this conveyor distributes the material into the bins of the roasters.

The roasting house is, no doubt, the most interesting part of the whole plant. It is here where there has been carried out one of the most remarkable of engineering feats. The roasters are sectional cast-iron cylindrical shells 150 feet in length. These have an outside diameter of nine feet and an inside diameter of six feet, and are lined with firebrick. Each of the roasters has a capacity of 900 bar-

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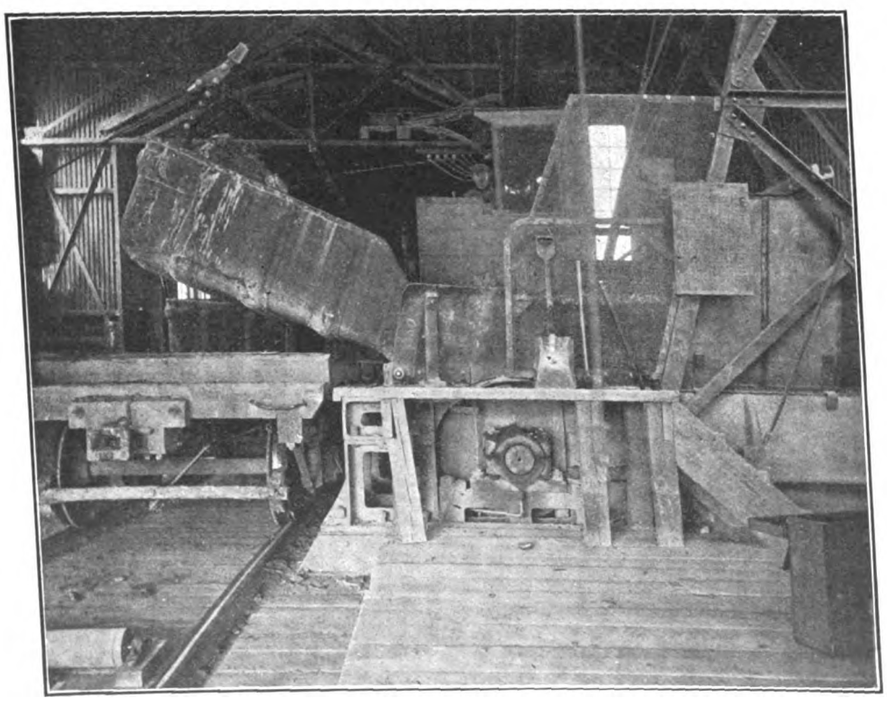
rels of cement for a day of twenty-four hours. They have a pitch of about four feet in one-hundred, and, as they are revolved, the material works down the slope.

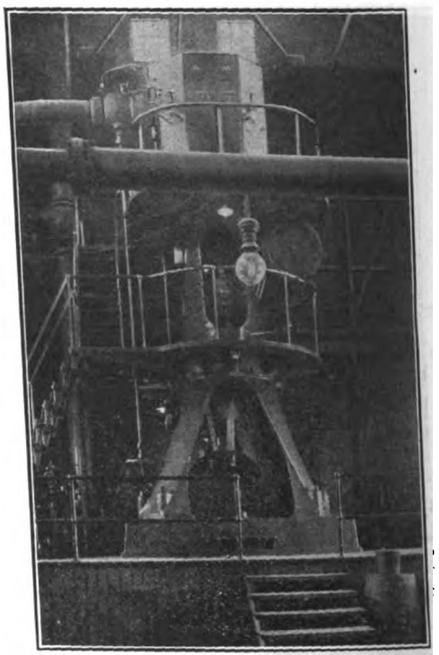
Cutting Out Cement Rock at Quarry, Edison Portland Cement Company, New Village, N. J.

Under each roaster are fifteen sets of friction wheels, and the roasters are revolved on these wheels through a motor and gearing. The main gear is situated a little below the centre of the roasters, and the shell is turned by a twenty-five-horse-power motor. The material comes into the back of the roasters, about ninety per cent of it passing through a 200-mesh screen. The clinking zone is about sixty feet long, commencing ten feet from delivery, and thirty feet from the end of the roasters. The heat is supplied to the matter in the roasters in a novel way. Pulverized gas coal is delivered from an elevated bin and injected into the roaster by compressed air at a pressure of 100 pounds. The amount of coal fed to the roasters is regulated by friction-driven screws. As the chalk passes through the roasters it comes in contact with this burning coal. The resulting clinker falls by gravity into a revolving cylindrical cooler, and from this into bucket conveyors Nos. 125 and 126. The latter conveyor delivers into the first clinker-crushing rolls. Then the material passes to the second clinker-crushing rolls, and by gravity to elevator No. 127. This elevates it to scraper conveyor No. 128, from which it is distributed to the clinker stockhouse, which has a capacity of 2,500 tons. These are thirty-six-inch rolls, and are duplicates of those described in the crushing plant.

The crushed clinker is taken from this stockhouse by chutes to belt conveyor No. 129. Here the proper amount of sulphate of lime or gypsum is added, and the material is then taken by belt conveyor No. 130 to elevator No. 131. The same process as that in the chalk plant is repeated here, the fine material settling into the dust chamber and being transferred by scraper conveyors Nos. 139 and 140, from which it is taken by belt conveyors Nos. 143 and 144 to the cement stockhouse, which has a capacity of 100,000 barrels.



The Automatic Skip Dump, Edison Portland Cement Company, New Village, N. J. This Dump Is Worked by Electric Motor, as Is Also the Hoisting Apparatus for Elevating the Cars. The Apparatus Is Controlled by Operator on Platform to Right of Dump.



One of the Engines, Edison Portland Cement Company, New Village, N. J.

The coarse material which is rejected by the blowers in blower house No. 3 is carried back by belt conveyor No. 138 to belt conveyor No. 132, which delivers it to the feed roll hopper over the grinding rolls. It is then taken through the same process until it has been reduced to a state fine enough to be deposited by settling in the settling chambers.

The cement, which is ground so that eighty-five per cent passes through a 200-

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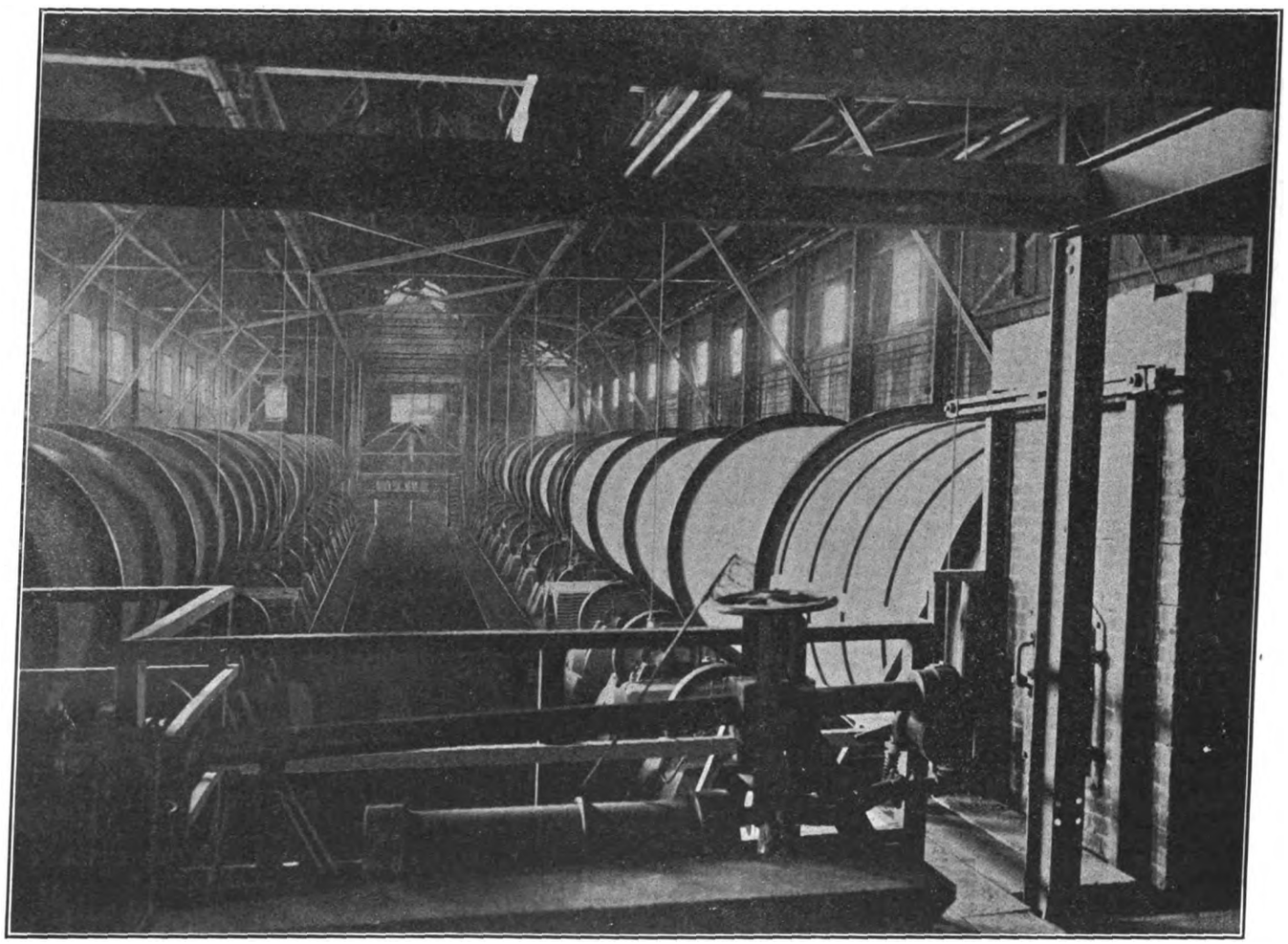
mesh screen, is dumped into two piles in the cement stockhouse, and beneath these piles there is a traveling screw conveyor, No. 145. This conveyor delivers from either pile to screw conveyor No. 146, and from this conveyor the material is taken by belt conveyor No. 147 to the bins of the packing house. The packing house contains four bagging and two barreling machines.

A very interesting part of the process is the preparation of the coal for use in the roasters. It is brought in on hopper cars and dumped over a grizzly. The fine coal falls through this grizzly into a large hopper, from which it is fed by feed rolls to conveyor No. 175 to the coal stockhouse. This coal stockhouse has a capacity of 400 tons. From the coal stockhouse it passes by means of belt conveyors Nos. 176 and 177 to the hopper over the coal dryer. The coal dryer consists of cast-iron sectional box, six feet by seven feet twelve feet. The coal passes down on either side by means of baffle plates to a storage hopper below. The heated air is forced into the dryer and passes through the coal, absorbing all its moisture. A 110-inch blower forces the air through steam coils to the dryer at the rate of 30,000 cubic feet per minute. Conveyor belt No. 177½ receives the coal from the storage hopper after it has passed through the drying plates, and from here it is taken to a Smidth ball mill by belt conveyor No. 178. In the ball mill it is continuously pounded in a revolving shell which is partially filled with steel balls. From this mill it is conveyed by screw conveyor No. 178½ to the tube mill.

This tube mill is a long cylindrical shell, partially filled with quartz pebbles, by means of which the coal is further pulverized. The ball and tube mills are driven from a line shaft, and the engine driving this shaft is a 250-horse-power horizontal tandem-compound. The exhaust from this engine is used in heating the coils through which the air is forced to absorb the moisture from the coal. The pulverized coal, after leaving the tube mill, is forced by a screw conveyor to transfer tower No. 5. This transfers it on another screw conveyor, which delivers it into the fine coal stock-bin. The capacity of this bin is 100 tons, and from this bin the coal is carried direct to the bins at the roasters by screw conveyor No. 137.

The steam supply for the whole plant is furnished by three vertical Climax boilers of 2,000-horse-power capacity. The compressed air is furnished by two McKernan Drill Company's air compressors. These supply the compressed air for injecting the pulverized fuel into the roasters, and also for the air used in regulating the pressure on the twenty-eight-inch rolls in the chalk-grinding house and in the clinker-grinding house.



THE ROASTERS, EDISON PORTLAND CEMENT COMPANY, NEW VILLAGE, N. J. THESE KILNS ARE EACH 160 FEET LONG, AND ARE OPERATED CONTINUOUSLY, BEING REVOLVED BY TWENTY-FIVE HORSE-POWER ELECTRIC MOTORS.

A thoroughly equipped machine shop is an important adjunct to the plant. This shop is 360 feet long and sixty feet wide. The castings for different machinery are received here and finished up. There is also a department for structural ironwork in this machine shop, a pattern shop, electrical repair room, a carpenter shop, storage for patterns, and a storage room for repair parts.

The laboratory is situated in the office building. This includes the physical testing room and the analytical department.

A complete system of signals has been

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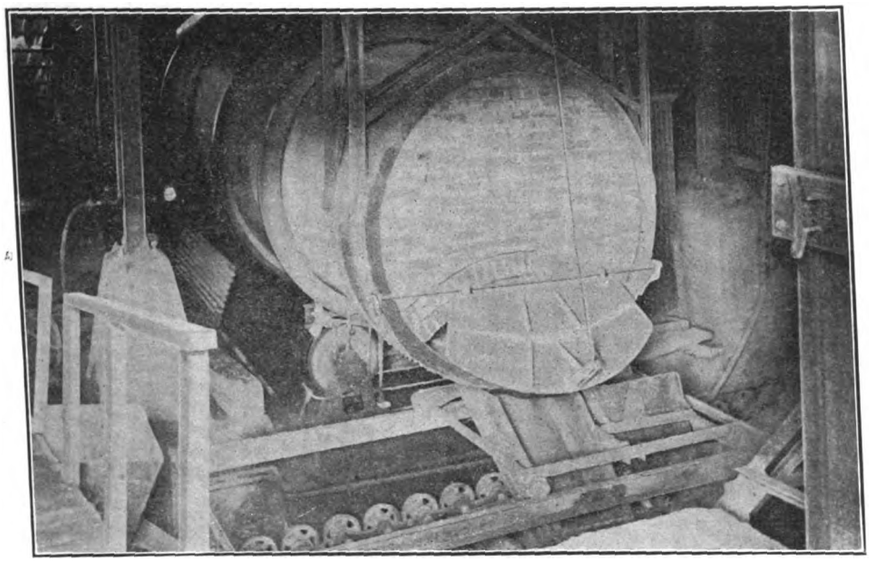
established from the superintendent's headquarters at the office to every foreman of a department throughout the works. There is also an annunciator system, by which any foreman can call a messenger for the delivery of reports to the office.

An elaborate oiling system has been established, whereby all of the oil is fed directly to the parts requiring lubrication. The oil which passes through the different parts of the machinery is collected by gravity in tanks, from which it is pumped to a filtering apparatus in the oilhouse. This oilhouse is located practically in the centre of the works. After the oil has been filtered it is pumped from the oilhouse to individual tanks in the top of each of the buildings, from which it drops by gravity to the necessary ports. The supply of oil to the working parts is regulated by needle valves, and is also in very nearly every case sight-feed. A 500-volt generator is used for supplying current for a water power station. The company has established a reservoir holding 5,000,000 gallons of water, and this is served by a Worthington triplex pump.



THE LEAVING END OF THE ROASTERS, WHERE THE CLINKER FALLS INTO AN ELECTRICALLY DRIVEN BUCKET CONVEYOR TO BE CARRIED TO THE CLINKER CRUSHING ROLLS.

The buildings are constructed throughout of structural steel and concrete. The different rolls are supported upon massive stone pillars, and the crushing house is a substantial concrete and steel structure. There are about 100 electric motors in use for conveyors, elevators and blowers, supplied by ten generators. All of the electric wiring is weatherproof and fireproof, and the construction is such as to render the possibility of damage by fire slight. In fact, the precautions are so numerous and well designed that the chance of accident of any nature is almost entirely eliminated.

OVERHEAD HIGH-TENSION DISTRIBUTING SYSTEMS IN SUBURBAN DISTRICTS.[1]

BY GEORGE H. LUKES.

An overhead distributing system must be constructed so that the service will be reliable and not subject to frequent interruptions. The voltage regulation must be as good as possible and danger to life from fire reduced to a minimum. This can be accomplished without adopting an extremely expensive method of construction. The great proportion of accidents and interruptions are caused by defects which are very easily guarded against, provided they are looked for. It is not the intention here to lay down rules for the construction of pole lines, but to draw attention to certain points which experience has shown to be often neglected.

Main Lines and Branch Circuits—Main lines leading from stations should be on not less than forty-foot, and preferably on forty-five-foot poles. This gives plenty of room for additional circuits and makes it easier to cross above telephone and telegraph lines. The branch circuits can be on shorter poles, but it is not advisable to use poles shorter than thirty feet. Where branch lines are taken off, the poles should be doubled-armed and buck-armed. Transformers, fuses, lightning arresters and other devices should not be installed on main lines where it can be avoided.

Poles—In the Middle West, the poles available at present are Michigan white cedar and Idaho cedar. Michigan poles are better proportioned than western poles and are longer lived. Michigan poles should have a top diameter of not less than seven inches. If western poles are used, it is well to note that eight or nine-inch tops should be specified in order to obtain proper butt diameter. Michigan poles are sorted and sold under the specifications of the Northwestern Cedarman's Association and it is therefore cheaper to buy under the above specifications and sort out to suit. Poles should be shaved, roofed and given one coat of paint in the yard. Poles are painted in order to improve their appearance, but the question of whether or not it adds to the life of the pole is an open one. In setting, particular care must be taken to select the best poles for the corners, turns, and ends of the line. If the line is on a highway that curves, set as many poles in a straight line as possible and make the turns on one or two poles, which can then be properly guyed. A line that changes its direction at every pole can never be held in position. Poles should be doubled-armed at corners, curves and ends.

Guying—This is one of the most important features in pole-line construction and is often neglected. Corners, junctions and ends should be carefully guyed. Wherever the line changes in direction, even if the change is very slight, a guy should be placed. Patent guys and land-anchors should be used with great caution and only on light work. The best guy is the old-fashioned one consisting of a guy-stub, set at some distance from the pole with a galvanized iron anchor rod-bolted to a slug buried in the ground. Strain insulators should be inserted in the guy-wire and care should be taken to make sure that the anchor-rod and guy-wire attached to it are grounded electrically.

Cross-Arms—The best cross-arms at present are made of southern yellow pine. They should be straight-grained, well seasoned, free from knots, and purchased unpainted. They are the first part of the line to give out. The action of the sun's rays causes the arms to crack on top and they soon rot around the pin-holes. The usual method of treating is to paint them with white lead and oil, but in the West cross-arms boiled in carbolineum have been used to some extent. The matter of the proper dimensions and pin-spacing for cross-arms has not received the attention it should, and it is high time that an attempt be made to standardize four, six and eight-pin arms for use on circuits up to 5,000 volts. The proper six-pin arm for such use should

[1] Abstract of a paper presented at the 182d meeting of the American Institute of Electrical Engineers, New York, December 18, 1903.

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have approximately the following dimensions: section, three and one-quarter inches by four and one-quarter inches; length, eight feet; spacing, between pins about sixteen inches, between pole-pin about twenty-two inches. Cross-arms for junction holes should be of special size with greater distance between pins.

Insulators—The ordinary deep-grooved, double-petticoated insulator has proved satisfactory on 2,000-volt incandescent and 4,000-volt arc circuits. It is perhaps advisable to use triple-petticoat insulators on 4,000-volt polyphase work.

Fuse blocks and lightning arresters are sources of trouble on pole lines. In some instances systems have been operated entirely without fuse blocks on the outside lines excepting, of course, the transformer blocks. The best plan is to install them on branch lines where there is a chance for trouble. Lightning arresters should be installed to protect groups of transformers and branch lines. They should be frequently inspected and the ground wires tested.

Transformers should be hung on double-arms below the lowest arm. If they are of large size the arms should be extra heavy and bolted securely to the pole. Methods of bringing the primary wires down from the circuit to the transformer are various and all are open to objections.

It is usually impossible to keep a regular arrangement of circuits upon cross-arms for the reason that as the business grows, circuits of all kinds are added. It is very desirable, however, that circuits be kept in the same relative position throughout their length in order to facilitate tracing. Houses should be, as far as possible, grouped upon three-wire secondaries which should be carried alone on the lower arm. The installation of 200-400 volt, three-wire secondaries would facilitate this work wonderfully in scattered districts. The neutrals of three-wire secondaries should be grounded on the first pole away from the transformer.

All series alternating arc lamps should be provided with absolute cutouts and high-voltage insulators in the lowering cable. Windlasses for raising and lowering lamps should be permanently grounded and an arc lamp when suspended from span-wires should be connected so that, should it fall, the lamp will not fall toward the windlass but away from it.

The importance of frequent inspections of pole lines can not be overestimated. Old pole lines can be made very reliable, provided they are well guyed and weak points kept in repair. For inspection work, linemen of considerable experience are needed, because only long years spent in repair work gives the ability to predict where trouble is likely to occur.

Accidents caused by overhead wires are remarkably infrequent, considering the number of miles of pole lines operated. They occur most often to electric linemen, less often to telephone linemen and very rarely to citizens. Accidents to linemen can largely be prevented by employing on live work only steady and tried men and using the inexperienced men and floating linemen on new construction work. Accidents to telephone linemen are mostly the result of want of care on the part of the men themselves. Accidents to citizens can be reduced to a minimum by care in constructing and maintaining lines.

The danger from fire is in the possibility of high-voltage current reaching buildings; first, through defective transformers, and secondly, through crosses between primaries and telephone wires. The first can be eliminated by grounding the secondary; the second can be made remote by proper cooperation between electric light and telephone companies in the erection of junction poles and substantial construction. The danger from fire is somewhat overestimated and it is to be sincerely hoped that any restrictive regulations will not only be carefully considered before final action is taken, but worked out in actual practice to determine whether or not their enforcement would introduce risks which would more than offset any advantage gained.

Mr. Westinghouse on "The Third-Rail Danger."

Replying to a request for an opinion on the danger of a third-rail system, in city tunnels, Mr. George Westinghouse has written the following letter to the New York *Evening Post:*

"Replying to your letter of December 12 concerning the third-rail question, I think the following points will be generally admitted:

"(1) That the operation of the elevated trains by electricity has been an undoubted success, and an enormous advantage to the traveling public, notwithstanding the fact that the continuous third rail has been employed to supply the current.

"(2) That the deaths and injuries to passengers and employés, considering the number of people involved, compare most favorably with any other railway operation in the world.

"(3) That if a third rail charged with an immense power of electricity and located upon the surface near the other rails is to be used for the supply of electricity to the trains, then there will always be a source of danger to those who have occasion to come near such third rail, and in addition there will always be a great source of danger due to the fact that a car may be derailed, or that some iron material may become detached and make a short-circuit between such third rail and the train.

"(4) That this third-rail danger may be lessened by the subdivision of the third rail into sections with provision for the automatic supply of the required amount of current to each section only as required, but that such arrangement will only minimize the third-rail danger.

"(5) That such third-rail danger may be entirely obviated by resorting to the use of overhead conductors, for which the elevated structure is peculiarly suited.

"(6) That there never was a good reason why the overhead wire should not have been used.

"In support of these last two propositions it may be stated that the third-rail is impossible for use on main railways at important junctions and terminals; that the Pennsylvania Railroad does not propose to use the third rail in its underground work between New Jersey and Long Island; that the overhead wire was used at the Zossen experiments in Germany, when a speed of 120 miles per hour was obtained; and finally, that the New York Railroad Commissioners have recently declared that they would not permit the use of a third rail on interurban lines crossed many times by highways.

"It may seem to be heresy to advocate the use of the overhead wire, but I venture to predict that there will be a complete revulsion of feeling on this point. When I speak of an overhead wire, I do not mean the slight construction which has prevailed, and the breaking down of which has occasioned trouble, but a substantial engineering arrangement so erected that it would, in fact, not be an offense to the eye. It is obvious that the use of an overhead trolley, with the removal of the third rail, would make impossible the present risks of short-circuits between the car or parts of the car and the third rail; but it would leave other questions yet to be settled; namely, first, the proper application of the electric apparatus to those cars, so that in no event could the passengers be frightened by a short-circuit visible to them, and this means that all of the wiring and electrical apparatus would have to be located beneath the bottom of a fireproof car and with no wires carrying large currents above the floors or near the ends of the cars which might be damaged by accident.

"I am satisfied, from my conferences with railway officials, that they are moving in the right direction and giving this subject the attention it deserves; but it must be borne in mind that it has required experience to demonstrate what is necessary for safety.

"Very truly yours,
"GEORGE WESTINGHOUSE.
"NEW YORK, December 14, 1903."

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STANDARDIZATION OF APPARATUS.[1]

BY J. C. KELSEY.

Before railways had grown to such extent that they had reached the terminals of other railways, each system made use of its own particular standards. For instance, one system had a broad-gauged track and axle, another a narrow-gauge and still another an intermediate-gauge. When conditions due to modern business methods demanded a rapid and uninterrupted interchange of traffic between all parts of our country, the terminals of a certain system were extended to meet the terminals of another system, and a common width of truck and axle became necessary. This resulted in what is called the standard gauge, and now all rolling stock is built to operate on this gauge, making possible the fast freight and comfortable through passenger service of the present day.

When telegraph companies were operated by different managements in the different districts of the country, each management had its own particular style of apparatus, and manner of operating it. Some systems used fast machine operating, and others, the slower manual method. As a consequence the systems could not be operated as a unit, and much time and expense were necessitated in getting long-distance service, because each system had to operate and record the message in its business way. Like the railroads, the telegraph met a demand for through service between cities and districts, and this necessitated a similarity in the style and usage of the apparatus in both sending and receiving systems. This similarity or standardization has given to the public a more rapid and reliable telegraph service.

Telephone systems, trying to compete in the transportation class, are naturally sure to encounter the same, and they are encountering the same, demands that are made upon the telegraph and railway. No longer can the telephone subscriber be confined to a limited district. He desires to talk to his neighbor, and that neighbor may be one mile or forty miles distant, or he may be one thousand miles away, in another management's district. Whatever the case, the subscriber wants to hear his neighbor's voice or his customer's voice or his client's voice, just as plainly as in ordinary conversation, and he does not care to have his message repeated by a careless operator, any more than the passenger bound for New York would care to change cars at Cleveland and Buffalo. Therefore, successful competition in telephone transportation demands standard tracks, that through connection may be made, and efficient apparatus, that will operate as a unit with this track, at both sending and receiving ends.

Experience has already decided the gauge of the telephone transportation track—copper wires. Whatever the locality of this track or line, its characteristics are in general the same. It is a well-known fact that this line must be transposed and well balanced to be quiet under all disturbing conditions. If of a considerable length, it becomes very sensitive to unbalances, and upon connection with a local exchange subscriber will quickly prove the unbalanced condition of the local switching apparatus, which would never be disclosed by a short toll line, or a purely local line. But if this toll line extends into territory where trolley wires, high-tension and electric light wires abound, it develops still more decided characteristics. It becomes supersensitive, and may be said to be looking for trouble. The unbalance that the long unexposed toll line would not detect will now be disclosed by a roar so great as to forbid conversation.

As the interurban lines, with their accompanying high-tension wires, invade the country, each and every exchange operator will inevitably experience this changed condition of his toll line. His local lines and switching apparatus, which once gave him good toll service, will be rendered comparatively useless, as the oversensitive toll line will not permit of the least unbalance. If this oversensitive line connects with an exchange using series drops in circuit, the connection will be too noisy for use. If it connects with a common return system, great noise will result. If it connects with a metallic exchange, with lines having bad joints and careless structure, the connection will also be too noisy for use. If it connects with a well-balanced metallic system, using cheap or poorly designed transmitters, poor transmission will result. If it connects with a common battery system, using twenty-volt battery pressure, the connection is noisy, and the signals are rendered inoperative. The same condition will apply to the forty-volt common battery system. Therefore, in view of the great number of independent exchanges, it is not likely that every exchange owner will consent to the making of radical changes. He will consent to any moderate change that will ameliorate conditions, and luckily, the repeating coil, if properly designed, will accomplish the result. This sadly neglected device must receive first aid and attention in the campaign of general standardization.

What does general standardization mean? Does it mean that each and every system shall be manufactured by the same company? No! Every company can manufacture standard drops, relays, ringers, generators and other devices. It means that a standardized system is one, if applied to local battery, that will operate in direct conductive relation with the standard toll line track, without the least noise due to unbalance, thereby giving absolute sway to the voice tones. To attain this efficiency, a system would have to have balanced and well-insulated metallic lines, 1,600-ohm bridging bells, 1,000-ohm clearing-out drops, and open-circuit generators. The absence of repeating coils and series apparatus would be quite conspicuous. However, if it is necessary to have a grounded party enter the standard exchange, a suitable repeating coil should be placed in circuit between the terminal arrestor and the line jack. What would be a suitable repeating coil? Can a single standard repeating coil be made? No! there is more difference in repeating coils than in any other telephone apparatus. Like lighting and power transformers repeating coils should be built for load and frequency, and carefully constructed. But as they are not a part of a standard system, no time will be spent on their characteristics by this paper.

What is a standard common battery system? It is one that will give a quiet line connection, and efficient transmission between the long-distance points. But strange to say, at this very moment, there is an idea gaining ground that common battery transmission has not come up to standard. As a result, one will find many companies maintaining local battery stations for long-distance service. It is an unfortunate condition, and I am compelled to admit the justification of the idea. The blame does not rest upon the system, because all transmitters have a central source of energy, for no reason can exist why a common battery transmitter can not be made just as good as a local battery transmitter. Nor is it a question of battery voltage, for on local service, one can not tell the difference between ten, twenty or forty volts, transmission being the best in all cases. But why is there difficulty upon long-distance connections? It is because of the generally mistaken idea among telephone engineers of the value of the electromotive force of

[1] Abstract of paper read before the Interstate Independent Telephone Association, Chicago, Ill., December 9, 1908.

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the alternating currents of common battery voice currents, which leads to the improper design of the repeating coil between the common battery subscriber and the long-distance line.

In explanation, a comparison will be made. It is conceded that a local battery induction coil must have comparatively few turns in the primary, and a great number of turns in the secondary, in order to transmit a small amount of current at a high pressure, and avoid the losses which would result from heavier current and low electromotive force. We will all admit that if this induction coil had equal turns on secondary and primary, we could not look for very good results on long-distance service. This is precisely the difficulty the common battery systems are contending with. They either use repeating coils of equal windings, of no potential raising power, or condensers with the effect exactly the same, and then expect a low electromotive force to transmit the voice currents to great distances. For the electromotive force of common battery voice currents is low, very low, and it is safe to say that it does not exceed the primary voltage of local battery instruments. If it is necessary in local battery practice to raise this low primary voltage to a high secondary voltage, running up into hundreds, why is it not necessary for the common battery systems to adopt the same practice? Common battery systems can be standardized, and the subscribers deserve it, for they do the bulk of the long-distance business.

A New Submarine Cable Plant.

The John A. Roebling's Sons Company has just completed a new building which will enable it to largely increase its product of insulated wires and cables of all kinds, and will provide room for introducing on an adequate scale the manufacture of submarine cables. It has made submarine cables for many years, but this part of its business seems to demand greater facilities, and to provide for this, one of the largest and most complete plants in this country will be installed.

The new buildings are located so that shipments may be made either by water or rail, and the company will soon be in a position to solicit the largest contracts in this line.

Both rubber and gutta-percha core is used, and its present large rubber plant will take care of those orders calling for insulated cables. Formerly it has imported gutta-percha core, but it is its intention, in the new plant, to provide a complete factory for manufacturing this core under the direction of a most competent and experienced manager, who has had a long and successful experience abroad in this kind of work.

It is the company's intention to so equip its new factory that submarine cables of any kind of core, with any description of armor, may not only be made, but it will also provide the necessary apparatus and equipment to lay any of the cables it manufactures.

The Roebling company will be in a unique position among American manufacturers, not only in the variety of insulations it can furnish, but also from the fact that it will be prepared to take contracts to turn over to the purchaser the submarine cable, laid and ready for use. It will also have the advantage of manufacturing all the constituent parts of a cable, *viz.*, copper wire, insulated core and armor wire. This should not only reduce the cost, but it should ensure to the purchaser the best materials, all manufactured under one supervision, and for which one company will be responsible.

The Roebling company has a reputation for taking large contracts, and its responsibility is also well and favorably known. It is expected that the new factory will soon be engaged on large government contracts for this class of materials.

The Opening of the New Bridge between the Boroughs of Manhattan and Brooklyn, New York City.

On Saturday, December 19, the formal exercises connected with the opening of the new Williamsburg bridge, joining the boroughs of Brooklyn and Manhattan, New York city, were held. The officials of both boroughs marched across with their escorts from the two ends of the bridge, meeting in the centre, where the formal exercises of opening were commenced. Mayor Low and President Swanstrom, of the Borough of Brooklyn, then led the way to the Brooklyn side, where, in the eastern district, a pageant was reviewed and congratulatory exercises held at the plaza, at the Brooklyn end of the bridge. The different organizations representing the business interests of Brooklyn, and several military organizations, were in line.

Among the more prominent officials were Mayor Low, Borough President Cantor, of Manhattan; Alderman James H. McInnes, vice-president of the board of aldermen; James B. Reynolds, Mayor Low's secretary; Comptroller Grout; Captain Perry, of the Brooklyn Navy Yard; Health Commissioner Lederle; Lieutenant-Commander Barry, of the United States Navy; Chief Judge Alton B. Parker, of the Court of Appeals; former Governor Levi P. Morton; Police Commissioner Greene; J. Edward Swanstrom, borough president of Brooklyn; Joseph Cassidy, president of the Borough of Queens; Bridge Commissioner Gustav Lindenthal; Lefferts L. Buck, chief engineer of the department of bridges; John L. Shea, former bridge commissioner; David A. Boody, Charles A. Schieren, Frederick W. Wurster, Daniel D. Whitney, Albert C. Chapin, former mayors of Brooklyn. There was also a notable attendance of engineers and city officials.

Electric Lighting of the Welland Canal.

It is reported that the work of installing the arc lighting equipment for the Welland canal is now under way. It is proposed to place a 2,000-candle-power alternating-current enclosed arc lamp every 500 feet along the canal, with six lamps at each lock. The contract for the erection of the necessary poles has been given to Mr. Joseph Battle, of Thorold, Canada, and tenders will shortly be called for the electrical supplies, including arc lamps, transformers, transmission line material, and for the construction of the line and terminal station. The terminal station is to be located at Thorold, Canada. It is proposed to install three-phase circuits for distributing the current to the motors for operating the lock gates, weirs, bridges and yard shops. The Lincoln Electric Light and Power Company, St. Catharines, Canada, has been given a ten years' contract to furnish the electrical energy. The plans for the complete equipment of lighting the canal were prepared by Roderick J. Parke, of Toronto, Canada.

American Electrochemical Society.

The executive committee of the American Electrochemical Society is requesting papers from members, to be presented at a meeting of the New York section, which will be held at an early date—probably during the month of January. Short, informal talks on any practical subject are especially solicited. Mr. Alois von Isakovics is the secretary-treasurer, 451 East 121st street, New York city.

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The American Institute of Electrical Engineers.

Central Stations the Subject for the 182d Meeting, Held in New York City.

THE one hundred and eighty-second meeting of the American Institute of Electrical Engineers was held in the chapter room of Carnegie Hall, 154 West Fifty-seventh street, New York city, December 18. The subject of the meeting was central stations, and several papers of more than ordinary interest were contributed. Owing to the temporary absence of Mr. B. J. Arnold, the president of the Institute, Mr. Calvin W. Rice presided and opened the meeting.

The first paper called for was on "Overhead High-Tension Distributing Systems in Suburban Districts." In the absence of the author, Mr. George H. Lukes, this paper was read by Mr. H. B. Gear, of the Chicago Edison Company.

Following the reading of this paper, the secretary announced that at the business meeting held during the afternoon, fifty-one associates had been elected, thirty students enrolled, and three members transferred from associate to full membership. These were Mr. H. L. Reber, of St. Louis, Mo.; Mr. F. O. Blackwell, of New York city, and Mr. E. E. Stark, of San Francisco, Cal. It was also announced that the next meeting of the association would be held at the Chemists' Club, 108 West Fifty-fifth street, New York city, on January 29, 1904.

After these announcements, Mr. Rice said that the paper by Mr. Lukes was valuable, in that it pointed out a number of important propositions which every central station manager had at some time to contend with. The question of the relation of companies to the municipality, the citizen and the fire underwriters was important, and he hoped that, in the discussion, these matters would be very completely taken up.

The next paper was by Mr. E. J. Bechtel, on "Automatic Apparatus for Regulating Generator and Feeder Potentials." In the absence of Mr. Bechtel, this paper was also read by Mr. Gear. Mr. Bechtel pointed out the fact that the efficiency of the conversion of electricity into light depends greatly upon the maintenance of a constant potential at the lamp terminals. For instance, a system having a potential regulation of two per cent can profitably use incandescent lamps which consume 3.1 watts per mean horizontal candle-power, based on the oval filament type of present quality, while a poorer regulation factor would require the use of lamps consuming from 3.5 to 4 watts per candle-power, representing a sacrifice of from 12.5 to 30 per cent in conversion efficiency. He described the type of automatic generator potential regulator which had been used in the Toledo Railway and Lighting Company's plant, on generators up to 250 kilowatts capacity, and which had given good service in alternating work. However, difficulties were experienced in the use of even the best designs of automatic regulators.

In commenting on this paper, Mr. Rice said that it offered an opportunity for the discussion of an important point, and he thought valuable information could be derived on this subject. The essential feature of operating central stations, particularly those which supplied current for incandescent lamps, was the definite knowledge of the point where it was safe to use a certain type of lamp to suit the regulation possible. The point of automatic regulation of the generator *versus* feeder regulation was one that should be given a great deal of consideration. In original installations, the automatic regulation of the generator was almost entirely the case. With the large systems of today, however, feeder regulation is very necessary and automatic regulation is essential.

Mr. W. C. L. Eglin read his paper on "Safeguards and Regulations in Operation of Overhead Distributing Systems." Mr. Eglin took up, in turn, the evolution of the city, with its inevitable ramifications to suburban properties, necessitating outlying service and the tying together of existing properties under one operating company. It was often the case that these existing properties showed wide variation in the type of apparatus installed, and the engineer had a difficult problem to solve in making a merged system work well as a unit. He took up in detail the specifications for material to be used, giving dimensions and treatment for poles, cross-arms, braces, pins, insulators, lightning arresters, series arc loop cutouts, interference with other wires falling or coming in contact with power circuits, effects of lightning storms, transformers, and emphasized the importance of thorough inspection.

At this point the question was raised as to whether discussion should follow on the three papers already presented, or whether a fourth paper by Mr. J. R. Bibbins, on "Gas Power for Central Stations," should be read and the discussion then taken up. On vote it was unanimously decided to have Mr. Bibbins read his paper.

Mr. Bibbins, in his paper, offered testimony on four contentions: one, that present gas power machinery is suitable for central station service; second, that a well-equipped gas power electric plant can operate with far better economy than a steam plant under similar conditions; third, that its operation is much simpler and requires lower running expenses for the same results; fourth, that gasworks laboring under low load or output factor can profitably install a gas power electric generating station and become its own largest customer, selling both gas and electricity at competitive rates.

The basis of the paper consisted of data collected from various electric light and power plants in the United States, using gas engines as their principal motive power. A number of these plants were operated in connection with illuminating gasworks, and it had been possible to observe the somewhat unique position of the gas engine station as a direct, though affiliated, competitor of the gasworks. Speaking of the possibility of continuity of service with a gas engine plant, he quoted a sixty-five-horse-power two-cylinder vertical engine as having, out of a total elapsed time of 8,472 hours, made a run of 8,230 hours. Of this 242 hours lost time, but three per cent was chargeable to the engine. Mr. Bibbins thought that the skill required for operating a gas plant was no greater than that for a steam plant; and in several instances where the steam plant had been replaced, the old employés had been retained. In newly established plants, steam engineers had invariably taken charge after a short preliminary instruction from the builder's erecting engineer. He thought that, in the economy of fuel, the gas engine had no rival. The present limit of steam engine practice was ten pounds of water per indicated horse-power-hour or eleven pounds per brake horse-power-hour. With an evaporation of ten pounds of water per pound of good coal (14,000 B. T. U. per pound), a performance of 1.1 pounds of coal or 15,400 B. T. U. per brake horse-power-hour is realized. The gas engine at present delivers at full load a brake

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horse-power-hour upon 10.5 to 11 cubic feet of gas (of 900 to 1,000 B. T. U. per cubic foot calorific value), which is equivalent to from 10,000 to 11,000 B. T. U. per brake horse-power-hour.

In summing up the advantages of the gas engine for central station, he thought that it showed a possibility of minimized fuel and heat consumption. The light-load efficiency was higher than for steam engines of corresponding size, and the cost of maintenance and operation was low. The equipment was simplified, a small number of auxiliaries was required; there was an absence of stand-by losses; quick starts could be made, and the waste heat in the jacket water was suitable for building heating. He took up the values of the fuel gases and the forms of gas which gave best service in internal combustion engines.

Referring to station economy, Mr. Bibbins's observation showed an average for several months' operation for day-in-and-day-out running in most cases in favor of the gas plant.

Mr. Gear opened the discussion by reading a paper which he had contributed to the subject. In this paper he emphasized the importance of thorough inspections and thorough drilling of employés in the dangers of handling high-tension circuits, and advocated the use of rubber gloves for linemen, and the use of weatherproof wire in construction work.

Mr. George T. Hanchett took the floor and stated that one of the most prolific causes of trouble to circuits of both high and low powers was in the grounding of wires by trees. Other than the absolute removal of the tree, he had found no satisfactory means of preventing this trouble, and thought it a good opportunity for any one who had solved this problem to give the engineers the benefit of his knowledge on this point.

Mr. Ralph D. Mershon made a vigorous protest against the use of so-called weatherproof wires for primary circuits. He said he would like to know why it was ever used. A weatherproof wire promoted a false confidence. He had always tried to use bare wires for primary circuits. With a new weatherproof wire there was some protection in dry weather. Later on, when the wire commenced to wear, it was more than unsightly and it was an absolute menace to linemen in the case of having to work on it during a storm.

In discussing Mr. Bibbins's paper, Mr. Mershon thought that it was not a fair comparison between the gas and steam engine plants. Figures should be given for a purely power station for both steam and gas economy. He thought that if every point were given its correct specifications, that the figures would not show so favorably for the gas engine plant. He did not wish to go on record as being an opponent of the gas engine. He thoroughly believed that the time was coming when the gas engine and gas producer would take the place of the steam engine and steam boiler, unless we should produce a satisfactory gas turbine. He said that he had observed a number of plants operating in foreign countries, and thought that the gas engine plants which work on the suction principle were particularly successful. In this system, the gas engine draws its fuel mixture only as it is needed. This method was made necessary because of the police regulations prohibiting the storing up of any great quantity of combustible gas. His observation had shown that steam was, in every case, favorable from an economical and operating point of view, and he thought that not only was this the case, but that the maintenance cost was higher with the gas engine, and that the practice in Germany had shown this to be so. Another point which he considered was against the rapid adoption of gas engines, was the high price demanded for units by the American manufacturer.

Mr. Bibbins replied, that the paper did not bring into comparison large stations —it simply covered the experience of the stations under consideration. These were not large, and the estimate was simply made to bring out the increased value of producing electricity in combination with the production of gas. The comparative cost of gas and steam engines depended on several conditions. When the holder capacity was taken into consideration, the cost would probably be in the ratio of $125 per unit of gas engine as against $100 per unit of steam engine. On the question of maintenance, his observation had justified the conclusions reached in his paper.

Mr. Paul M. Lincoln took the floor and made several excellent suggestions with regard to the use of insulators. He stated that every engineer should make it a point to depend entirely upon an insulator for insulation, and to make the pin no part of the insulation of a high-tension system. If anything at all were to be done with the pin, it should be made a good conductor, in order that if there were a leakage of current the resistance would not be such as to create a burning which would destroy the pin.

In reply to a question on the parallel operation of gas engines and on fluctuating loads, Mr. Bibbins stated that his observation has shown that the spring coupling almost universally used had been satisfactory in taking care of this difficulty.

Mr. Rice called upon Mr. M. P. Rider to give his testimony on the question of the insulation of high-tension wires and the use of weatherproof wire. Mr. Rider thought that weatherproof wire was a very good protection in dry weather, on potentials up to 2,500 volts. There were many times when crosses were avoided with the use of this wire. He admitted that when weatherproof wire became worn and the binding frayed out and made streamers all along the line, it was unsightly, and that in wet weather the weatherproof insulation was not an insulation. On the subject of lightning arresters, he has never as yet found anything to be an absolute protection against lightning. He did not think it paid to use a great number of protectors. The greatest part of the trouble from lightning discharges occurred at either end of the circuit, although sometimes trouble was experienced out on the line. He thought that a couple of good lightning arresters at each end of the line was sufficient protection against lightning storms. A point that he would like to have information on was the reason why lightning storms invariably caused the blowing of the primary fuses, without injuring the transformer in any way.

Mr. Fremont Wilson caused considerable amusement by accusing Mr. Rider of having no lightning arresters on his (Mr. Wilson's) end of the line, and said that he now knew why trouble existed. He stated that he thought the use of weatherproof wire a farce, and that not only was the weatherproof wire unsightly, but it was a menace, in that it produced a false confidence and allowed people who would otherwise steer clear of the wire to come into contact with it. He questioned the danger of running high-tension wires through trees and the possibility of shock during a period when a tree was wet. He said that the use of rubber gloves should be abandoned, as it was not possible to detect a fault in the glove until a potential was being handled which would probably prove fatal.

Mr. Philip Torchio, Mr. Wells and Mr. Bibbins then carried on the discussion on the gas engine, and Mr. H. A. Wagner told of a station which had had anything but a satisfactory experience in the use of gas engines, abandoning them for a steam plant. These engines, however, had not

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been of the latest type, but this company's experience seemed to show that the gas company could not produce current profitably.

Mr. Calvert Townley quoted an interesting experiment which was made on a railroad system in western Pennsylvania, with regard to the operation of lightning arresters. A lightning arrester had been placed on every pole, and during a storm the working of these arresters was observed. Tissue paper was placed in the regular way, and after the passage of the storm the protectors were examined. It was found that, notwithstanding there was a lightning arrester on every pole, there were but four to the mile which had been affected. It seemed to him that this was adequate protection, and that the lightning never picked out more than this number of paths to the ground. In early practice, he said, it was the custom to put the lightning protection in the station. He thought it was good to have some out on the line, as lightning did not always hunt up the station to find a lightning arrester, but frequently took an opportunity to discharge through a transformer.

Professor George F. Sever stated that the department of electricity, water and gas for Greater New York was having some difficulty in devising the proper means for getting the high-tension circuits underground. Ninety-eight per cent of the telephone wires were underground, but he could not say what percentage of lightning and power wires had been taken from the aerial lines. It was a vital question, however, for the engineers to decide, and there should be no evading of the matter. It was a business proposition which should be approached in a business way, and it should be a point of honor with every engineer to either remove the high-tension circuit from proximity with the telephone and signal line, or remove the signal line from proximity with the high-tension circuit. There should be no possibility of these circuits falling one upon the other.

Mr. Rider, in reply to a further question, stated that there were a great many of the underwriters' rules which were very impracticable. The ordinary high-tension conductor used in this territory was of such a nature that it would stand up against all sorts of weather conditions, and that the solution of the problem consisted of putting the low-tension wires below the high-tension wires, as these were the most likely to break.

Mr. Eglin, in reply to a question with regard to the insulation of wire running through trees, said that his company had made a number of experiments to avoid this difficulty, and had invariably failed. The last experiment which they had made, and one in which they had placed considerable hope, was with a specially prepared wire which had a heavy rubber insulation, and about this rubber insulation there was wound an iron armor wire. It was thought that the armor wire would prevent the limbs of the tree chafing the rubber and breaking down the insulation. Instead of this being the case, it was found that the armor wire broke down the rubber insulation, making contact with the high-tension conductor and making it dangerous for any lineman to handle the wire at all.

Mr. Gear closed the discussion with a few words on the operating conditions in Chicago. His company has overcome a good deal of the difficulty of running wires through trees by making poles high enough to clear the tops of the trees. As the trees grew up, they, by careful trimming, were able to avoid most of the trouble. In some cases they had found it wise to put a porcelain sleeve, sometimes as much as two feet long, over the conductor, and this was a very good form of insulation. They were fortunate in Chicago in having an extensive series of alleys, in which it was possible to run for miles in some cases, without any recourse to the open streets.

The meeting then adjourned.

Eighth Annual Dinner of the Brooklyn Engineers' Club.

The Brooklyn Engineers' Club enjoyed its eighth annual dinner in the banquet room of the Oxford Club, Brooklyn, N. Y., on Tuesday evening, December 15, 1903. The menus were novel in design and made to resemble a specification of work to be performed, and were so inscribed, being enclosed in an envelope of legal size. President A. J. Prevost, Jr., was the first to deliver an address; Mr. Henry Sanger Snow spoke on "Professional Training;" Mr. Helmle, "International Improvements;" and Mr. Taylor, "The Professional Man in Municipal Life." Following this business matters were transacted, and Mr. Othniel F. Nicholas was elected president, Mr. John Middleton as treasurer, and Mr. Joseph Strachan as secretary for the coming year. Mr. Prevost, the retiring president, made a brief address of thanks to the club for its courtesy to him in the past year, and bespoke a cordial support to his successor during the coming year.

American Institute of Electrical Engineers.

ASSOCIATES ELECTED FRIDAY, NOVEMBER 20, 1903.

John Patterson Agnew, Wilkinsburg, Pa.
Walter Clymer Barnes, New York city.
Thomas Edson Barnum, Milwaukee, Wis.
Henry Jerome Bildhauser, New York city.
Frederick Edmond Cooley, Schenectady, N. Y.
Charles Louis Crabb, Yonkers, N. Y.
Ernest Edgar Davis, Savannah, Ga.
Roger Dennison De Wolf, Wilkinsburg, Pa.
Albert Esling, Toronto, Ontario.
Michael Birt Field, London, S. W., England.
Clarence Dudley Fitts, Oakville, Ct.
Lewis Alfred Freudenberger, Newark, Del.
Herbert Willard Goddard, New York city.
Roy William Gray, Los Angeles, Cal.
Bernard Charles Groh, Trenton, N. J.
Walter Binkerd Gump, Rumford Falls, Me.
Charles Caesar Hawkins, Bedford, England.
David Carl Henry, Chicago, Ill.
Adolf G. B. Hess, Brooklyn, N. Y.
Edwin George Hindert, Elyria, Ohio.
Robert Milne Hopkins, Evanston, Ill.
Maurice De Hoor-Tempis, Budapest, Hungary.
Charles Henry Hurd, Indianapolis, Ind.
Irving Phelps Keeler, Asheville, N. C.
James Gifford Kellogg, Ithaca, N. Y.
Roger Nelson Kimball, Kenosha, Wis.
Henderson William Knott, New York city.
Rudolph I. Kunze, Yonkers, N. Y.
George Foreman Landers, Fort Totten, N. Y.
Emanuel William Lewis, Pittsburg, Pa.
Alexander Maxwell, New York city.
Samuel Harvey McLeary, Ithaca, N. Y.
Frances Mearson, New York city.
Thomas Lodwick Miller, Liverpool, England.
Jacob Alaric Leo Möller, New York city.
William J. Mowbray, Brooklyn, N. Y.
George Barrows Obear, Lynn, Mass.
Herman Henry Oswald, Schenectady, N. Y.
Bertrand Perry Rowe, Wilkinsburg, Pa.
Burton Mansfield Sawyer, Pittsburg, Pa.
Frederick E. Schmitt, New York city.
Joseph Henry Siegfried, New York city.
Arthur Gaylord Slocum, Jr., St. Louis, Mo.
Julian Cleveland Smith, Montreal, Quebec.
Rex Thomas Stafford, Buffalo, N. Y.
Joseph Brown Stevens, West Lynn, Mass.
Harry Winthrop Turner, Rugby, England.
Harry Casper Walter, West Lafayette, Ind.
James Thomas Whittlesey, Montclair, N. J.
Samuel Thayer Willis, Pittsfield, Mass.
Alfred Wohlauer, Schenectady, N. Y.

THE FOLLOWING ASSOCIATES WERE TRANSFERRED TO THE GRADE OF MEMBERS:

Walter Ambrose Pearson, New York city.
Wynn Meredith, San Francisco, Cal.
Lorin Everett Imlay, Niagara Falls, N. Y.
Bernard Edward Sunny, Chicago, Ill.
John Joseph Carty, New York city.
Eugene B. Clark, Chicago, Ill.

Magnetic Iron Sand in Java.

In the neighborhood of the town of Yjilatjap, on the coast of the island of Java, extensive deposits of magnetic iron sand have been found. The deposits begin opposite the island of Noesa Kembangan and extend about twenty-nine miles to the east along the coast line. The sand lies on the surface and is said to contain in some places as much as eighty per cent of iron. Samples taken in different parts give a very good result when smelted. Some time ago an English company, with a Hollander at its head, acquired the right of exploiting these deposits, which have been known since 1845.

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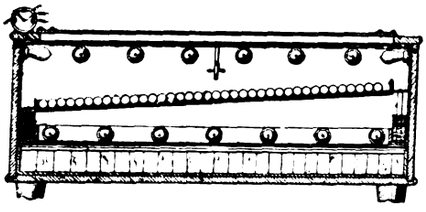
Electrical Patents.

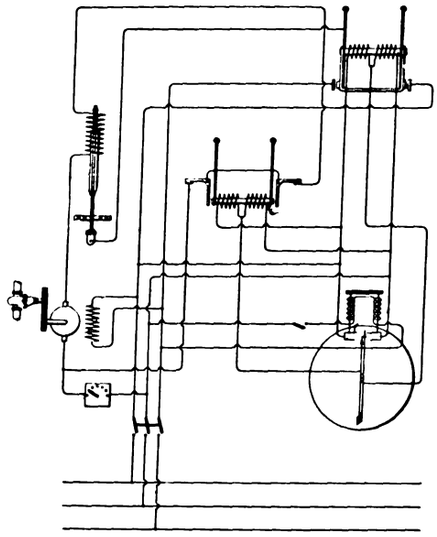
Mr. Frank C. Perkins, of Buffalo, N. Y., is the inventor of a novel electrical incubator, the object of which is to provide an incubator in which eggs are hatched and chicks are kept warm by means of an electric heater, which, together with a thermostatic regulator is arranged directly within the incubating chamber. Another object of the invention is to provide simple automatic means for turning the eggs and also cooling the same periodically. The incubator is furthermore so organized that the eggs may be readily tested without removing the same from the incubator. An incubating chamber is provided in which is arranged an oscillating egg tray which is shifted by electromagnets having their magnets connected with opposite ends of the tray. An electric heater is also arranged in the chamber and is connected on one side with one end of the magnet coils. Arranged in the chamber and interposed between one pole of an electric generator and the heater is a thermostat. A rotary contact arm is connected with the other pole of the generator, and on opposite sides of the contact arm are arranged a pair of magnet contacts which are connected respectively with the opposite ends of the magnet coils. Segmental contacts are arranged around the magnet



Longitudinal Section of Elevation Plan of an Electric Incubator.

contacts and alternate with the same, and are connected with that side of the heater opposite the thermostat. An insulating section is arranged between two adjacent contacts, which are adapted to be successively engaged by the contact arm during its rotary movement.

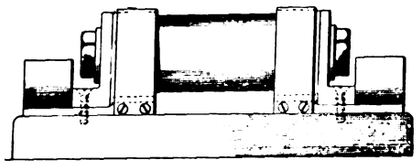
Austin R. Dodge, of Schenectady, N. Y., has recently patented an automatic regulator, which he has assigned to the General Electric Company, of New York. The present invention has for its object to provide a regulator which will automatically maintain a constant pressure on the engine or other apparatus under test, or which will automatically maintain a constant voltage or current on the system when the regulator is employed in connection with electrical apparatus. In carrying out the invention, an electric motor is provided which is geared or otherwise connected to the throttle valve or other device to be actuated. When the motor revolves in one direction, the throttle or other device is opened more or less, and when it revolves



Diagrammatic View of a Motor Geared to a Valve or Other Regulating Device, Together with the Necessary Magnets, Controlling Devices and Circuit.

in the other direction the valve or other device is closed to a greater or less extent. In the case of electrical apparatus the motor is connected to a regulator of suitable character in such manner that the effect on the system or generator is to increase or decrease the current or voltage, as desired. The circuit of the motor is controlled by a pressure gauge or equivalent device, which, acting through electromagnets, starts and stops at the proper time, suitable means being provided to prevent the motor from overtraveling or "hunting," as it is called. Two sets of motor-controlling magnets or devices are provided, one being employed to rectify slight changes in pressure, voltage or current, the other to rectify material changes. The second device is arranged to act on the motor through the first. This is done by rendering the former inoperative until the conditions are approximately normal after which the first comes again into service. The second regulating device, however, may act directly on the motor. In order to stop the motor the instant the desired change in addition is effected, a suitable and additional load is applied to the armature.

An electric fuse or cutout has been devised and patented by Mr. Louis W. Downes, of Providence, R. I., and the patent obtained has been assigned to the D. & W. Fuse Company, of Providence, R. I. The improvements are particualrly applicable to high-capacity fuses, although capable of being employed with fuses of low capacity. Upon a base of porcelain or the like is mounted the fuse terminals. Upon one end of the plate at each terminal rests a casting, comprising a socket for receiving the end of the circuit-conductor, and an upright plate having a notch extending from its centre upward. The casting and plate of the terminal are secured by screws to the base. Upright spring-blades are secured to opposite edges of the terminal plate. A tubular casing is provided, closed at its ends by caps, each cap having an outwardly projecting, hollow, exteriorly screw-threaded stud thereon. The caps are secured to the tubular casing by screws. Movably inserted in the casing is a cartridge fuse, which comprises a sheath composed of a tube, closed at its ends by thin, stamped, sheet metal caps, which are perforated to permit the escape of gases evolved on the blowing of the fuse. When the cartridge fuse is in place in the casing the projecting ends of the fuse link fit closely and are preferably soldered or sweated in the hollow studs of the caps. The cartridge fuse is inserted in its casing by removing one of the caps. After the cap has been replaced and secured the studs are heated and touched with solder, which melts and runs into the small space between the projecting ends of the fuse link and the inner walls of the studs, uniting them both electrically and mechanically. The insertion of this cartridge fuse into the terminals of the live circuit is facilitated by two sets of spring-blades, which make electrical contact with the



Elevation View of a New Electric Fuse or Cutout.

caps and temporarily carry the current while the fuse casing is being adjusted to its final position in the terminals. In this manner blistering or burning of the contact surfaces of the upright plates and at the ends of the caps is prevented. As it is not always desirable or reliable to depend upon the spring blades alone to carry very heavy current, nuts are provided adapted to clamp the end surfaces of the caps into tight and positive contact with the inner surfaces of upright plates, thus relieving the spring-blades of the necessity of carrying any great volume of current. Upon blowing the fuse, the nuts are loosened and the casing withdrawn from the terminals, one or both caps removed, which is readily accomplished as the fuse link has been melted in two at its middle. Sufficient heat is then applied to the studs to melt the solder and permit the ends of the fuse link to be pushed out, leaving the opening clean and ready for the insertion of another fuse link.

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Reviews of Current Engineering and Scientific Literature.

The Electric Supply of Calcutta, India.

Calcutta, it is said, has the best electrical supply system in Asia. The generating station is located on Imanbagh lane, and has a total output of over 2,405 kilowatts. The generating sets are eight in number, and consist of Bellis & Willans engines, direct-connected to the generators. The largest generating set is rated at 713 kilowatts, 550 volts, there being two of these, and they are thought to be the largest in the East. The distributing mains, of which there are twenty-three, are laid underground, there being eighty miles of cable. The three-wire system is employed. The station operates night and day, with three shifts of attendants. The price of electrical energy at Calcutta varies, for lighting, from eight annas to three and one-quarter annas per kilowatt-hour. For power, the rate varies from four annas to two annas. In spite of the conservatism of the natives, the use of electrical power is spreading.—*Abstracted from the Indian Textile Journal (Bombay), November* 16.

The Boma-Leopoldville and Leopoldville-Equateur Telegraph Line.

A telegraph and telephone line 1,199 kilometres in length has been constructed in the Belgian Congo settlements, Africa. The first work was from Boma to Matadi, twenty-nine kilometres. It required not less than eight months' construction. The climate is very hard, and most of the work has been carried out by the natives under direction of Europeans. Several difficult streams were crossed. The crossing at Underhill was made by means of two steel pylons, fifteen metres high and 800 metres apart, and placed, respectively, seventy-three and sixty-three metres above the high-water level. The construction of the line from Léopoldville to Equateur was very difficult. Surveys were particularly dangerous and the zone unhealthy. The width of the clearing is twelve metres, and the poles are placed 100 metres apart. In the forest the supports are thirty, forty or fifty metres apart, according to the position of the trees, to which they are attached by means of iron bars. The crossing of the Kasai was the most difficult, as it was necessary to provide for the passage of steamers. Advantage was taken of a rocky island in the river, and the crossing was made in two spans, one of 450 metres and the other of 670 metres, the supports being three iron pylons, 14, 36.5 and 38.5 metres high, respectively. Much trouble was experienced in getting the four conductors in place. This was finally carried out by means of a tug. The line does not suffer from white ants, as the posts are either iron or living trees. On the contrary, they are frequently broken by elephants. Storms occasion great interference by throwing down trees across the line, and atmospheric discharges are also troublesome. Birds make their nests on the wire; wasps nest in the insulators, and spiders cover the poles with web, collecting a litter of leaves and twigs. The line is used both for telephone and telegraph service, and the stations are protected by the local garrison. Numerous branch lines are projected and are in process of construction.—*Translated and abstracted from the Revue de L'Électricité (Berne), November.*

The Radiant Efficiency of the Nernst Lamp.

The radiant efficiency of the Nernst lamp is placed at twelve per cent in Drude's "Lehrbuch der Optik," but this figure seems not reliable. Mr. L. R. Ingersoll has made a determination of the Nernst glower efficiency under varying conditions, using Angstrom's method, and at the same time testing the accuracy of this method. The method consists in dispersing the light radiated from the glower, cutting off with a screen the non-luminous rays, and then, by means of a cylindrical lens, reassembling the visible part, which is balanced photometrically against the total radiation from another exactly similar source. In the arrangement of the apparatus, two glowers were connected in series, the power consumed by each being maintained constant. The radiation from one of these glowers was received upon a concave mirror, reflected upon a movable prism, and after passing through this was, by means of a pair of mirrors, passed through an adjustable screen which could be accurately adjusted to cut off all the non-visible rays. Just beyond this screen was placed the cylindrical lens which recombined the spectrum into a band of white light upon the receiving screen or thermopile, so as to compare it with the radiation from the other glower, the latter being movable, so as to obtain the balance. In addition to this arrangement, a small water cell was used for a time to absorb any stray infra-red rays, but this was found by trial to be unnecessary. Correction was made for selective reflection, for absorption by the glass prism and lens, for inaccuracy in setting the screen, and for the disturbing effects of the instruments and radiation from the surrounding apparatus. It was found in the study of these corrections that the error of the method was about ten per cent. The efficiency of new glowers was found to vary from 4.35 per cent to 4.70 per cent, with a mean of 4.61 per cent. The efficiency falls rapidly for the first twenty hours, decreasing to 4.3 per cent, but varies only slowly after this. This decrease in the efficiency does not agree with the results obtained by Mr. L. W. Hartman, but the discrepancy was thought to be due to the fact that the latter investigator maintained the current constant, and not the power, as was done in this work. Some very old glowers gave efficiencies of only 3.6 per cent. These results were all for 110-volt glowers, consuming eighty-nine watts, and for every watt above eighty-nine, within narrow limits, the efficiency increases 0.06 per cent, and below this, *vice versa*. The energy curve, plotted from Wein's law, gives the efficiency as 4.17 per cent. This lies well within the limits of 2,200 and 2,450, as given by Lummer and Prigsheim.—*Abstracted from the Physical Review (New York), November.*

The Gola Lightning Arrester.

To protect electrical conducting systems against damage due to lightning, two distinct actions may be made use of—first, atmospheric charges may be caused to discharge at a fixed point; and, second, the action of the arrester may depend upon breaking the arc which forms when the line current follows the atmospheric discharge. Nearly all arresters act according to the latter method, and they are connected in parallel with the lines to be protected. The Gola arrester, which is here described by Mr. Attillio Sachs, is, however, a series arrester. The apparatus consists of two concave plates of magnetic material, placed with their concave sides opposing, and connected together at the edges by a non-magnetic metal ring. The plates are oval in shape and are supported upon a strong insulator. Above them, and supported from the upper surface by means of bolts of non-magnetic metal, is a third plate, in shape very similar to the other two and placed with its concave side downward.

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Two arms extend from the upper and lower of the three plates, and between them is placed a solenoid, one end of which is connected at part of the line to be protected, and the other to the lowest plate. The line wire is connected to a terminal on the upper plate. There is thus a metallic path from the line wire through the three plates successively, and then through the coil. The latter, however, when a current is flowing, sets up a magnetic field in the two gaps between the three plates. Opposite the edges of the plates are two sets of carbon rods, held in clamps, but adjustable. These are supported on insulators and are connected to the earth. This design of apparatus is intended to present a large surface and suitable discharging gaps, across which atmospheric discharges will take place, due to the magnetic field, but in such manner that the line current will not follow. The discharge points are tipped with non-arcing metal. This form of apparatus, which has been reached after several designs, has been tried in several Italian installations, among them being the Centrale de Bedonia. The lines here pass over a mountainous country, and have been protected by the Gola arresters only. During two seasons the installation has not had a single interruption due to lightning, although there were many storms during this period, and several other installation in the neighborhood which were not protected by these arresters, had great difficulty in maintaining their service during these storms. The author thinks, however, that to assure entire protection from lightning, a combination of the two types of arrester should be used, so as to provide suitable discharge gaps; and at the same time provide for interrupting any arcs which may be formed.—*Translated and abstracted from the Bulletin des Ingénieurs Electriciens (Liege), November* 30.

The Effect of Impurities on Commercial Copper.

A study of the effect of impurity on copper has been made by Mr. Ernest A. Lewis, who here gives a partial report of his work. Impurities in copper are divided into three groups, according to their effect on the microstructure. The first group contains those metals which separate out around the copper crystals in the free state, such as lead and bismuth. The second group contains those metals which alloy with a portion of the copper and separate out around the crystals as an alloy, such as arsenic, antimony, tin, zinc and the non-metals, oxygen, phosphorus and sulphur. This group is again divided, according as to whether the alloy separates into two constituents after it is solidified, or not. The third group contains those metals which dissolve in the copper crystals and do not separate out, but form a solid solution, such as iron, manganese, aluminum and nickel. When pure copper is alloyed with 0.2 per cent of lead or bismuth, after polishing and etching, the crystals of copper are seen to be surrounded with a thin skin of lead or bismuth. These two metals make copper so brittle, when present in small quantities, that it will not roll. Pure copper containing 0.2 per cent arsenic, phosphorus or tin, when polished and etched, is seen to consist of crystals of copper surrounded by a network which can not be resolved into two constituents. Such copper can be rolled and is malleable. Pure copper, containing 0.2 per cent antimony, arsenic or oxygen, when etched, shows a network, but it can be seen that the network contains two constituents. Such copper rolls poorly, cracking at the edges. Pure copper, containing 0.2 per cent iron, manganese, aluminum or nickel, does not show any network. The microstructure is similar to pure copper. A table is given showing the behavior of copper under mechanical treatment, containing various percentages of these impuritics. It is noticed that arsenic has the property of neutralizing, to a certain extent, the injurious effect of bismuth, lead and antimony, and that tin, manganese and aluminum intensify the effect of the impurity. Manganese and aluminum, when present in quantities of 0.5 per cent, are capable of neutralizing the effect of 0.1 per cent of sulphur.—*Abstracted from Engineering (London), December* 4.

Meeting of the Philadelphia Branch of the American Institute of Electrical Engineers.

A meeting of the Philadelphia branch of the American Institute of Electrical Engineers was held on Tuesday, December 8, in the Engineers' Club, Philadelphia, Pa. Mr. Lamar Lyndon read his paper on "The Comparative Behavior of Floating and Booster-Controlled Batteries on Fluctuating Loads." Mr. E. F. Northrup gave an abstract and discussion of Mr. Addick's paper on "The Electrical Conductivity of Commercial Copper." Professor Joseph W. Richards, of Lehigh University, gave a very interesting and instructive address on "The Energy Absorbed in Electrolysis." The discussion of the papers was interesting and spirited. It was participated in by Messrs. Woodbridge, Blizard, Lyndon, Clauder, Hewitt, Richards, Northrup, Hodges and Sanville. After the discussion Messrs. W. L. Hodges and John Kelly showed the talking arc lamp. The experiment was very successful. A number of phonographic records were given out by the arc, as well as the human voice. The phonograph was operated and the speaking was done in a room remote from that in which the lamp was exhibited.

The American Association for the Advancement of Science.

The annual meetings of the American Association for the Advancement of Science and of the American Physical Society will be held in St. Louis, Mo., in "Convocation Week," from December 28, 1903, to January 2, 1904. The opening session of Section B, physics, will be held on Monday, December 28, after the adjournment of the general session—probably about eleven o'clock A. M. At this time the section will organize, elect committees and transact other suitable business. At four o'clock on the same day the retiring vice-president, Professor Ernest F. Nichols, will give an address on "The Infra-Red Spectrum."

The section will meet on the morning and afternoon of December 29, for the readings of papers. On Wednesday, December 30, the annual business meeting of the American Physical Society will be held, and on this day the programme will consist of papers by members of the society.

A regular session will be held on Thursday morning, while the afternoon will probably be devoted to a visit to the World's Fair grounds.

If the number of papers is sufficient, the sessions will continue through Friday and Saturday.

All sessions for the reading of papers will be held in room 317 of the Central High School building. The vice-presidential address on Monday will be given in room B2.

Professor B. Rutherford, of McGill University, Montreal, Canada, will give a popular lecture on radium, the time and place to be announced later.

The Southern Hotel has been selected as the general headquarters. Hotels for the headquarters of sections have not been announced.

A rather long list of papers has been submitted to both Section B and the American Physical Society, and an attractive and successful meeting seems assured.

Mr. Dayton C. Miller, of the Case School of Applied Science, Cleveland, Ohio, is secretary of Section B, and Mr. Ernest Merritt, of Cornell University, Ithaca, N. Y., is the secretary of the American Physical Society.

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INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

A 30,000,000-Candle-Power Beacon.

At the mouth of the river Elbe, in Germany, there has recently been installed at the Heligoland Lighthouse an electric searchlight, which is perhaps noteworthy because of its intensity. This searchlight was built and installed by the Siemens-Schückert Werke, of Berlin, Germany, and has an illuminating intensity of 30,000,000 candle-power. The electrical apparatus was constructed by the Elektricitätts Actiengesellschaft, formerly Schükert & Company, of Nuremberg, Germany.

FIG. 1.—THE ARRANGEMENT OF PROJECTORS FOR THE BEACON AT HELIGOLAND, GERMANY.

FIG. 2.—A NIGHT PICTURE OF THE LIGHTHOUSE AT HELIGOLAND, GERMANY.

The arrangement of the searchlight, as can be seen by reference to Fig. 1, is as follows: there are three lower searchlights arranged 120 degrees apart, and another mounted on top, all operated automatically and driven by means of electric motors. The carbons, which are fed by automatic mechanism, are placed in a horizontal position, as is usual with most large searchlights. The maximum current used is 100 amperes.

The light flashes occur every five seconds and they remain in one position only a tenth of a second. The three lights, mounted 120 degrees apart on the lower revolving platform, have mirrors twenty-nine inches in diameter and utilize a direct current of twenty-four amperes each, this platform revolving at the rate of four revolutions per minute.

Fig. 2 shows the lighthouse as it looks at night, and Fig. 3 shows the famous lighthouse at Heligoland, Germany.

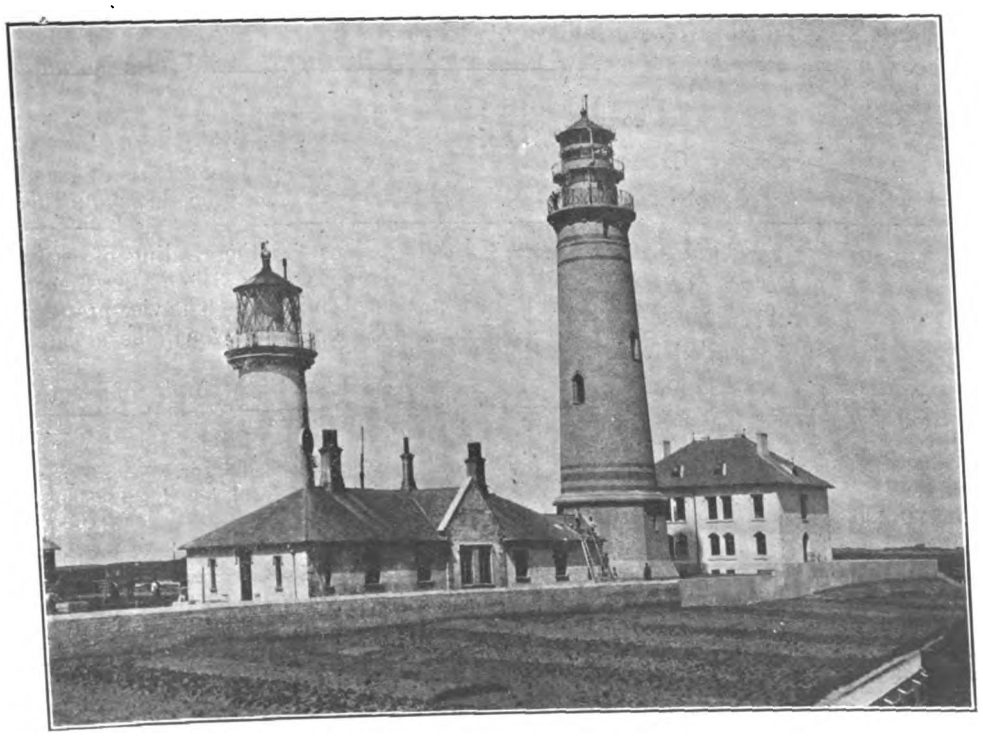

FIG. 3.—THE LIGHTHOUSE AT HELIGOLAND, GERMANY.

The Wireless Railway Company.

The Wireless Railway Company has been formed to exploit the Pullen patents on a surface-contact system of electric car propulsion. This system is in operation on a branch track at Atlantic City, N. J., and has been visited by a number of interested investors and electric railway people.

This system is the invention of Mr. Leon W. Pullen, and the object of his invention is to provide means adapted to both new and existing railways, for operating an electric car from a circuit which is completed only at points adjacent to the car as it travels over the working or supply conductor or contact blocks. By this method the supply conductor may be enclosed or protected beneath the roadbed, and the contact block upon the surface put into electric circuit with the supply conductor only when and during the time the car is over the contact block.

The roadbed is provided with a series of specially constructed tubular armatures, adapted to be energized by magnets upon the car, and by which they will close automatically for a period corresponding to the time the car is over them. The car is provided with electric motors to propel it, and with magnets for operating the tubular armatures; and is further provided with a long-travel contact shoe or collector, which makes contact with the contact blocks along the track.

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A New Lock Push Switch.

The Hart & Hegeman Manufacturing Company, Hartford, Ct., is placing on the market a new form of push switch which is a departure in this apparatus. The accompanying illustrations show the assembly of the switch and also a diagram of the mechanism.

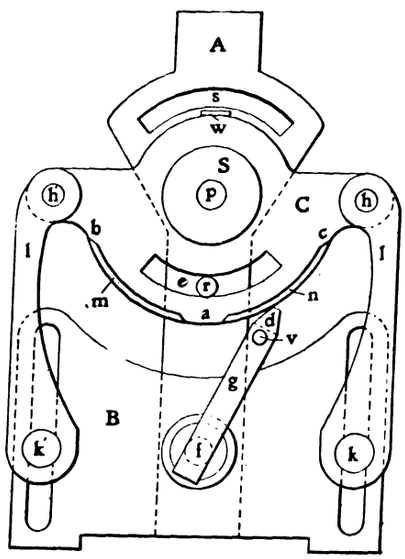

FIG. 1.—A NEW LOCK PUSH SWITCH. DETAILS OF OPERATION.

This switch is intended to be operated only by a person having a key which will fit it. Its appearance, when fully assembled, is very much the same as that of an ordinary push switch. It is impossible, however, to manipulate it unless the keys are in the possession of the operator. When the switch is worked, the key must be inserted in the button, and this, engaging with a lug on an ingeniously constructed lever, performs the operation of the ordinary push-button.

The switch is illustrated by the accompanying Figs. 1, 2, 3, 4 and 5.

The mechanism of this switch is somewhat complicated, and a reference to the diagrams will be necessary to understand the operation. Fig. 1 is a plan view of a portion of the mechanism. This portion, as will be understood from the description, is not in normal position. Fig. 2 is a view of the switch blade, bottom side up. In assembly, the switch blade would be turned over, the hole *p*, in Fig. 2, fitting on the shaft *p*, in Fig. 1. The slide *u*, in Fig. 2, would engage with the pin *v*, in Fig. 1.

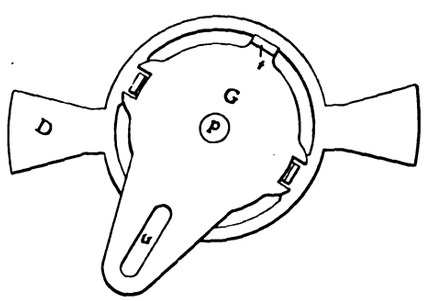

FIG. 2.—A NEW LOCK PUSH SWITCH. THE SWITCH BLADE.

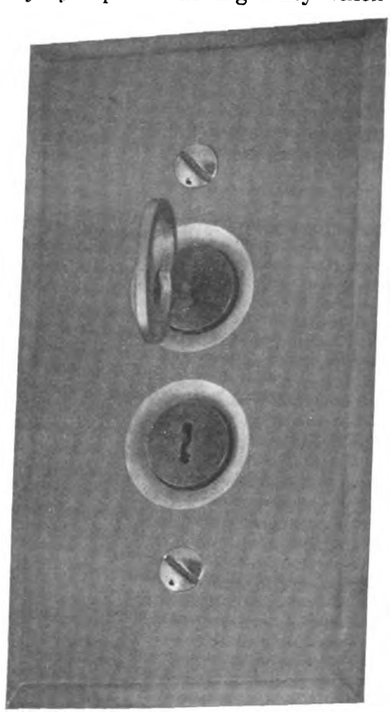

FIG. 3.—THE LOCK PUSH SWITCH, WITH FACE-PLATE, ASSEMBLED.

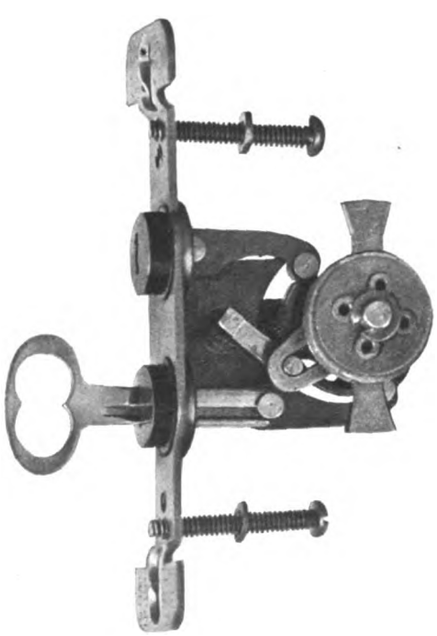

FIG. 4.—THE LOCK PUSH SWITCH, SHOWING DETAIL OF MECHANISM.

Referring again to Fig. 1, the parts *g* G form a sort of toggle joint, the pin *v* working in the slot *u*. All of these parts are fastened rigidly together, and are held in tension under the action of a spiral spring *s*, which works on the shaft *p*. Both ends of this spring press on either side of the fingers *w*, projecting upward in Fig. 1, and *t* projecting downward in Fig. 2, which work one inside the other, the motion of *t* being limited by the slot *s*; and the motion of *w* by the stop *r* in the slot *e*. The lever *g* has a lip *d* projecting downward at one end. This lip rests against the guards *m* and *n*, which are turned up on the portion C, and slotted at *a*, *b* and *c*.

When the key is inserted in one of the buttons, it is pressed against a stud *k'*, on the link *l'*. This turns the part C to the right. The finger *t* is stationary so long as the lip *d* is restrained from moving the guard *n*. The finger *w* moving with the part C puts the spring on the tension, the other end of the spring being held by *t*. When the part C is turned as far as it will go to the right, the lip *d* escapes at the guard *c*, passing back of it and out at *a*; then resting against the guard *m*. As soon as the lip escapes the guard, the spring is released, and the blades D fly over, opening or closing the circuit, as the case may be, by passing into engagement or out of engagement with the switch jaws. These are shown in Fig. 5. The same cycle of operations is performed if it so happens that the key must be inserted in the other button.

The switch blade D is made of one continuous piece of brass, which is insulated from the mechanism by sheet mica.

This apparatus is contained in a porcelain box, this box holding the switch jaws. The wires are brought up outside of the porcelain, and ample assembly room is made for contact. The switch is finished with a handsomely nickel-plated flush-plate, making a decidedly ingenious and efficient piece of apparatus.

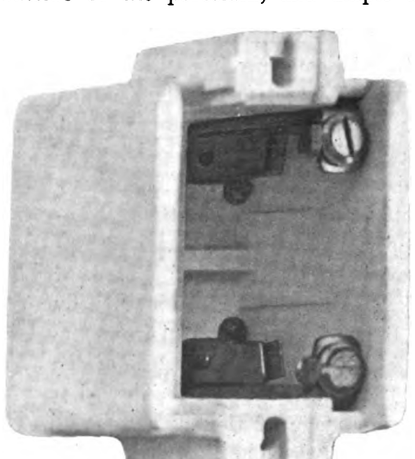

FIG. 5.—THE PORCELAIN RECEPTACLE AND SWITCH JAWS, LOCK PUSH SWITCH.

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The New "G. I." Floor Outlet Box.

In modern electrical construction work there is a growing tendency, year after year, to place electric light, telephone and bell wires in iron conduit, and the need

FIG. 1.—FLOOR OUTLET BOX.

of first-class floor outlet boxes has long been felt by engineers and architects who aim for high-grade work and endeavor to protect their clients against future trouble with broken circuits, interrupted service, or possible fires through poorly designed or faulty floor outlet boxes. Floor outlet boxes have often been the weakest points of a wiring installation, being exposed to water and dirt when floors are swept or scrubbed, and, from the nature of their location, are subjected to hard usage. The engineers of the General Incandescent Arc Light Company, it is said, were the first to design and patent a universal, interchangeable floor outlet box, which is at all times water-tight, whether in use or not. The company has still further improved its standard floor outlet box by having all parts stamped and drawn, thus ensuring a perfect fit, and reducing the weight. The manufacturer states, that the General Incandescent outlet box has been approved by the National Board of Fire Underwriters. The lower body of the outlet box is drawn from one-eighth-inch cold rolled steel of the best grade, in one piece. The collar is also made of the same material in one piece. The threaded portion is arranged to give an adjustment of one inch, so that the depth of the box may be lengthened from four inches to five, and remain perfectly level after once being set in position. The top plate is made of heavy brass and is fastened to the iron collar, a rubber gasket being placed between, which ensures a water-tight connection. This floor outlet box is especially adaptable in construction work, for electric lights, electric fans, push-buttons or telephones located on tables, desks, counters or showcases, as will be observed by referring to Fig. 2. The manufacturer claims it has the following features which will be appreciated by engineers and construction men: It is strong and substantial and will not sink in the floor when subjected to heavy weight. It is thoroughly dust and waterproof. It is adjustable with respect to floor level, saving wiremen's time. Adjustment can be made after floor is laid. It is accessible after being installed, the parts being held together by standard machine screws. It is not liable to injury for the reason that the flexible cord comes from the side of the outlet nozzle, where it can not be stepped on and the insulation crushed or injured. It is not necessary to detach cord when floors are swept or scrubbed. When not in use a brass plug can be screwed into floor-plate, making it water-tight and flush with the floor. If it is desired not to use unsightly cords from nozzle at floor level, one-half inch plain iron conduit, or conduit encased in polished brass tubing, can be screwed into the one-half inch gas pipe thread in the floor-plate and extended to the under-side of desk, table, counter or showcase. When placed between two or more desks or tables, as shown in Fig. 2, a two, three or four-outlet cluster can be attached to the pipe extension and connected by two or more flexible cords and Edison attachment plugs for operating electric fans or lights on two or more desks.

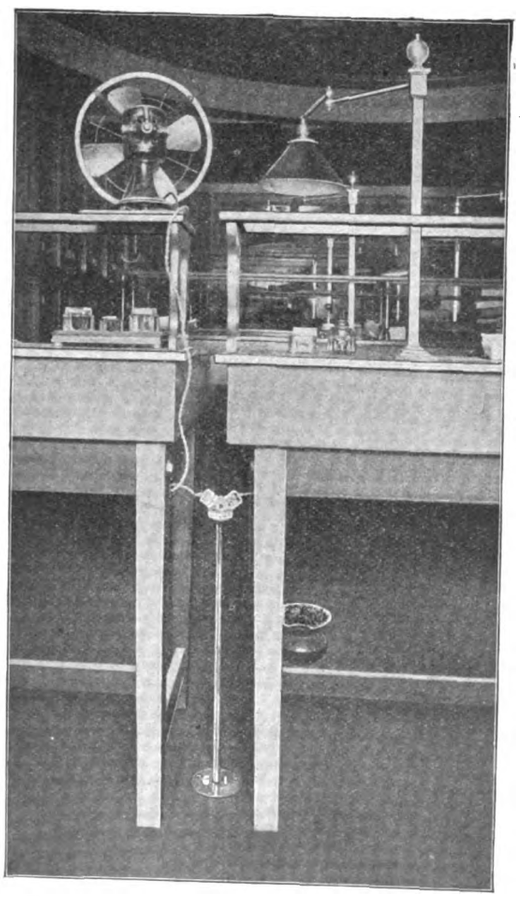

FIG. 2.—FLOOR OUTLET BOX PLACED BETWEEN DESKS.

The exposed portion of the box has a polished brass finish, and the steel body is heavily japanned inside and out.

New Types of Voltage Regulators for Generators.

Recently there have been placed on the market two new types of voltage regulators which admirably suit the conditions for which they were designed. They are known to the public as type TD and type TA. Type TD regulators (Fig. 1) are designed for direct-current generators only, while type TA (Fig. 2), though primarily designed for use with alternating-current generators, may, if provided with an exciter, be used on direct-current generators as well.

These instruments operate on the principle of rapidly opening and closing a shunt circuit across the field rheostats, the rheostats having considerable resistance turned in to give the regulator a good margin to work on. The type TD regulators are arranged to open and close a shunt circuit across the generator field rheostat; type TA across the exciter field rheostat.

Direct-current regulators, type TD, consist of a main control magnet and relay. The relay is differentially wound, one of these windings being permanently connected to the circuit, while the other is opened and closed by the main contacts which are operated by the main control magnet. As the main contacts are opened and closed, they simultaneously open and close the relay contacts by means of the differential winding of the relay. These relay contacts open and close a shunt circuit across the generator field rheostat. To prevent injurious sparking at the relay contacts, condensers are connected in multiple across them. This regulator will maintain constant voltage on one shunt-wound generator, or will maintain constant voltage on several compound-wound generators operating in parallel, regulating, however, only one at a time. Several generators can be arranged to be controlled by one regulator, by means of the five-point rotary switch as shown in Fig. 1. The generator being regulated has a tendency to take the sudden fluctuations of load, but it is quickly equalized between the several generators by means of the compound winding of the machines. With shunt-wound generators it will be necessary to have a regulator for each generator to be regulated. These regulators are usually arranged to maintain constant voltage at the bus-bars, but may be connected to pressure wires brought back from the

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centre of distribution, thus maintaining constant voltage at the centre of distribution.

Elementary connections of this regulator are shown in Fig. 3. Type TA regulators are designed to maintain a steady(but not a constant) exciter voltage, and consists of the same direct-current control magnet and relay as the type TD, with the addition of an alternating-current control magnet having a potential and an adjustable compensating winding. These two windings work in opposition to one another. This magnet operates the lower main contact. The magnet core and lever are arranged by means of a counterweight to come to a balance at the correct voltage. Should the alternating voltage tend to vary for any cause, it would change the position of the lower main contact, which would cause the exciter voltage either to be raised or lowered, thus overcoming the disturbing factor. Without the use of the compensating winding, the regulator will maintain a constant bus-bar voltage, and by the use of the adjustable compensating winding and current transformer in the circuit to be regulated, the regulator will automatically compensate for line losses. The alternating voltage is automatically kept at its desired value by varying the exciter voltage. Once the regulator is adjusted to maintain constant voltage at the centre of distribution, it will require no further adjustment and the station voltage will be increased or decreased with the load to automatically maintain the desired voltage at the centre of distribution.

This regulator is independent of temperature and frequency changes. Elementary connections are shown in Fig. 4.

These regulators are switchboard instruments in design and finish, and may be placed on the front of a switchboard panel or be placed at either end of switchboard on rigid iron brackets made for that purpose.

The great value of these regulators will be recognized in their maintaining the desired potential on a system, regardless of variations of speed and load. It naturally results in reduced attendance at the switchboard, increased output of station and reduced lamp renewals due to perfect regulation. These instruments are manufactured by the General Electric Company, Schenectady, N. Y. That they have proven satisfactory is shown by the fact that there are now in service regulators controlling upward of 100,000 kilowatts of generating apparatus and giving full satisfaction.

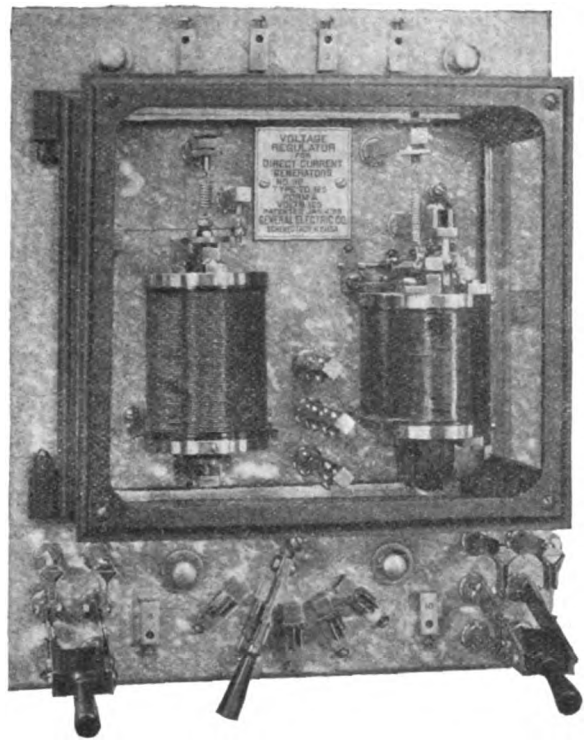

FIG. 1.—VOLTAGE REGULATOR FOR DIRECT-CURRENT GENERATOR.

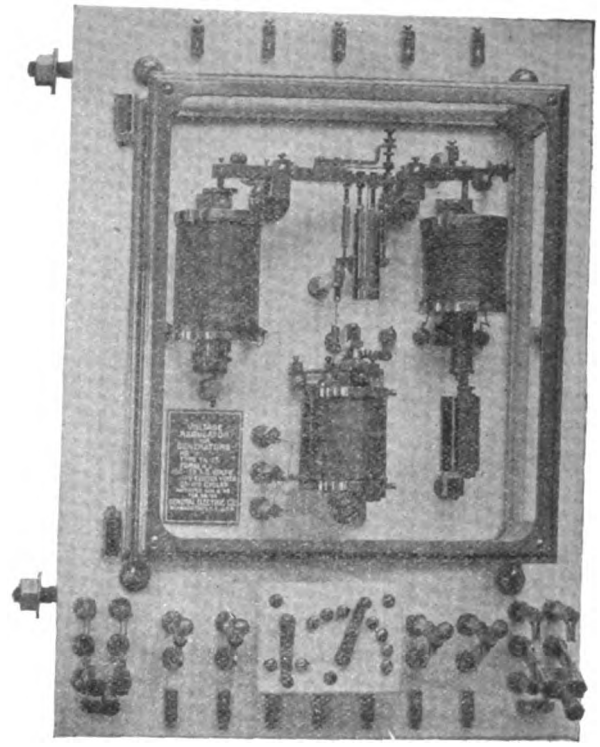

FIG. 2.—VOLTAGE REGULATOR FOR EITHER ALTERNATING OR DIRECT-CURRENT GENERATOR.

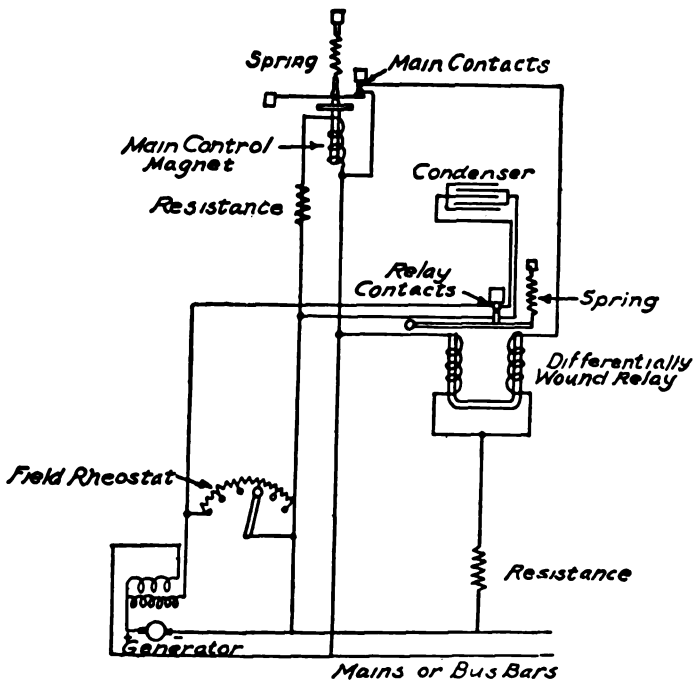

FIG. 3.—ELEMENTARY CONNECTION OF REGULATOR.

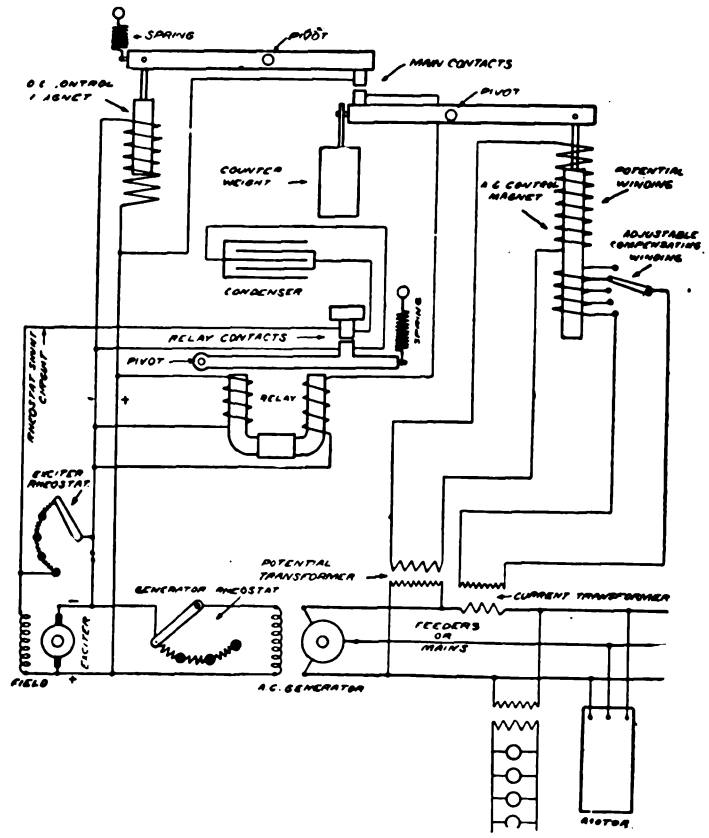

FIG. 4.—ELEMENTARY CONNECTION FOR REGULATOR.

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Automatic Block Signals for Electric Railways.

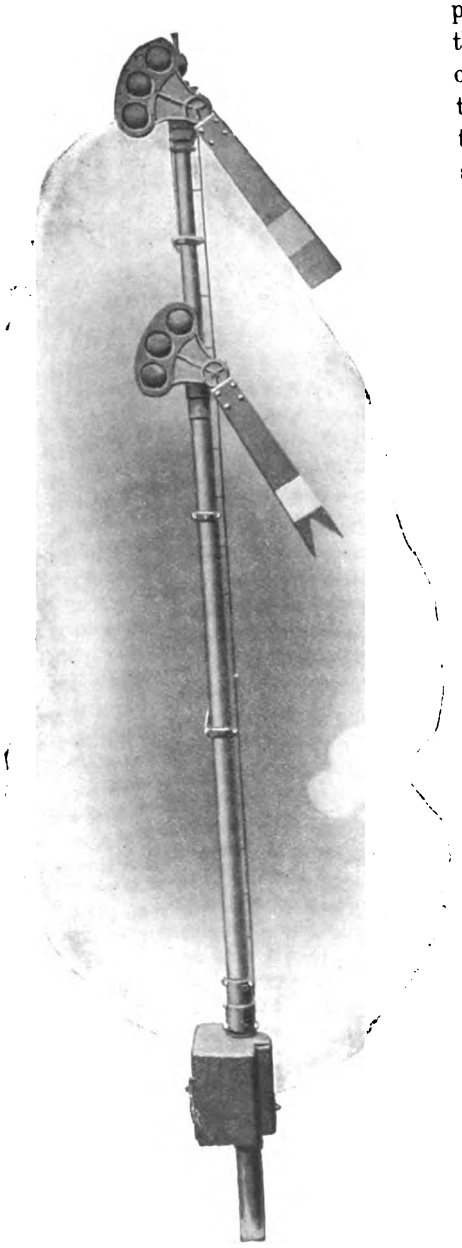
On Friday, December 18, the practical working of the automatic block signal system for electric railways, devised by Mr. S. M. Young, was shown at Rochester, N. Y., to a party of railway engineers, and representatives of the technical papers.

The system has been installed on a section of the Rochester & Sodus Bay Electric Railway at Float Bridge, N. Y. The section of the road selected is about half a mile long, includes a steep grade, and is exposed to unfavorable conditions, the idea being to make as complete a test of the reliability of this system as possible. The rails on this part of the road are frequently covered with snow, and mud and ice have to be contended with, but these, it is said, give no trouble. At the time of the demonstation, the track was filled in with snow.

The apparatus worked perfectly during the demonstration, setting the semaphore at danger whenever the car entered the block, and setting it at clear immediately upon its leaving the block. The system is entirely automatic, the semaphore being set by the car as it enters and leaves each block. Arrangement is also made so that in case of a breakdown of the system at any point the semaphore will be held at danger until the fault is rectified. The system is extremely simple; it is independent of the number of cars on the block, holding the signal at danger until the last one has left, and it allows the full conductivity of both rails to be utilized for the return circuit. Automatic block signals, as installed on steam railroads, require that the track shall be cut into sections, insulated from each other, each section representing a block. At the one end of each section a source of power is installed, connected to the two rails. At the other end, also connected across the rails, is a relay which, when there is no train on the block, holds the semaphore local operating circuit closed, and the semaphore stands at clear. The presence of a single pair of wheels on this section short-circuits the two rails, thereby throwing the relay out of action, and consequently opening the operating circuit and setting the signal at danger, where it remains as long as the two rails are connected by a train.

A simple arrangement of this kind can not be used for an electric railway, unless the use of the track as the return circuit is abandoned. However, the system may be operative by leaving one rail continuous and dividing the other into sections corresponding to the blocks. This, of course, prevents the insulated rail from being used as a part of the return circuit, and may necessitate the use of copper in the return circuit to make good for the loss of the rail.

In the Young system, both rails are utilized for the return circuit, each section being connected to the two adjacent



HOMING AND DISTANT SIGNAL, AUTOMATIC BLOCK SYSTEM.

sections with a bond of high conductivity; and at least one cross bond per section is installed, connecting the section rail to the continuous rail. Thus, due to the section bonds and cross bonds, there is a continuous path of low conductivity for the current taken by the cars, and the two rails are maintained at the same potential by the cross bonds. This, however, is the case only for the direct current returning from the cars, as the construction of the bond is such that an alternating difference of potential may be maintained beneath them.

Referring to the diagram, X and Y are the rails, X being divided into sections corresponding to the blocks. IJ is the insulating joint, and B1 and B2, the bonds connected around the insulating joints and cross-connecting the two rails. L is a line wire supplied with an alternating current from a generator at the power-house, the continuous rail forming the other side of this circuit. At one end of each section a transformer is installed, the primary of this being connected between the line L and the rail Y, and the secondary across the two rails. At the other end of each section a special type of relay R is placed, connected across the two rails. At this point is placed the semaphore and the means for operating it. This apparatus may be of any type, provided it can be controlled electrically.

Under normal conditions, when there is no car on the section 2, the relay R will be acted upon by an alternating potential from the secondary of the transformer T'. This, as seen in the diagram, closes the local circuit containing the batteries B, and thus holds the semaphore S at clear. As soon as a car enters the block 2 the rails are short-circuited by the wheels, the relay opens by gravity, and a counterweight sets the semaphore to danger. As soon as the car leaves the section, the relay again closes the local circuit, showing a clear track.

The operation of this system depends upon two special pieces of apparatus—the bonds and the relay. These bonds are merely high conductivity bonds containing a reactance. They thus offer no resistance to the flow of continuous current, but choke back the alternating signaling current. The frequency used in the demonstration was 100 cycles per second, the line being supplied from a 300-volt generator. The power taken is very small; transformers step down the pressure to three volts across the rails, and but a quarter of a volt is necessary to operate the relay. This small voltage, however, must be supplied at a given frequency. As the power is small, a wire about No. 10 is all that is necessary for the line L.

A relay for this system must not only be operated surely by a low voltage of proper frequency existing between the two rails, but it must not respond to any other difference of potential, whether due to the direct current flowing in the rails or to an accidental supply of alternating current of a different frequency. Thus, the rapid starting of a car on the block might

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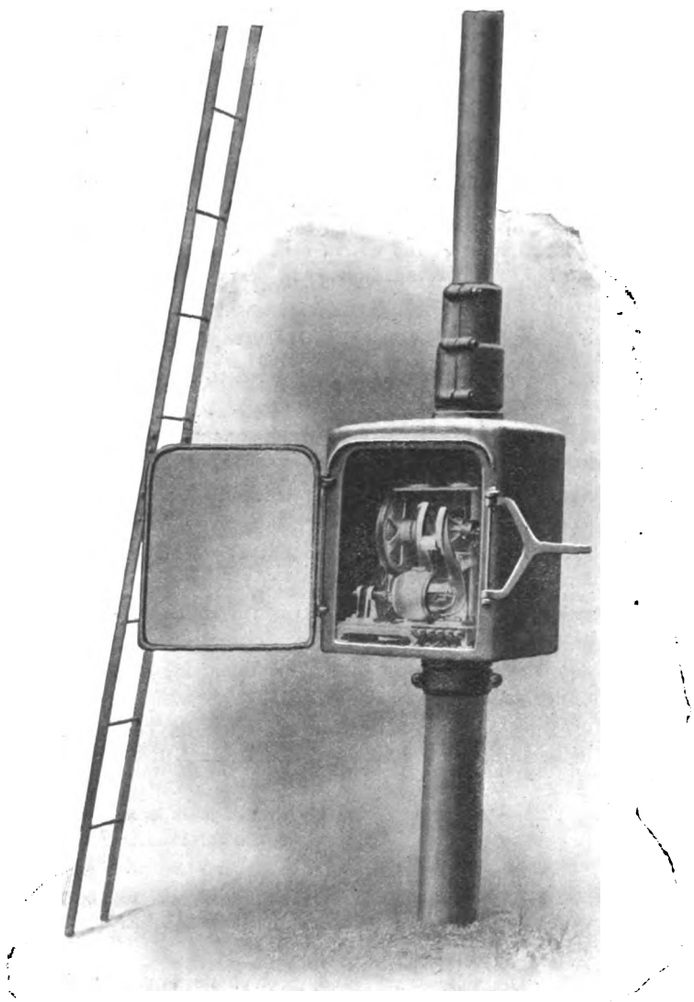
send a momentary impulse through the relay, but this should not affect it. In construction the relay is similar to a shunt motor, with a drum armature containing but one coil. The field is supplied from the primaries of the small transformers,



OPERATING MECHANISM, AUTOMATIC BLOCK SIGNAL SWITCH.

and the armature is connected across the rails. The armature is counterbalanced so as to hold the relay contact open, except when there is a current flowing through its field and another flowing through its armature, of the same frequency. Under this condition, a torque exists between the alternating field and the current in the armature coil. This closes the relay contact and sets the signal to clear. The field and armature cores are, of course, laminated.

In signal engineering, for a system to be considered, it must meet rigid requirements. Thus, the signal must go to danger whenever any part of the apparatus breaks down, and must remain so until this condition is remedied. Examining the Young system in detail, it will be seen that a break in either armature or field circuit of the relay will set the signal to danger. A break in either rail would open the supply circuit, with the same result; as will also a break in the alternating-current supply, due to a fault in the line or a breakdown of the transformer. It is also necessary that a breakdown of the insulating bond should hold the signal to danger. To secure this condition, the secondaries of the signal transformers T and T′ are connected in opposite directions to alternate sections of the track. If, then, a joint breaks down, say at the station S, the relay will be held open by the transformer T, which is not only closer to the relay R than the transformer T′, but acts with the counterweight against T′. Thus, it will be seen that the only apparatus required in this system, in addition to any signaling device which may be controlled electrically, is a small alternating-current generator and a light line extending continuously along the road to be protected; the small transformers and the special relay, one of each being required for each block; and the special bonds, each section requiring at least two—one for a cross bond, and one for a bond around the insulating joint. The system is applicable to alternating-current railways as the frequency of the power supply will differ from that of the signaling circuit and the relay will not respond to any current passing through its armature unless the frequency is the same as that of the signaling circuit.

In the system as installed at Rochester, the electric motor signal of the Pneumatic Signal Company, of Rochester, was used, though any electrically controlled system might have been employed. This company also controls the American rights for the Young system. This signal is operated by a small electric motor contained in a case attached to the semaphore pole, and power is supplied to the motor from a local storage battery, so as to be independent of the line current. This battery is of low voltage, so as to avoid objectionable sparking at the relay contacts. It is charged continuously by a small current drawn from the line through incandescent lamps used as resistance. Incandescent lamps not only furnish a cheap and convenient form of resistance, but they are made use of to give a position, as well as a color, signal at night. There are ten lamps mounted on the semaphore arm, five white and five red, the white being lighted when the signal stands at clear, and the red when it is at danger.

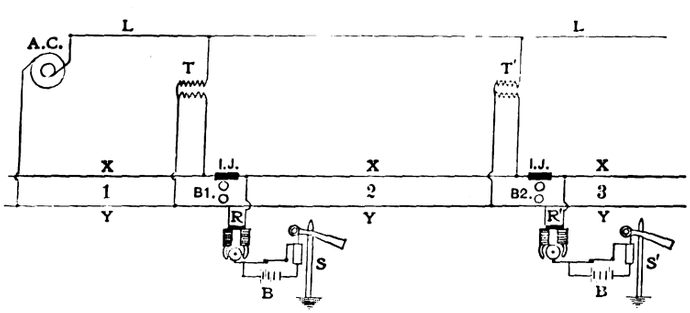
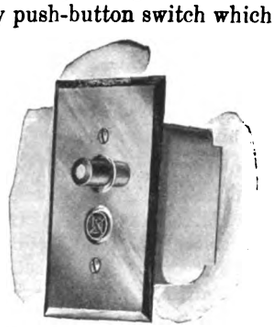


DIAGRAM OF CIRCUIT, AUTOMATIC BLOCK SIGNAL SYSTEM.

A New Key Push-Button Switch.

The accompanying illustration shows a new key push-button switch which is being



KEY PUSH-BUTTON SWITCH.

placed on the market by the Marshall-Sanders Company, of Boston, Mass. This is made upon the well-known lines of the M-S push-button switch, but with the added feature of the key, which prevents the switch from being tampered with by unauthorized persons. These switches can be used in asylums, public halls, etc., where it is not desirable to have them operated by any but the properly authorized persons.

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CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

TELEPHONES IN CUBA—The Senate at Havana, Cuba, has passed a bill granting a concession to the Compania Nacionale, an American concern, for the installation of long-distance telephones. There was some opposition to the granting of the concession on the ground that the company would come into competition with the government telegraphs.

INCANDESCENT LAMPS FOR THE LOUISIANA PURCHASE EXPOSITION—The contract for incandescent lamps for the Louisiana Purchase Exposition provides for 300,000 incandescent lamps. In the Palace of Education alone there will be installed 12,000 lamps. Mr. E. B. Ellicott is acting chief electrician and mechanical engineer. He is on leave of absence from his post as city electrician of Chicago, Ill., pending the return of Mr. Henry Rustin, chief electrician and mechanical engineer, who is now in the Adirondacks undergoing treatment for his health.

LAKE SUPERIOR COMPANY SALE—The assets of the Consolidated Lake Superior Company, which were pledged with Speyer & Company as collateral for a loan of $5,050,000, were sold at auction at noon December 15. The assets were bid in by Edward C. Henderson, of Guthrie, Cravath & Henderson, representing Speyer & Company. The price paid was $4,500,000. As soon as the list of securities to be sold had been read notices were served by various interested parties protesting against the sale. The Stanley Electric Manufacturing Company, of Pittsfield, Mass., served notice that it was the owner of the machinery in the electric lighting plant in the Michigan Lake Superior power-house. The notice stated that the machinery had been placed with the company, the Stanley Electric Manufacturing Company reserving all rights thereto until the purchase price should have been paid. The purchase price, $60,000, it was stated, has not been paid.

PROGRESS ON CONNECTICUT POWER ENTERPRISE—The project of installing the equipment for transmitting electricity from the New Milford Power Company's plant at Bulls Bridge on the Housatonic river, in Litchfield County, to Waterbury, New Britain and Cheshire to operate the traction and lighting properties of the Connecticut Railway and Lighting Company is being rapidly pushed. This is the biggest power enterprise ever undertaken in Connecticut. The distance from Bulls Bridge to Waterbury is over thirty miles, and to New Britain and Cheshire it is considerably greater. Six cables, each containing seven wires, will be used in transmitting the current. The cables form two lines of transmission wire, the poles paralleling each other at a distance of about twenty-five feet. The wires are of aluminum. Distribution power plants are being built at Waterbury, Cheshire and New Britain. It is expected that the new power system will be in partial operation early in the new year, but it will not be entirely ready until summer. The contract by which the New Milford company is to furnish power to the trolley combine is to run for a period of thirty years.

TIME SIGNALS AROUND GLOBE—The United States Naval Observatory has announced the details of its scheme to send telegraphic time signals throughout the world to mark the beginning of the new year. The signals were sent out last year for each of the four great standard time belts of the United States. This year it is proposed not only to secure a wide distribution of these new year signals throughout North and South America, by the cooperation of the telegraph and cable companies, but also to send one or more of the four series of signals around the world and back to the room in the Naval Observatory where they started. The signals will begin at 11.55 P. M. and end at midnight, eastern time. The same series will be sent out an hour later, ending at midnight, central standard time; again an hour later, ending at 2 A. M., for midnight of mountain standard time, and again an hour after that, ending at 3 A. M., for midnight of Pacific coast standard time. During each of these four five-minute intervals the transmitting clock will send an electric impulse practically every second. On the world circuit the signals will go by land lines to Cape Canso, N. S., thence by cables to the Azores, Lisbon, Gibraltar, Malta, Alexandria and Port Said; by land to Suez, by cable to Aden and Bombay, by land to Madras, by cable to Penang, Singapore, Saigon, Hong Kong, Manila, Guam, Midway, Honolulu and San Francisco, and by land back to Washington. It is proposed to receive both the outgoing and incoming signals on the same chronograph at the Naval Observatory, and thus preserve a permanent graphic record of both on a single sheet of paper. It is suggested that, besides demonstrating the possibilities of practical astronomy and telegraphy, working together through international cooperation, benefits will result from the general attention that it will direct to the advantages of the use of accurate standard time throughout the world. The messages also will carry a new year's greeting to the world.

TELEPHONE AND TELEGRAPH.

HARRISBURG, PA.—A charter has been issued to the Montour Telephone Company.

CHAMPAIGN, ILL.—The new farmers' telephone line to Pickettsville is in operation.

MOOSUP VALLEY, CT.—The telephone line will be extended from Coventry to Moosup Valley.

PUTNAM, TEX.—C. V. Marten has bought the telephone exchange of Putnam from W. A. McCreight.

SCHENECTADY, N. Y.—The Hudson River Telephone Company has moved to its new building in this city.

WARREN, OHIO—The Jefferson & Warren Telephone Company will establish a telephone exchange at Bristolville.

CARBONDALE, PA.—The Northeastern Pennsylvania Telephone Company will build a line from Tirzah through Welsh Hill to South Gibson.

SARASOTA, FLA.—The new telephone exchange is completed, and Sarasota is connected with Tampa, Bradentown, Palmetto and other towns.

BUFFALO, N. Y.—The Commercial Telephone Company has been incorporated with a capital of $50,000, to do business in Erie and Cattaraugus counties.

JOANNA, PA.—The Conestoga Valley Telephone Company intends to rebuild its line from Joanna to Morgantown, using heavier poles to carry the wires.

ALBANY, N. Y.—The New York & Northern Telephone Company has petitioned the city for a franchise to construct and maintain telephone and telegraphic services.

HOLLY BEACH, N. J.—The borough council has passed an ordinance granting the Eastern Telephone and Telegraph Company permission to string wires in the streets of this place.

WILLIAMSPORT, PA.—The telephone line through the Nippenose valley is now completed and in operation. It is a part of the system of the United Telephone and Telegraph Company.

TOLEDO, OHIO—Under the new organization of the business of the Central Union Telephone Company in Ohio, the office of the general division superintendent will be at Columbus, and division offices will be established at Toledo, Chillicothe, Dayton and Akron.

ONTARIO, CAL.—The Home Telephone Company has presented an application to the city trustees for a telephone franchise to run for fifty years. It is provided that after five years two per cent of the gross earnings of the company shall be paid to the city each year.

WEBSTER CITY, IOWA—D. C. Chase, of this city, and a number of other business men are organizing a stock company for the purpose of taking over the lines and franchise of the Stratford Independent Telephone Company, and putting in a second telephone system and exchange in this city.

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OBITUARY NOTICES.

HERBERT SPENCER, the famous author and philosopher, died on the morning of December 8, at his home in Brighton, England. Herbert Spencer was the son of a schoolmaster of Derby, England, and was born on April 27, 1820. At seventeen, after a private education, he took up railway engineering and followed this profession for eight or nine years. He was a prolific writer on philosophical subjects, and one of the leaders in thought and literature on the new subject of psychology.

SIR FREDERICK BRAMWELL, F. R. S., died on Monday, November 30, 1903. He was born in London, England, on March 7, 1818. When he was sixteen years of age he went as an apprentice to one of the old schools of mechanical engineering. After a varied experience he commenced practising on his own account as a civil engineer in 1853, and the following year became a member of the Institution of Mechanical Engineers. He was elected an associate of the Institution of Civil Engineers in 1856 and in 1862 attained full membership. In 1874 he was chosen president of the Institution of Mechanical Engineers. As president of the Institution of Civil Engineers in 1884, he described in his address the chief factors of past progress, and advocated the treatment of large steel forgings by hydraulic pressure instead of steam hammers. He was president of the mechanical science section of the British Association in 1872, and again in Montreal in 1884. He was elected president of the Association for the Bath, England, meeting in 1888, when he delivered an address on the greatness of the work which the engineer creates out of minute beginnings. In 1873 he was elected a fellow of the Royal Society. In 1881 he was appointed member of the Ordinance Committee. After serving on the council and as a member of the board of management he was (on the retirement of Sir William Bowman in 1885) made honorary secretary of the Royal Institution. On the foundation of the City and Guilds of London Institute he was appointed by the Goldsmith's Company one of its representatives on the governing body. A knighthood was conferred upon him in 1881, and a baronetcy in 1889. He received the honorary degree of D. C. L. from the universities of Oxford and Durham, and that of LL. D. from Cambridge and McGill.

MR. THOMAS CYPRIAN FRENYEAR, sales manager of the new Canadian Westinghouse Company, died of typhoid fever at Fort William, Canada, on December 10. He was a man of exemplary life, unusual business judgment and ability, and was remarkable for the clearness and force of his ideas. As an electrical engineer he was a good adviser. His is the first death in nearly five years among the higher officials of the Westinghouse Electric Company. Mr. Frenyear was the son of the Rev. T. C. Frenyear and was born on March 16, 1865, at Middletown Spa, Vt. He began his business career before he was fifteen years old, in the office of the Boston Electric Company, where an uncle, Mr. W. R. Nutting, was manager. While there he entered the Latin School, doing his studying at night. From there he entered Phillips Exeter Academy, paying his way by keeping a bookstore for students. He was graduated in 1885. He entered Harvard that autumn, but could not spare time from business to continue the course. He afterward entered the Boston University, but a business reverse put an end to his efforts to gain a collegiate degree. For several years after that he was in the employ of the Thomson-Houston and Brush Electric companies as a salesman, with his headquarters in Buffalo. From 1892 to 1895 he was superintendent of the Cayadutta Electric Railroad. In the fall of 1895 he entered the employ of the Westinghouse Electric and Manufacturing Company. He was connected with the sales office of that company until November 1, 1903, when he was placed in charge of the sales department of the new Canadian company, with headquarters in Toronto. He was married to Miss Emma L. Chase, of Exeter, on June 28, 1893. Mrs. Frenyear and three children survive him. Mr. Frenyear was a deacon and trustee of the Delaware Avenue Baptist Church, of Buffalo, and had been superintendent of the Sunday-school. In announcing the death to the officials of the Westinghouse company, Vice-President Taylor said: "The management desires to place on record its thorough appreciation of his able and loyal service and of the loss to the Westinghouse interests by the untimely removal of a young and zealous official, whose future seemed so full of promise."

ELECTRICAL SECURITIES.

Considerable strength was shown in the stock market developments of last week, and several net advances were made in leading issues. This investment advance in prominent issues strengthens the hope that popular investment is again taking hold of the market. Notwithstanding the pessimistic rumors which emanate from the bear headquarters, there is apparent a firm undertone which bids fair to carry the stock market over the holidays and maintain the present increase in prices. The money market during the week was much easier, and the bank statement of Saturday was more favorable than has been known for some time.

November exports amounted to $160,455,000, as against $125,200,000 for November, 1902. The imports were $77,000,000, against $85,300,000 for last year. The excess of exports over imports was $83,300,000, as compared with an excess in November, 1902, of $39,800,000. For the eleven months of the year, the exports amount to $1,284,000,000, against $1,212,000,000 for the same period last year. The imports were $917,000,000 this year, against $874,000,000 last year. The excess of exports over imports for the eleven months amounts to $392,000,000, against $337,000;000 last year for the same period.

ELECTRICAL SECURITIES FOR THE WEEK ENDING DECEMBER 19.

New York:	*Closing.*
Brooklyn Rapid Transit	50
Consolidated Gas	188⅞
General Electric	165½
Kings County Electric	178
Manhattan Elevated	141⅝
Metropolitan Street Railway	121¾
New York & New Jersey Telephone	147
Westinghouse Manufacturing Company	185

The regular quarterly dividend of 1¾ per cent on the stock of the Metropolitan Street Railway Company will be paid January 15, 1904. Books close December 24 and reopen January 16.

Boston:	*Closing.*
American Telephone and Telegraph	126
Edison Electric Illuminating	218
Massachusetts Electric	75
New England Telephone	122
Western Telephone and Telegraph preferred	81

The transfer books of the Boston Elevated Railway Company will be closed from December 23 until January 5, for the annual meeting.

The directors of the American Telephone and Telegraph Company have declared a regular quarterly dividend of 1½ per cent and an extra of ¾ per cent. The dividends are payable January 15 to stockholders of record December 31. Transfer books close January 1 to January 15, both days inclusive. The company's instrument statement for the month ended November 20 shows gross output of 96,963, and 32,297 returned, leaving net output of 64,666, as compared with 56,649 for 1902. Since December 20, 1902, the gross output has been 1,020,941, and the returned 441,013, the net output being 579,928, as against 573,740 for the preceding year. The total number now outstanding is 3,730,248.

At the annual meeting of the Massachusetts Electric Companies the stockholders voted to accept the annual report as submitted. S. Endicott Peabody, Philip Dexter, Everett W. Burdett, Philip L. Saltonstall and E. Rollins Morse were reelected trustees for three years.

Philadelphia:	*Closing.*
Electrical Company of America	8
Electric Storage Battery common	54
Electric Storage battery preferred	54
Philadelphia Electric	6
Union Traction	45½
United Gas Improvement	84⅜

Electric Storage Battery directors have declared a regular quarterly dividend of 1¼ per cent on the capital stock, payable January 2. Books close December 24 and reopen January 2.

Chicago:	*Closing.*
Chicago Telephone	123
Chicago Edison Light	144½
Metropolitan Elevated preferred	54
National Carbon common	17½
National Carbon preferred	90
Union Traction common	6
Union Traction preferred	29

It is stated that the local elevated railroads will show the largest percentage of increase this month of any month during the year.

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PERSONAL MENTION.

PROFESSOR LUDWIG BOLTZMANN has been elected honorary member of the Moscow Academy of Science, Moscow, Russia.

MR. FRANK T. CRAVEN has resigned his position with the C. J. Field Conduit Company, to represent the American Conduit Company, New York city, N. Y.

MR. ALFRED G. HEGGEM, who has been located as consulting engineer at Massillon, Ohio, has opened offices for the practice of his profession in the Bryant Building, Kansas City, Mo.

MR. OLIVER N. EILER has resigned as superintendent of the municipal electric light and waterworks plants of Portland, Ind., to accept a position with the S. M. Smith Company, Noblesville, Ind.

MR. H. I. MILLER has resigned his position as general manager of the Vandalia line to accept that of general manager of the Chicago, Rock Island & Pacific Railway Company, with offices at Chicago, Ill.

MR. A. H. BABCOCK has resigned his position as electrical engineer of the North Shore Railroad Company, San Francisco, Cal., and has been appointed electrical engineer of the Southern Pacific Company.

MR. CHARLES J. REED, Philadelphia, Pa., announces that, although he has already received assurances of renomination as secretary of the American Electrochemical Society, it will be impossible for him to serve if elected.

MR. FREDERICK SARGENT, of Chicago, Ill., has been retained as a consulting engineer by the commission in charge of the work of electrically equipping the suburban lines and terminals of the New York Central Railroad in New York city.

MR. W. E. L. GAINE, general manager of the National Telephone Company, of London, and Mr. Frank Gill, chief engineer of the same company, will arrive in New York this week, and intend to visit the telephone interests of the United States.

MR. EMIL O. LUNDIN, president of the Lundin Electric and Machine Company, Boston, Mass., was a visitor to New York city last week. Mr. Lundin announces a brisk trade in the specialties for which his house is well known in the electrical field.

MR. RUSSELL HOWLAND, advertising expert, announces that he has moved to larger quarters at 120 Liberty street, from 150 Nassau street. Mr. Howland is well known in the electrical field, and has a large clientele in this and allied engineering industries.

MR. F. L. WAUKLYN has resigned as vice-president and general manager of the Montreal Street Railway Company and the Montreal Park & Island Railway Company, of Montreal, Quebec. It is reported that he will become vice-president of the Dominion Coal Company and also vice-president of the Mexican Light and Power Company.

MR. GEORGE L. COLGATE, general eastern and export sales agent for the Kuhlman transformer, has the management of a project to utilize current from Niagara Falls, at Batavia, N. Y., for power and lighting purposes. A new street railway company will be one of the first purchasers of power, and it is expected that electric power will also be used to a considerable extent by business interests of the city.

MR. BION J. ARNOLD, president of the American Institute of Electrical Engineers, has met with a serious setback in his plans for a demonstration of his experimental electric pneumatic single-phase railway system. On December 18 a fire in the engine house of the road at Lansing, Mich., destroyed the locomotive, cars and machine shop. The system had been completed and was to have undergone a private test the following morning, to be followed by a public demonstration on January 1. Mr. Arnold will immediately rebuild.

MR. U. N. BETHELL, vice-president and general manager of the New York Telephone Company, has been elected vice-president and director of the Hudson River Telephone Company. Mr. Bethell is rapidly becoming known as the "Pooh-bah" of the telephone operating field. In addition to the above, among other offices held by Mr. Bethell is that of president of the Chesapeake & Potomac Telephone Company, president of the Bell Telephone Company, of Philadelphia, and president of the Atlantic & Delaware Telephone and Telegraph Company.

MR. WILLIAM BARCLAY PARSONS, chief engineer of the Board of Rapid Transit Commissioners of the City of New York, had his left arm fractured while riding on a hand car on December 14 in the tunnel. He was sitting on a front seat rigged up in the car, and threw his arm over the back of the seat. The long-handled bar with which the car was being propelled caught the arm, breaking the bone below the elbow and dislocating the wrist. Mr. Parsons had a narrow escape at the time Major Shaler was killed by a fall of rock in the tunnel.

MR. LARUE VREDENBURGH, who will present at the twenty-seventh convention of the National Electric Light Association, to be held in Boston, a report on advertising methods for central stations, has sent out a circular to members of the association, asking them to give expressions of opinion as to the methods they have found most effective along this line; what their experience has been as to traceable results from such advertising as they have done, and requesting them to forward him for use in his report samples of advertising matter that, in their opinion, have been the best business bringers. Mr. Vredenburgh will also make a similar request of a large number of foreign central station companies, with a view of comparing methods in this country and abroad, as well as giving the association the benefit of any novel ideas that it would be well to adopt here. The report will have immense practical value for all members wishing to extend their business.

MR. ROBERT T. LOZIER, general manager of sales for the Bullock Electric Manufacturing Company, New York city, announces the following sales organization: Mr. A. F. Wolf, former assistant to the general manager of sales at Cincinnati, has been transferred to the New York office to act as assistant district manager of that office, Mr. E. W. Goldschmidt being the district manager at that point. Mr. W. L. Fairchild, late treasurer of the J. F. Kelly Engineering Company, is now located with the Bullock company and will operate from the New York office. Mr. Halbert P. Hill, formerly with the General Incandescent Arc Light Company and latterly general manager of sales of the Storey company, will take charge of the Bullock exhibit at the St. Louis Exposition, 1904. Mr. Walter B. Spellmire, late district manager of the Atlanta office, has accepted the vice-presidency of the A. W. Wyckoff company, with headquarters at Pittsburg, Pa.; the Wyckoff company taking the place of the Pittsburg Engineering Company in representing Bullock interests in that section. Mr. G. C. Henry, formerly general manager of the Florida Electric Company, has been appointed district manager at Atlanta. These increases in the sales forces are brought about to meet the very largely increased demand there is for Bullock apparatus.

MR. S. MARSH YOUNG, manager of the electric railway department of the Pneumatic Signal Company, New York, tendered a trip to Rochester, N. Y., to a party of prominent signal engineers and railway men on Friday, December 18. The party inspected the Young automatic block signal system, which has been installed on the Rochester & Sodus Bay road at Float Bridge. In the party were C. W. Hotchkiss, president of the Indian Harbor Railroad Company; Azel Ames, signal engineer, Boston & Albany Railroad; J. C. Irwin, New York Central & Hudson River Railroad; Charles A. Barnes, engineer, New York State Railroad Commissioner; Professor Fitzhugh Townsend, Columbia University; D. F. Carver, chief engineer, Public Service Corporation; R. E. Danforth, general manager, Rochester Railway Company; J. M. Waldron, signal engineer, Interborough Rapid Transit Company; R. G. Siegel, signal engineer, Brooklyn Rapid Transit Company; J. N. Beckley, president, Charles Hansel, vice-president and general manager, John T. Cade, sales manager, F. L. Dodgson, chief engineer, and Arthur Dean, signal engineer, of the Pneumatic Signal Company. The party was entertained very hospitably, and was conveyed to and from the several points of inspection in a special car provided by Mr. Young.

LEGAL NOTE.

IMPORTANT DECISION INVOLVING TELEPHONE SWITCHBOARDS—In the suit on the Scribner patents, Nos. 357,538 and 552,729, and the Scribner and Warner patent, No. 488,033, covering long and short springs in spring jacks, a decision was handed down on December 22 in the United States Circuit Court, Northern District of Ohio, by Judge Francis J. Wing, in favor of the North Electric Company. This suit was contested by the Western Electric Company. The opinion in full reads: "In this cause the bill is dismissed, and judgment for costs is awarded against the complainant." Barton & Tanner were the attorneys for the complainant, and Lawrence for the defendant. An adverse decision would have been a very severe blow to independent telephone interests.

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ELECTRIC RAILWAYS.

MARSHALLTOWN, IOWA—The Iowa City, Davenport & Muscatine Interurban Railway Company is surveying a line from Davenport to this city.

NOBLESVILLE, IND.—The city council has granted Wallace B. Campbell, of Anderson, a franchise for fifty years to operate an interurban line through this city, connecting Anderson and Lebanon.

WASHINGTON, PA.—The Washington & Canonsburg Railway Company will build a line across the country from Washington to Finleyville, and will commence work on the same within a period of three months.

GREELEY, COL.—George J. Spear has been granted a franchise by the city council. It is to run for fifty years, and provides that at the end of thirty years the city shall receive $250 a year for each mile of trackage for the use of the streets.

BENTON HARBOR, MICH.—It is reported that the right of way for the proposed line of the Kalamazoo & Lake Michigan Electric Railway between this place and Kalamazoo has been secured, and it is now expected to have the road in operation by July next.

MEMPHIS, TENN.—An amendment to its articles of incorporation has been filed by the Fort Smith Suburban, increasing its capital stock to $100,000. The promoters intend to extend the line so as to make connection with the St. Louis, Iron Mountain & Southern Railroad.

JOPLIN, MO.—The Southwest Missouri Electric Railway has purchased the Mineral Cities Electric Line, which is partially constructed, between Joplin and Pittsburg, Kan. This will give the Southwest Missouri a through line from Carthage to Pittsburg, a distance of forty-five miles.

BAY CITY, MICH.—Advices from Detroit state that traffic arrangements have been completed whereby the line now being built from Flint to Saginaw will run to Bay City over the tracks of the Bay City-Saginaw United Traction Company, through service to be given from Bay City to Flint.

CHARLOTTESVILLE, VA.—The Charlottesville City & Suburban Street Railways Company's holdings in the city and suburbs have been sold at public auction for $50,000 to the bondholders, represented by a committee of three—R. H. Wood, C. J. Rixey and Lewis T. Nackel. The amount paid is equivalent to from $95,000 to $100,000.

ASHTABULA, OHIO—An electric railway is projected from Warren, Ohio, to Jefferson, Ashtabula County, where it will connect with three Pennsylvania and Ohio lines for Ashtabula. It would pass through Cortland, Mecca, Greene, Colebrook, New Lyme and Lenox. At Kennelworth it would cross the Middlefield-Sharon division of the Cleveland & Eastern.

WHEELING, W. VA.—The Wheeling & Elm Grove Railway Company has opened its line to West Alexander, a distance of eighteen miles. The company's next step will be the extension of its lines on through to Claysville and later to Washington, Pa., when a connection with another interurban line will give this city through traction service to Pittsburg.

READING, PA.—In order to increase the service from the Klapperthal station of the Metropolitan Electric Company, a heavy copper feed wire is being strung from this city. The distance is three and one-half miles, and the weight of the cable about 35,000 pounds. When the work is completed the company expects to increase the service for railroad purposes about one-third.

SAN JOSE, CAL.—Articles incorporating the Palo Alto & Suburban Railway Company have been filed in the county clerk's office. It is capitalized at $100,000, its principal place of business is to be in Palo Alto, and its existence is placed at fifty years. The directors of the company are John F. Parkinson, G. F. Gray, K. H. List, W. P. Gray, L. N. Hobbs, G. S. Parkinson, W. E. Crossman.

QUINCY, ILL.—The survey for the proposed electric line between Palmyra and Philadelphia. Very little of the line follows The entire distance is twenty-one and one-half miles—ten and one-quarter between Hannibal and Palmyra, and eleven and one-quarter between Palmyra and Philadelphia. Very little of the line follows the county roads, but cuts directly across the country, and in most cases the grade is very slight.

GOSHEN, IND.—Local capitalists have effected a temporary organization for the formation of a company to build an electric line from Goshen to Warsaw, to make a connecting link between the trunk lines of the Indiana Union Traction Company and the Indiana Railway Company. The officers are: president, F. E. C. Hawkes; vice-president, Haines Egbert; secretary, B. F. Deahl; treasurer, F. G. Hubbell.

RICHMOND, IND.—The Wayne County commissioners have granted a franchise to the Columbus, Greensburg & Richmond Traction Company. The franchise is for the townships of Center, Abington, Washington and Wayne. The franchise only grants the right to cross the roads wherever necessary. The company has its own right of way. The franchise states that the line is to be built within two years.

MINNEAPOLIS, MINN.—The Minnesota Power and Trolley Company has filed articles of incorporation with the secretary of state. The company is capitalized at $500,000, and it purposes, according to the articles of incorporation, to develop water powers and construct electric railways. The incorporators are Charles O. Straub, Joseph L. Kichli and Mathias Schuienberg, all of Minneapolis, and Charles Swanson, of Fridley, Anoka County.

CARLISLE, PA.—Preliminary to the construction of a trolley line from Harrisburg to this place, a charter has been granted by the State Department to the Camp Hill Turnpike Company, of Cumberland County. This company is to construct a turnpike from the Susquehanna at Bridgeport for a distance of three and one-half miles. The incorporators are L. A. Sweigard, of Atlantic City; John A. Cox, of Gettysburg, and S. J. Harris, of Carlisle.

KOKOMO, IND.—The Kokomo, Marion & Western Traction Company has doubled its service between Kokomo and Greentown. Cars now run every half hour, instead of every hour. The company let a contract with a Philadelphia electrical house for the equipment of a new power station in Kokomo. The machinery will cost $250,000, and the buildings and power plant complete will cost $400,000. Work on the line is progressing eastward, and cars will be running to Marion before many weeks.

JOPLIN, MO.—Articles of incorporation have been filed for the Joplin, Neosho & Pierce City Interurban Railroad Company. The company's offices will be in Neosho, and it intends to operate in the counties of Jasper, Newton, Barry and Lawrence, touching the towns of Joplin, Sarcoxie, Pierce City, Stotts City, Newtonia, Granby and Neosho. The capital is fixed at $50,000 and there are five directors, as follows: Charles Cunliff, William S. Brawner, John Kimpel, John Weathers and Benjamin Cunliff.

FREDERICK, MD.—At the annual meeting of stockholders of the Myersville & Catoctin Electric Railway Company, held at Myersville, the following directors were elected: Christian W. Lynch, J. Clarence Lane, William Jennings, John M. Lane, W. C. Hepperle, H. H. Keedy, of Hagerstown, and Cyrus F. Flook, John C. Leatherman, Herman H. Routzahn and George D. Gover, of Myersville. The board organized by electing Christian W. Lynch, president; J. Clarence Lane, vice-president; John M. Lane, secretary, and William Jennings, treasurer.

INDIANAPOLIS, IND.—The Dayton & Western Traction Company, capitalized at $10,000, has been formed for the purpose of constructing a traction line from Richmond east to the Ohio state line, to connect with the Ohio portion of the company's line. Henry C. Starr and John F. Robbins, of Richmond, are the Indiana capitalists interested in the scheme. The other incorporators are Valentine Winters, Howard Fravel, Frederick Funkhouser and Albert S. Weusthoff, all of Dayton, Ohio, and Richard W. Deaver, of West Alexandria, Ohio. The line will connect with the tracks of the Indianapolis & Eastern Traction Company in Richmond.

PENN YAN, PA.—The amended incorporation papers of the Lake Keuka & East Side Electric Railroad Company recently filed with the county clerk show that the capital stock will be $130,000. The directors for the first year are: James T. Harris, Joseph C. Harris and Charles H. Hanscomb, of New York; Morris F. Sheppard, William H. Fox and Charles H. Sisson, of Penn Yan; David H. Hoover, of Keuka Landing; Frederick Crosby, of Crosby's Landing, and J. Monroe Shoemaker, of Elmira. The road will run from this village along the eastern shore of lake Keuka to Keuka Landing, twelve miles from Penn Yan, and eventually it will be extended to Hammondsport.

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INDUSTRIAL ITEMS.

THE ELECTRIC APPLIANCE COMPANY, Chicago, Ill., will be glad to answer enquiries addressed to its transformer department, regarding "Salus" compound, the new insulation for Packard transformers.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, Pa., in bulletin No. 80 describes the installation of chloride accumulators for the Ottawa Electric Railway Company. This bulletin will be sent upon request.

MESSRS. BRAMWELL & HARRIS, 5 Great George street, Westminster, England, announce, in referring to the recent loss which the company sustained in the death of Sir Frederick Bramwell, that the business of Bramwell & Harris will be carried on as heretofore at the above address, and that the offices at Edinburgh and Cardiff will be continued and the name of the firm remain unchanged.

THE MARSHALL-SANDERS COMPANY, Boston, Mass., reports an exceedingly lively interest in its push-button switches. The company has important installations of these switches specified in nearly all of the large cities of the country, and by some of the most prominent architects and electrical engineers. The uniform plates and universal adaptation to all forms of conduit boxes are greatly appreciated by the contractors' trade, as their work is thereby simplified.

THE MANHATTAN ELECTRICAL SUPPLY COMPANY, New York city, will be pleased to send its new price list "C," applying to catalogue No. 14. This price list takes effect December 14, 1903, and supersedes all previous quotations. This list gives the quotations on every conceivable character of electrical apparatus. A new design of an electrical portable which this company is marketing is a lamp nineteen inches to top of shade, finished in combination brush brass and black.

THE CARLETON-CHASE ELECTRIC COMPANY, New York city, is placing on the market a universal adjuster for suspended electric lamps, which is designated as the "Electrogrip." This is a device for attaching to the socket of an incandescent lamp, and is so constructed that it adjusts the lamp to any position desired. The device may be used with any size of cable, and is not only used as an adjuster, but also as a take-up, and, the manufacturer states, will not in any way wear the insulation off the cord.

THE KELLOGG SWITCHBOARD AND SUPPLY COMPANY, Chicago, Ill., has published a souvenir bulletin descriptive of magneto telephones. This is one of the handsomest pieces of telephone literature which any company has had the good fortune to produce. The typography and illustrations are excellent, and the cover is artistic to a high degree. The information given in this bulletin is valuable and may be looked up with profit by not only the prospective exchange operator, but by the telephone engineer as well.

THE ROTARY ENGINE COMPANY, 135 South Second street, Philadelphia, Pa., will be pleased to send its bulletin No. 1 to interested parties. This describes and illustrates the direct-connected generating sets for power and lighting, running from 12½ to 130 kilowatts. This bulletin presents a concise description of the Warren rotary engine, the principles involved in which have been developed and tried through several years of study and a long series of practical experiments. The manufacturer states that as a prime mover the Warren engine possesses every desired qualification and represents an extreme of simplicity of construction and perfect mechanical action.

THE MISSOURI-AMERICAN ELECTRIC COMPANY, St. Louis, Mo., reports a rapidly increasing business, for which it has extended the capacity of its plant. This is a new plant, and the building has a total floor space of about 20,000 square feet. The plant is equipped with a large number of labor-saving devices, some of which have been invented and patented by Mr. McDonnell, vice-president and general manager of the company. In addition to the manufacture of lamps, this company intends placing on the market very soon a new current controller, a new lighting device and a new sign flasher. Mr. A. W. W. Miller is president of the company and Mr. George P. McDonnell is vice-president and general manager.

THE C. W. HUNT COMPANY, West New Brighton, N. Y., in a handy booklet describes the general line of machinery which it manufactures. This company has had thirty years' experience, and has one of the largest and best-equipped shops in America for this line of manufacture. The company designs and builds every article in its own works, and fully guarantees the material and workmanship. Among the more important machines described in this booklet are steeple towers, parabolic boom towers, steam shovels, elevators, overhead trolleys, coal tubs, automatic railways, cable railways, steam and electric hoisting engines, blocks and sheaves, coal crackers, conveyors, coal screens and valves, industrial railways and electric locomotives.

THE LAIDLAW-DUNN-GORDON COMPANY, 114 Liberty street, New York city, has recently issued bulletin L 509, describing a new line of air compressors. These compressors are fitted with Meyer steam valve gears, permitting of an adjustable cutoff. The air ends are arranged both with poppet inlet and outlet valves and with mechanically operated inlet and poppet outlet valves, the valves in either case being placed in the head of the cylinder, permitting the body to be effectively water-jacketed. The frames of these compressors are especially heavy. The capacities listed range from 468 to 2,220 cubic feet of free air per minute, and the air pressure from 80 to 100 pounds per square inch. This pamphlet will be sent upon request to those interested.

THE DIELECTRIC MANUFACTURING COMPANY, St. Louis, Mo., will be pleased to send its catalogue on insulating materials to any one interested in this subject. The aim of the Dielectric Manufacturing Company has been to reach the closest practical approximation to an ideal insulation, by a careful study and manipulation of the raw materials, supplemented by a careful study of the mechanical, chemical and electrical requirements of the different parts of electrical apparatus which require to be insulated from one another. "Dielectrol" is a black fluid of varnish consistency, and is intended for either dipping finished coils or for painting on coils as they are being wound. It dries in air, but the company recommends baking, for the double reason of driving out all moisture from the cotton covering and allowing the excess of material to drain off. The company will be pleased to furnish samples of this material on request.

ROSSITER, MacGOVERN & COMPANY, 17 Battery place, New York city, in their December bulletin, call attention to an extensive line of electrical and steam machinery. The apparatus described in this bulletin is guaranteed to be first-class in every particular, and the dealers state will be found to be most modern in type and of the best known manufacture. With few exceptions, this company is in a position to make immediate deliveries, and the material can be inspected at any of its factories, either in Jersey City, N. J., or in St. Louis, Mo. The machinery which this firm handles is invariably overhauled or thoroughly looked over and tested before shipment, so that the company has no hesitancy in giving the same guarantees as are furnished by the leading manufacturers. In addition to dealing in electrical and steam machinery, Rossiter, MacGovern & Company maintain in both Jersey City and St. Louis extensive repair shops, where they are prepared to execute promptly any kind of electrical repair work.

THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, Rochester, N. Y., and Chicago, Ill., in bulletin No. 8 describes its line of non-multiple central energy switchboards. In publishing this switchboard bulletin the company has endeavored to show illustrations and drawings of the various styles of cabinets which it manufactures for non-multiple central energy systems. Especial attention is called to the matter of equipment and the method of specifying this. In connection with the illustration of each switchboard a number of standard equipments are given and designated, as Standard Equipment "A," "B," etc. These cabinets and equipments are regularly carried in stock, and the orders for these are not subject to delay, whereas special equipments are subject to more or less delay, depending upon the amount of work necessary to provide for the special orders. In addition to the strictly commercial descriptive matter, there is a lot of valuable information which has been compiled for the benefit of purchasers of this class of apparatus. This information will prove of great value to parties operating small magneto or generator-call systems, or who are thinking of equipping their plants with a central energy system.

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index

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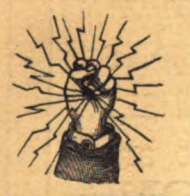
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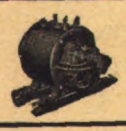
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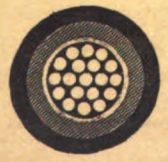
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INDEX TO ADVERTISERS PAGE 20

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CLASSIFIED INDEX PAGE 28

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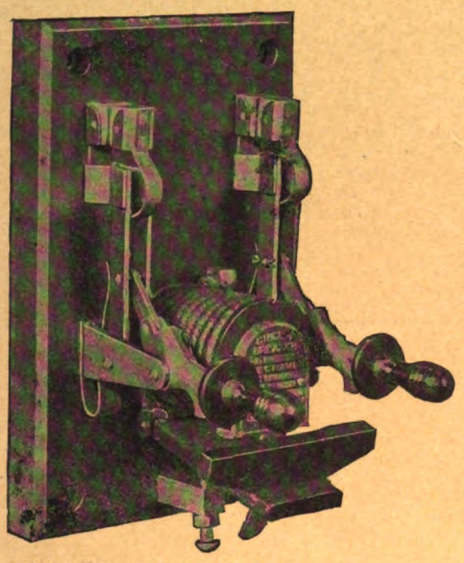

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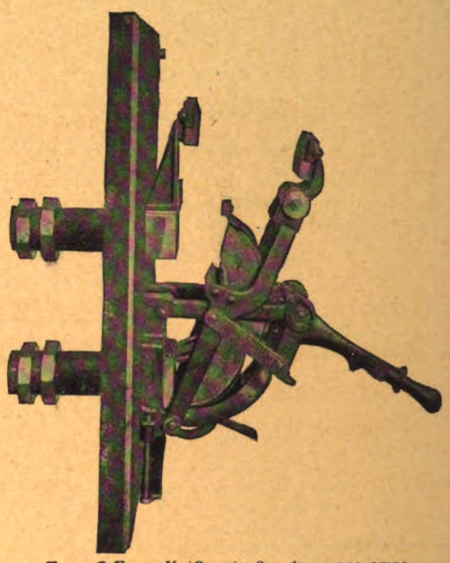

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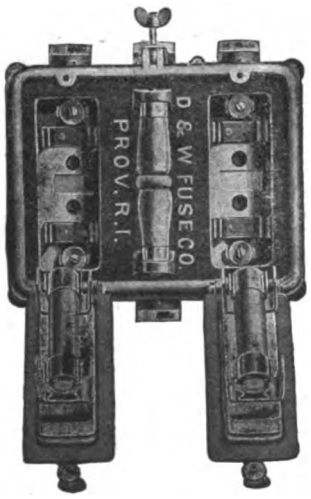

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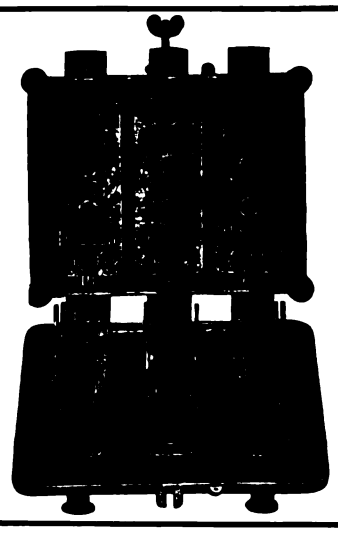

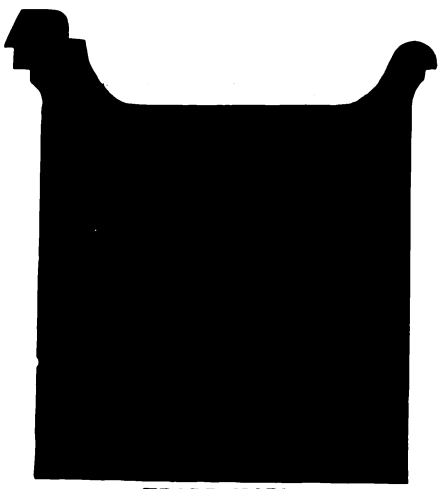

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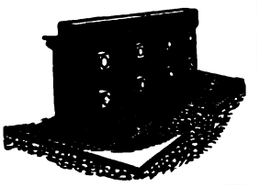

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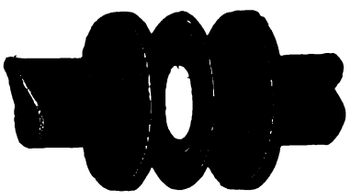

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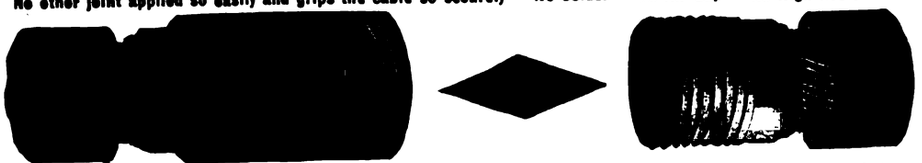

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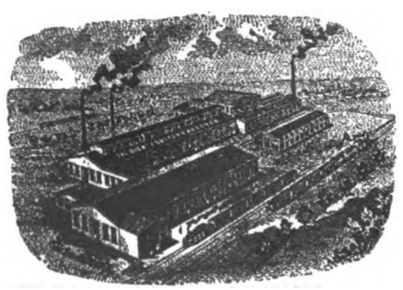

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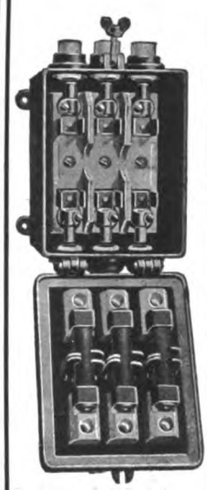

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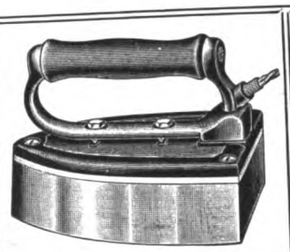

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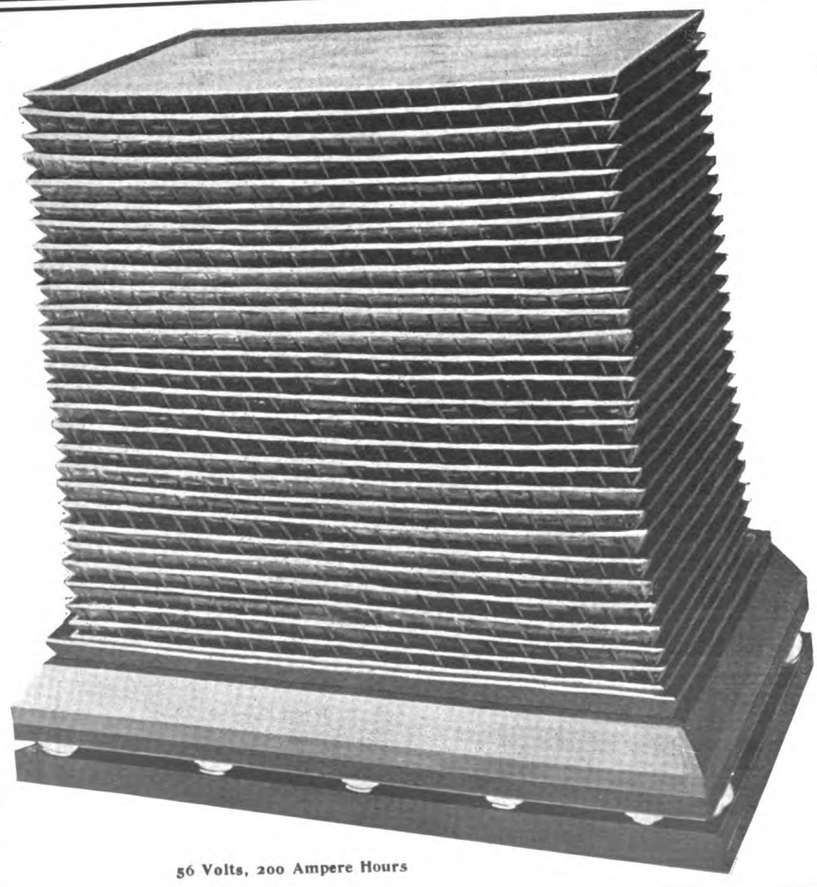

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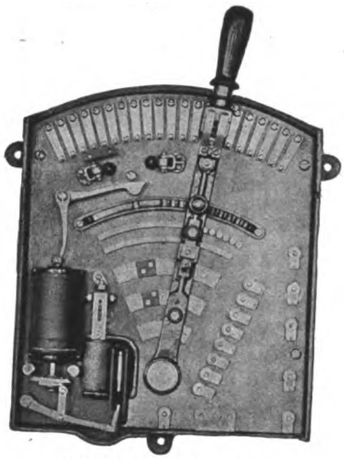
C  H

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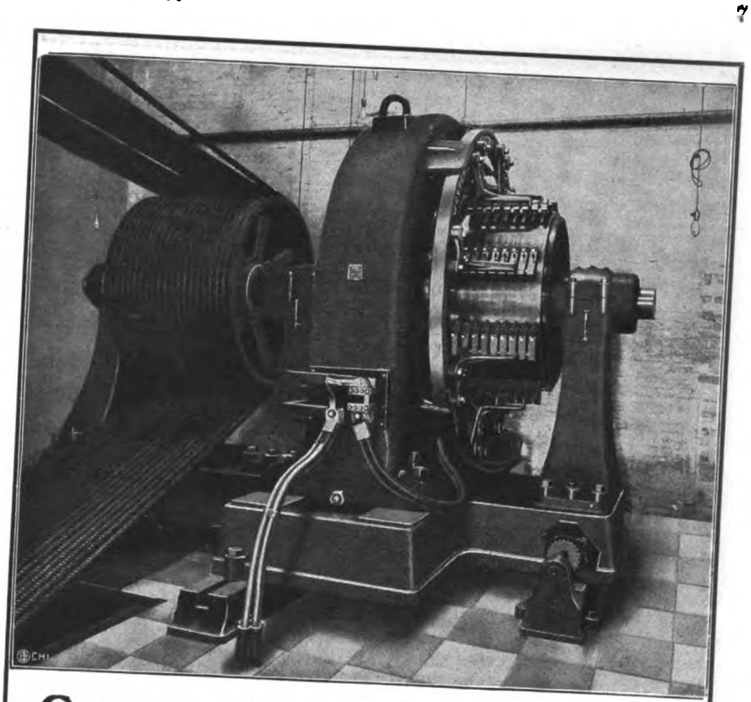

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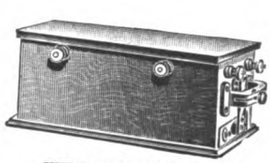

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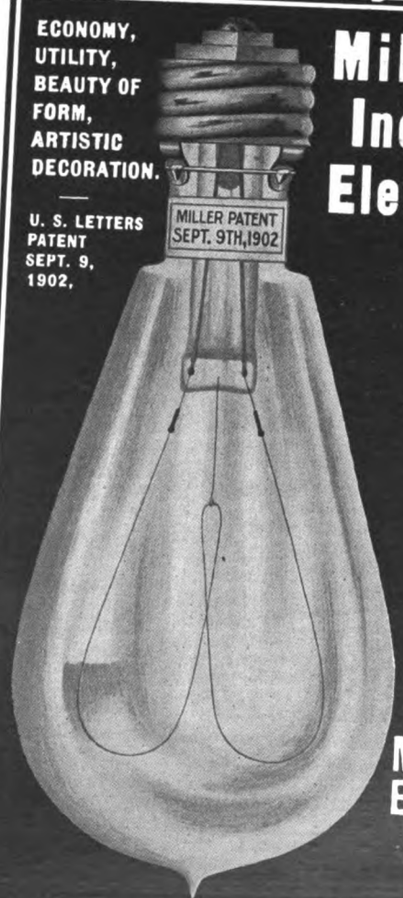

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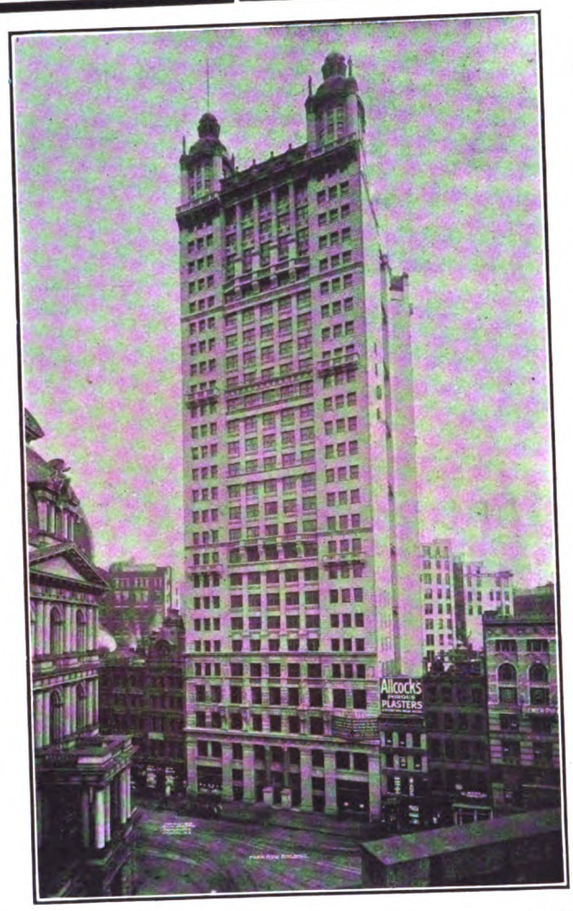

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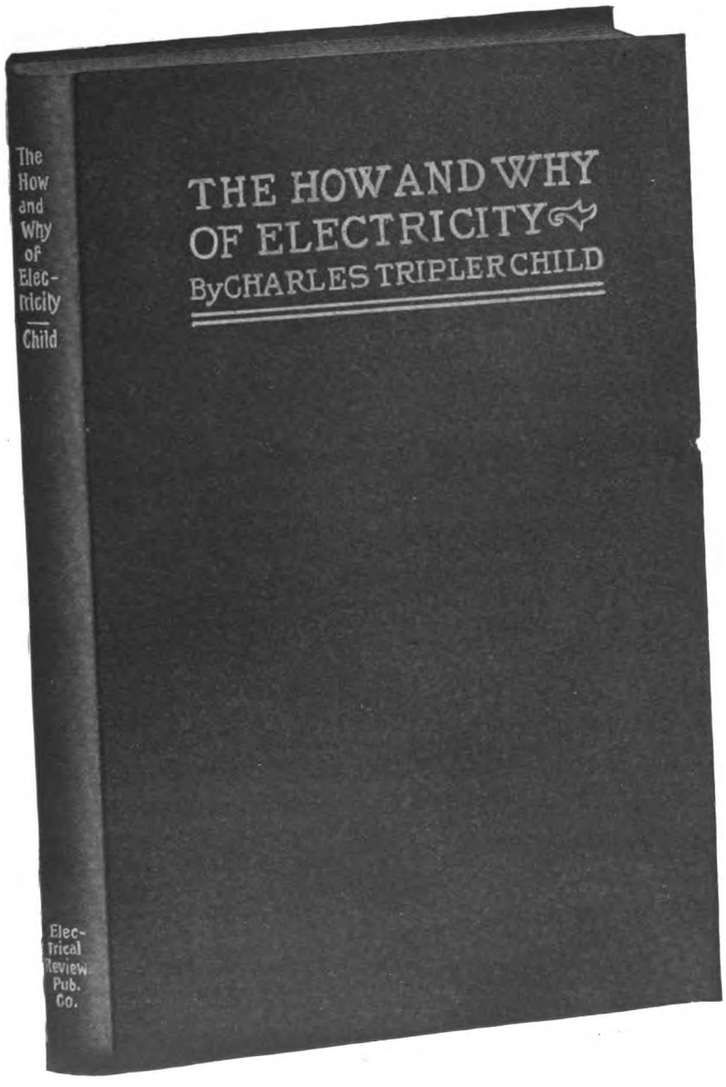

CONTENTS

CHAPTER

Preface.
I The Electric Current.
II The Electric Battery.
III The Effects of Electric Flow in the Circuit—Heat and Chemical Action.
IV The Effects of Electric Flow Outside the Circuit—Magnetism and Induction—The Electrical Units.
V Electromagnets—The Telegraph.
VI Electric Signaling Apparatus.
VII The Relations Between Magnets and Electric Currents.
VIII Induction and Reactive Coils.
IX The Telephone.
X Telephone Accessories.
XI The Mechanical Generation of Electricity.
XII The Dynamo Machine.
XIII Various Types of Dynamo Machines.
XIV Alternators—Polyphase Currents.
XV The Electric Motor.
XVI The Electric Railway.
XVII Polyphase Currents and Motors.
XVIII Electrical Power Transmission.
XIX The Incandescent Light.
XX The Arc Light.
XXI Electrochemistry—Storage Batteries.
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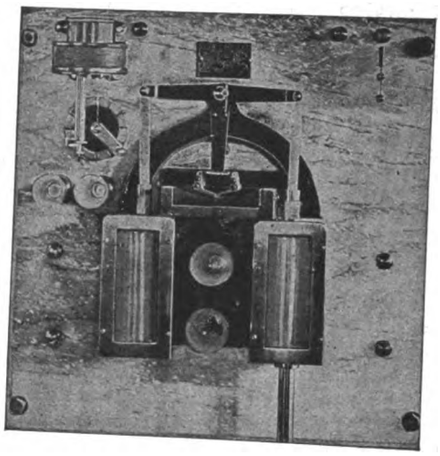

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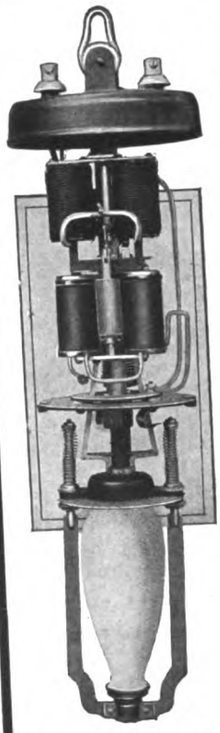

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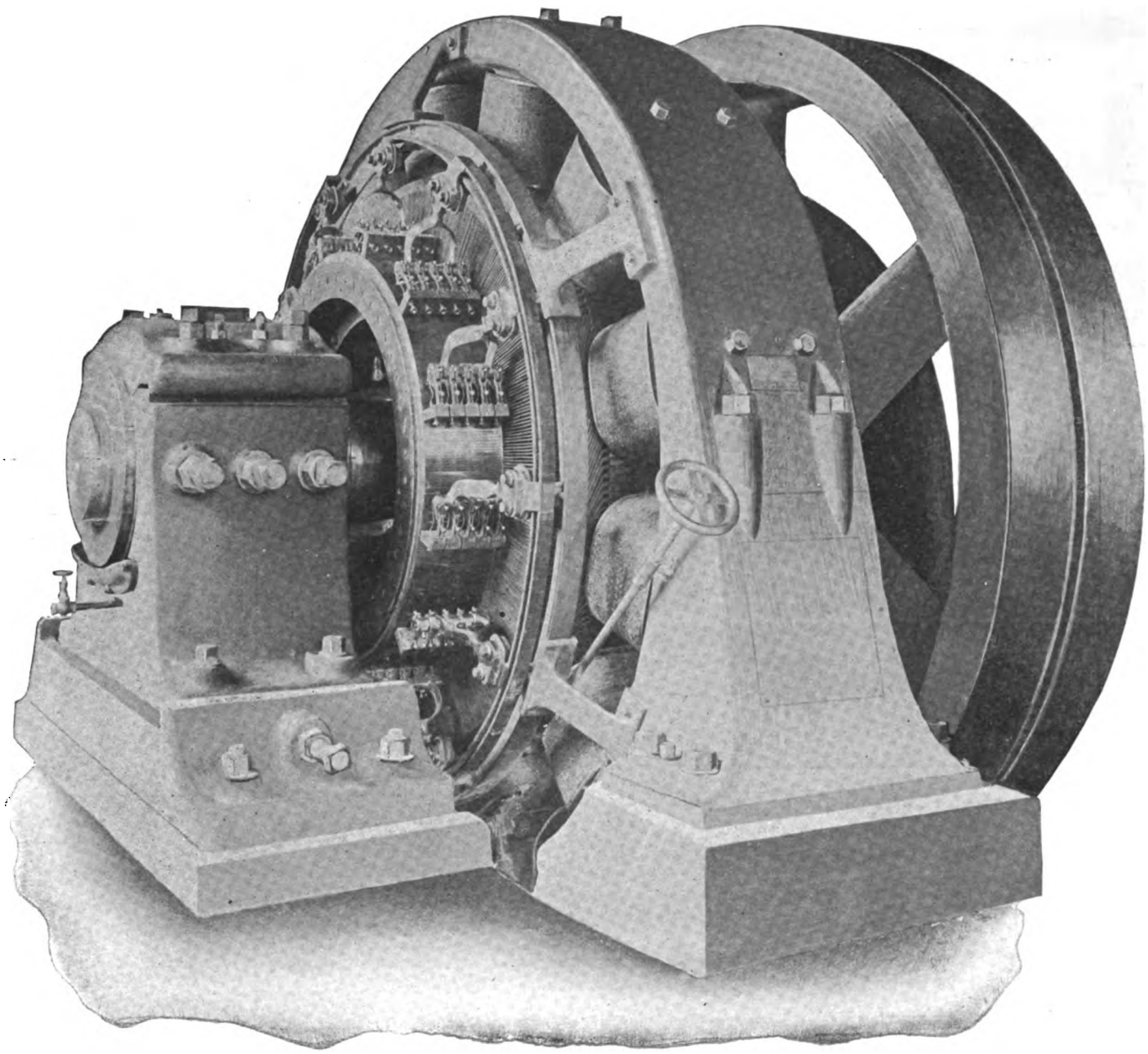

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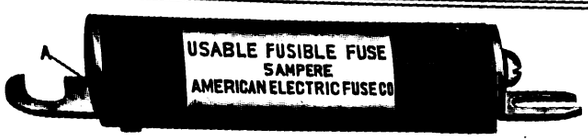

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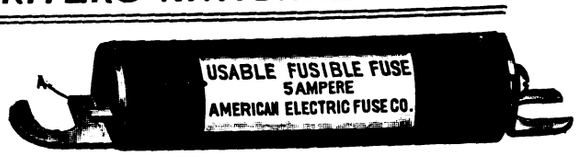

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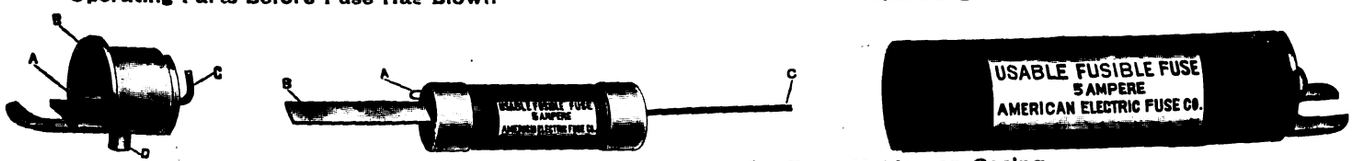

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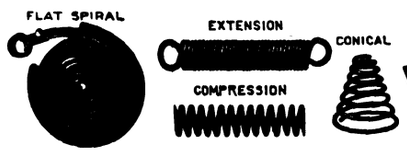

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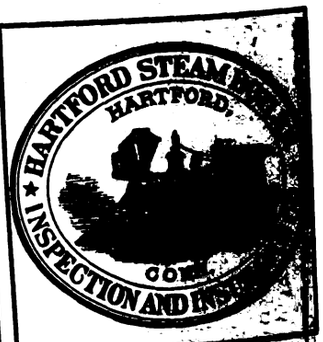

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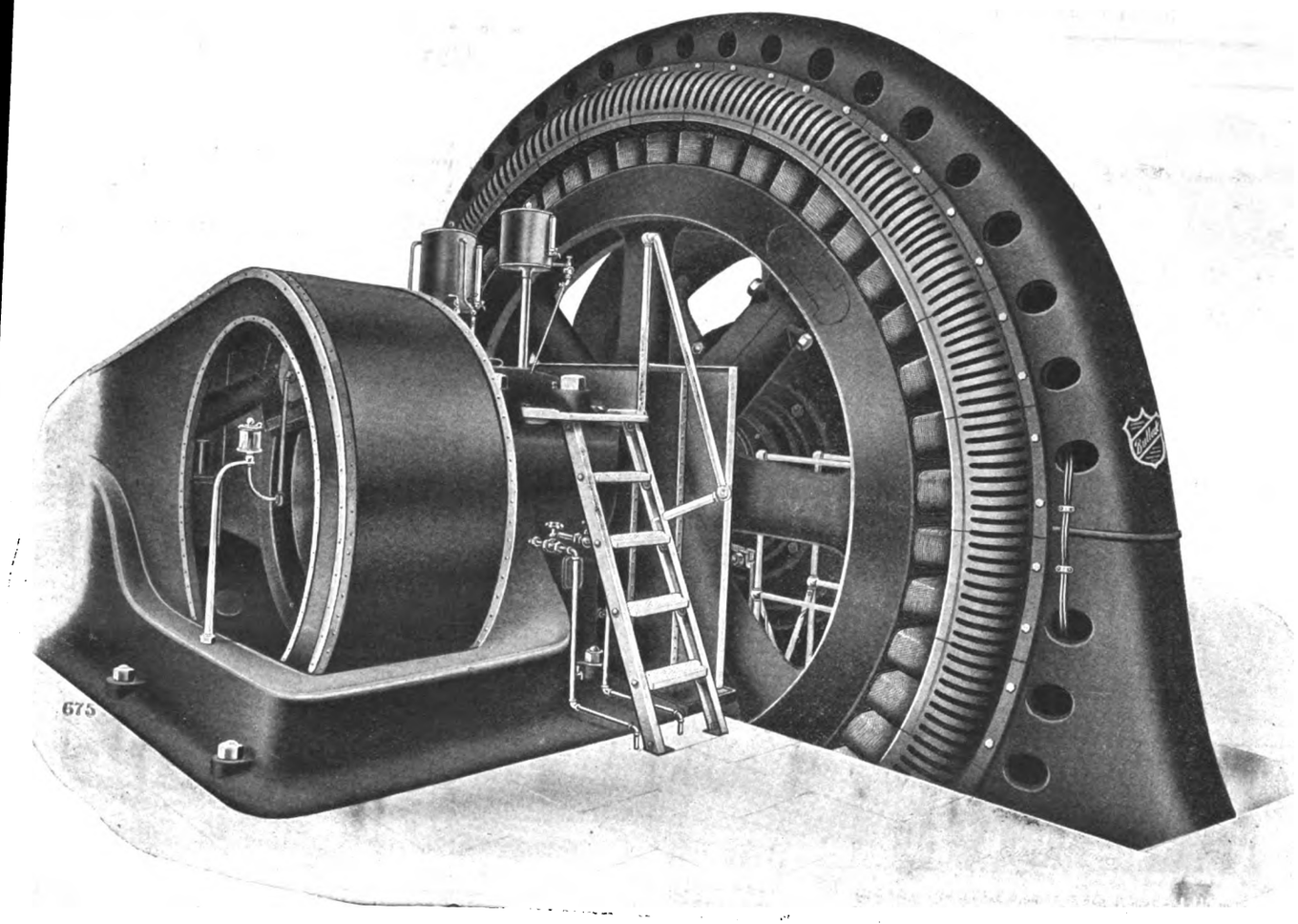

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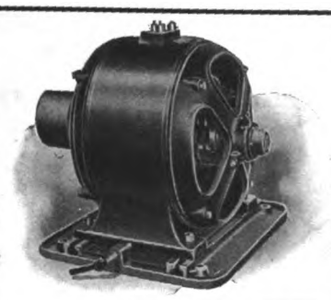
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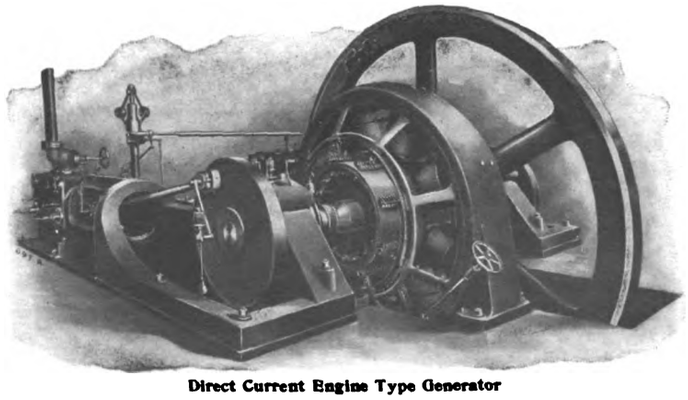
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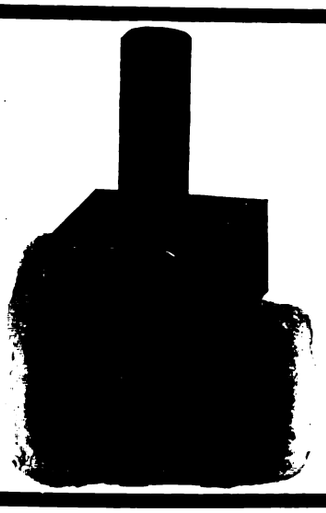

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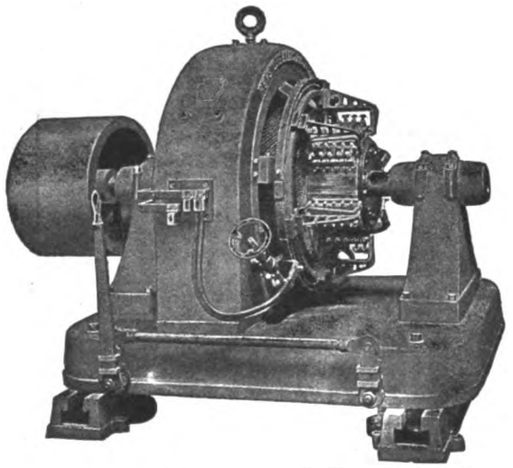

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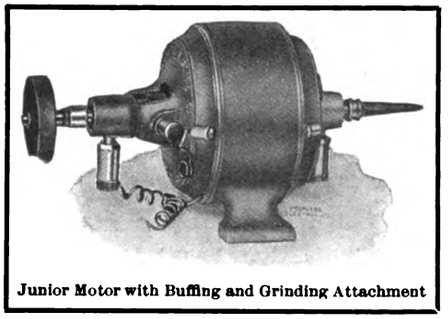

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INDEX TO ADVERTISERS.

A

Abbott, Eugene B.....
Adams-Bagnall Electric Co.....
Allen & Co., L. B.....32,41
Allis-Chalmers Co..... 45
Alphaduct Mfg. Co..... 44
American Battery Co..... 32
American Bell Telephone Co..... 51
American Carbon & Battery Co... 47
American Circular Loom Co 1
American Conduit Co..... 23
American Diesel Engine Co 45
American District Steam Co.....
American Electric Fuse Co..... 16
American Electrical Heater Co.... 6
American Electric Telephone Co.. 51
American Electrical Works..... 1
American Engine Co..... 43
American Insulated Wire & Cable Co..... 56
American Insulating Machinery Co. 18
American Platinum Works..... 21
American Push-Button Telephone Co .....
American School of Correspondence .....
American Steel & Wire Co..... 10
American Stone Conduit Co..... 22
American Vitrified Conduit Co.... 23
American Vulcanized Fibre Co.... 49
American Watchman's Time Detector Co.. 44
Arnold Electric Power Station Co. 46
Ashcroft Mfg. Co..... 41
Atchison, Topeka & Santa Fe R. R.
Atlantic Insulated Wire & Cable Co. 44
Atwater Kent Mfg. Works..... 44
Aultman Company..... 43
Automatic Electric Co..... 49

B

Babcock & Wilcox Co..... 45
Baker & Co.. 32
Baker & Co., W. E..... 46
Baker, Jos. B..... 46
Ball & Wood Co..... 45
Banner Electric Co.....
Barnes Co., The Wallace..... 16
Barr, W. J..... 48
Barron & Co., Jas. S..... 41
Barstow, W. S..... 46
Bates Machine Co 19
Benjamin Electric Mfg. Co. 21
Benson & Co., William W..... 49
Biddle, James G.....
Big Four R. R.....
Billings & Spencer Co..... 32
Bishop Gutta-Percha Co..... 1
Bossert Electric Construction Co.. 43
Boston Electric Co..... 44
Brady, T. H..... 1
Bridgeport Brass Co.....
Bristol Co.....
Brookfield Glass Co..... 42
Browning Mfg. Co. 18
Bryan, Wm. H..... 46
Bryan-Marsh Co.....
Bullock Electric Mfg. Co..... 17
Bunnell & Co., J. H..... 4
Bureau of Expert Investigation and Construction..... 46
Burnley Battery & Mfg. Co..... 49
Byllesby & Co., H. M..... 46

C

Cahen-Bertram Co.....
Cahoon, James Blake.....
Camp Co., H. B.....
Camp, W. M.....
Cary Spring Works.....
Case Bros.....
Central Electric Co.....
Chicago Edison Co.....
Chicago Fuse Wire Mfg. Co.....
Chicago Insulated Wire Co.....
Chicago & Alton Railway.....
Chicago & North Western R. R...
Church, L. H.....
Christensen Engineering Co.....
Clark, Thos. E., Wireless Tel. & Tel. Co.....
Cleveland Armature Works.....
Coho & Co., H. B.....
Collyer Insulated Wire Co.... ..
Columbia Incandescent Lamp Co.
Columbus Storage Battery Co....
Consolidated Engine Stop Co.....

C

Consolidated Railway Electric Lighting & Equipment Co..... 18
Consolidated Safety Valve Co. ...
Consumers' Carbon Co..... 4
Continuous Rail-Joint Co. of America. 4
Cope, T. J..... 22
Corson, Wm. R. C..... 46
Cosmos General Engineering Co... 46
Crescent Insulated Wire and Cable Co..... 56
Crocker-Wheeler Co..... 19
Couch & Co., S. H..... 41
Cutler-Hammer Mfg. Co..... 7
Cutter Co..... 1

D

Dayton Electrical Mfg. Co..... 26
Detroit & Buffalo Steamboat Co.. 42
Diamond Meter Co..... 5
Dickey-Sutton Carbon Co..... 4
Dielectric Mfg. Co.....
Diehl Mfg. Co..... .....
Dixon, Jos., Crucible Co..... 6
Donnelly, John..... 44
Doubleday-Hill Electric Co.....
Downward Light Co.....
Duncan Electric Mfg. Co..... 24
Dustin Co., Chas. E..... 43
Duvall, E. S., Jr..... 42
D. & W. Fuse Co..... 3

E

Eastern Carbon Works..... 6
Eck Dynamo & Motor Works.... 18
Eccleston Lumber Co..... 49
Economical Electric Lamp Co.... 26
Economy Electric Co.....
Edison Decorative & Miniature Lamp Department..... ... 32
Edison Mfg. Co. 6
Edwards & Co..... 29
Elblight Co. of America.....
Electric Appliance Co..... ... 1
Electric Cable Joint & Appliance Co..... 4
Electric Contract Co..... 7
Electric Gas Lighting Co.....
Electric Motor & Equipment Co.. 44
Electric Storage Battery Co..... 21
Electrical Engineer Institute of Correspondence Instruction..... 42
Elmore-Fowler-Jacobs Co..... 49
Elwell-Parker Electric Co..... 18
Ericsson Telephone Co.....
Eureka Electric Co 52
Ewing-Merkle Electric Co.....

F

Fahnestock Transmitter Co..... 51
Feilden Publishing Co., Ltd..... 14
Ferodowill Mfg. Co.....
Fidelity Electric Co.....
Field, C. J.....28,46
For Sale..... 44
Fort Wayne Electric Works..... 20
Fostoria Incandescent Lamp Co...
Four-Track News, The..... 52
Franklin Elec. Mfg. Co 47
Franklin Mfg. Co.....
Franklin Model Shop..... 56
Frink, I. P.....
Frisco System..... .....

G

Garton-Daniels Co..... 42
General Electric Co..... 2
General Incandescent Arc Light Co. 14
Gest, G. M..... 23
Gould Storage Battery Co..... 3
Green Fuel Economizer Co..... 24

H

Hanchett, Geo. T..... 46
Hancock Inspirator Co..... 14
Hartford Faience Co.....
Hartford Steam Boiler Inspection & Insurance Co..... 16
Hartford Time Switch Co..... 42
Hart & Co.....
Hart & Hegeman..... 29
Hart Mfg. Co..... 4
Hartman Circuit-Breaker Co..... 49
Hayden & Derby Mfg. Co..... 10
Hazard Mfg. Co..... 22
Hill, N. N., Brass Co 28
Hill, W. S., Electric Co..... 1
Hobart Electric Mfg. Co..... 21
Hubbell, Harvey..... 46
Humphrey, Henry H.....

(Continued on page 24.)

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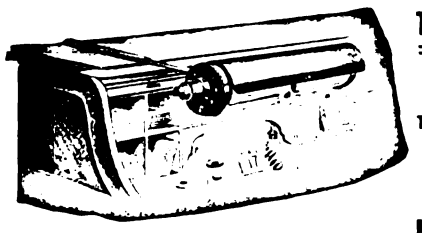

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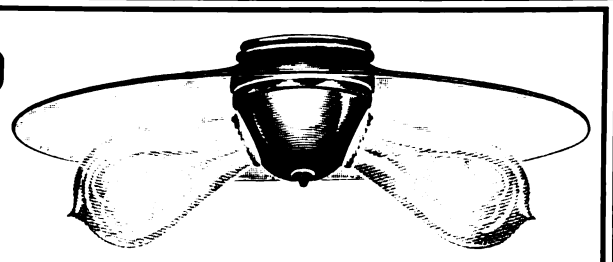

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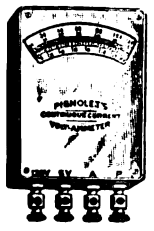

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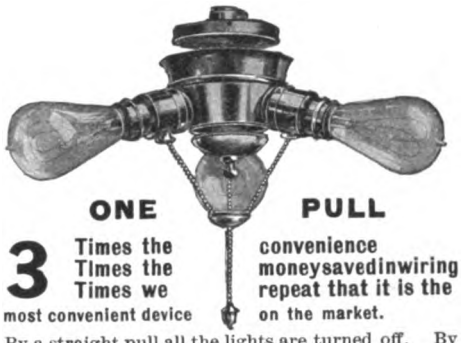

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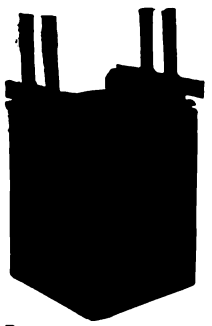

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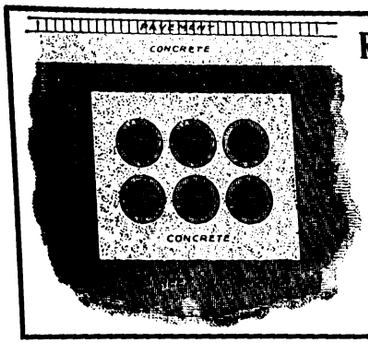

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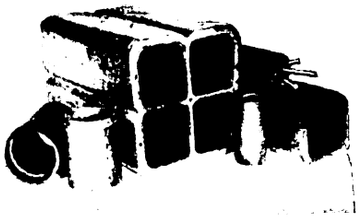

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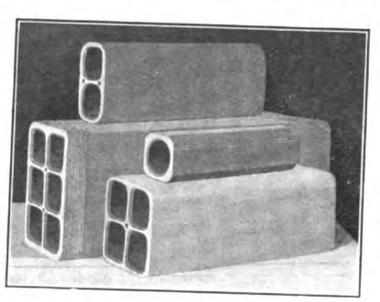

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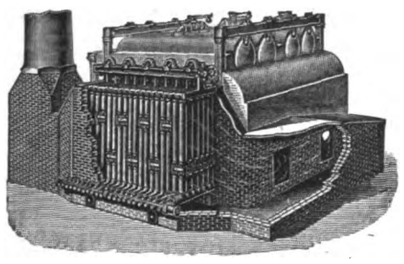

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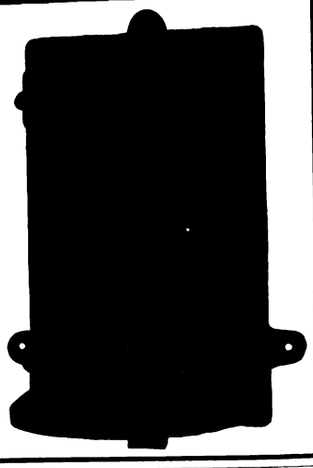

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ALPHABETICAL INDEX.—(*Continued from page 20.*)

H

Hungerford Electric Mfg. Co.....
Hunt Co., C W..... 44

I

Incandescent Electric Light Manipulator Co.. 16
India Rubber & Gutta Percha Insulating Co..... 8,10
Indiana Rubber & .nsulated Wire Co..... 1
Index of the Technical Press..... 13
Internat'l Correspondence Schools
Inventive Age Publishing Co..... 41

J

Jandus Electric Co.....
Jeffrey Mfg. Co..... 26
Jewell Electrical Instrument Co.. 14
Johns-Manville Co., H. W..... 5
Johnson, Chas. F..... 42
Johnson & Morton..... 14
Jordan Bros..... 43

K

Kellogg Switchboard and Supply Co 51
Keystone Electric Co..... 19
Kinsman Elec. & Ry. Supply Co...
Klein & Sons, Mathias 49
Knott Apparatus Co., L. E..... 43
Knowles Edward R..... 46

L

Lamp Testing Bureau 4
Lawrence-Hall Electric Co..... 13
Leeds & Northrup Co .....
Leffel & Co., James..... 25
Lincoln Electric Co..... 18
Lombard Governor Co..... 25
Lundin Electric & Machine Co.... 26
Lunkenheimer Co..... 56

L

Lyndon, Lamar..... 46

M

Machado & Roller..... 21
Magnet Wire Company.....
Manhattan Dial Co..... 6
Manhattan Electrical Supply Co.. 16
Manross, F. N..... 26
Marshall, Wm..... 44
Marshall-Sanders Co..... 27
Massachusetts Chemical Co..... 9
Matthews & Bro., W. N..... 41
McGill University..... 44
McLeod, Ward & Co..... 21
McTighe, Thos. J..... 46
Mica Insulator Co.....
Miller Anchor Co.....
Missouri-American Electric Co.... 7
Monarch Fire Appliance Co 18
Montauk Fire Detecting Wire Co. 10
Morris Company, I. P..... 45
Morse Twist Drill Co.....
Munsell & Co., Eugene..... 32
Murdock, H. D.....
Murdock Corporation..... 4

N

National Battery Co..... 6
National Carbon Co..... 5
National Conduit & Cable Co 1
National Electric Co..... 18
National India Rubber Co.....
Nernst Lamp Co.....
New England Butt Co..... 10
New England Engineering Co...41,46
New Jersey Central R. R.....44,49
New Process Raw Hide Co.....
New York & Ohio Co..... 1
New York Cent. & Hud. Riv. R. R.
New York Insulated Wire Co..... 1
New York Telephone Co..... 48

N

North Electric Co..... 51

O

O'Brien & Co., J. W..... 22
Okonite Co..... 1,11
Osborn-Morgan Co..... 44
Osburn Flexible Conduit Co..... 1
Ostrander, W. R. & Co..... 44

P

Pairpoint Corporation.. ... .
Pardridge Shade & Reflector Co... 43
Parsell & Weed..... 42
Payne & Co., B. W..... .....
Peerless Electric Co..... 19
Peirce, C. L., Jr.....
Pennsylvania Iron Works..... 18
Pennsylvania R. R .....
Phelan, D. W..... 49
Phœnix Glass Co..... 1
Phelps Co.. 41
Phillips, Eugene F., Bare and Insulated Wires 1
Phillips Insulated Wire Co..... 56
Phosphor-Bronze Smelting Co.... 43
Pignolet Louis M..... 21
Pittsburg Sewer Pipe and Conduit Co..... 23
Polytechnic Institute of Brooklyn. 44
Portland Co., The..... 13
Power Installation Co..... 46
Powers Co., The E. L..... 46
Prentiss Clock Improvement Co.. 16
Prometheus Electric Co..... 32

R

Rae, Frank B.. 46
Reisinger, Hugo..... 13
Reuterdahl, Arvid..... 46

R

Reynolds Elec. Flasher Mfg. Co. 10
Reynolds & Co.....
Risdon-Alcott Turbine Co..... 25
Rittenhouse-Miller Co.....
Robbins & Myers Co..... 18
Robertson & Sons, James L 42
Roebling's Sons Co., John A. ... 36
Rooney-Westbury Elec. Lamp Co.32,42
Rossiter, MacGovern & Co..... 48

S

Safety Insulated Wire & Cable Co. 10
Schwerdtle Stamp Co..... 42
Shelby Electric Company..... 1,4
Siggers & Siggers..... 42
Sills-Eddy Mica Co..... 21
Simplex Electrical Co..... 1
Simplex Electric Heating Co..... 49
Smith Storage Battery Co..... 6
Smith & Hemenway Co..... 45
Speer Carbon Co..... 56
Sprague Electric Co..... 32
Standard Electrical Mfg. Co..... 24
Standard Paint Co..... 49
Standard Pole and Tie Co..... 43
Standard Underground Cable Co.. 22
Standard Vitrified Conduit Co.....
Stanley, Arthur F..... 1
Stanley Electric Mfg. Co..... 16
Stanley Instrument Co..... 10
Stanley & Patterson..... 46
Stanton, Le Roy W..... 24
Sterling Electrical Mfg. Co..... 32
Sterling Varnish Co..... 25
Stilwell-Bierce & Smith-Vaile Co.. 45
Stirling Co.....
Stow Manufacturing Co.....
Stromberg-Carlson Telephone Mfg. Co..... 51

(*Continued on page 25.*)

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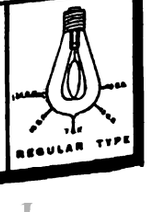

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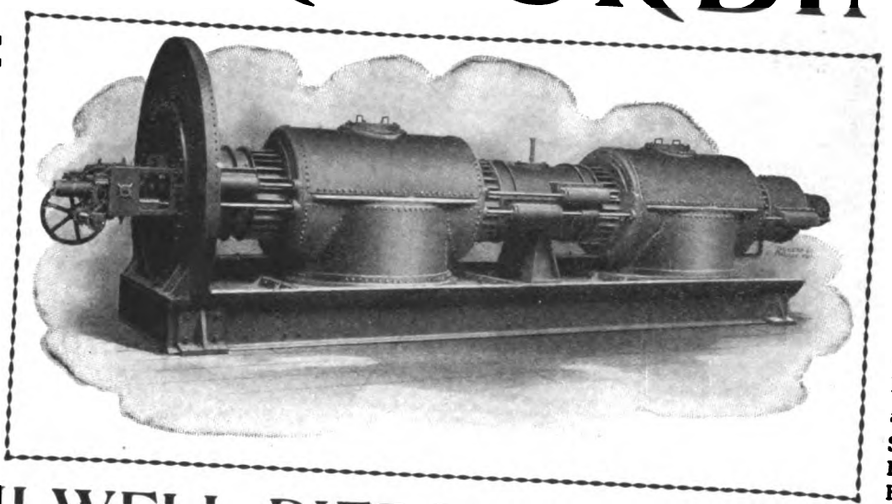

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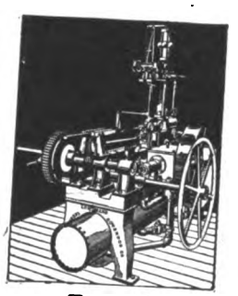
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ALPHABETICAL INDEX.
(*Continued from page 24.*)

S
Stuart-Howland Co..... 1
Swedish-American Telephone Co. 48

T
Talmont Electric Engineering Co. 8
Thresher Electric Co..... 15
Trumbull Electric Co..... 8
Turbine Engineering Co 2

U
United Electric Heating Co.....
U. S. Battery Co..... 56
U. S. Mineral Wool Co... 4
United Telpherage Co..... 26
Utica Drop Forge & Tool Co..... 45

V
Valentine-Clark Co..... 49
Van Loan Co., I. S..... 43
Van Nostrand Company, D.....
Varley Duplex Magnet Co..... 41
Viaduct Mfg. Co..... 48
Vindex Electric Co ....

W
Waclark Wire Co..... 10
Wagner Electric Mfg. Co.....
Wagor, P. R., Mfg. Co..... 41
Walker Co.....
Walsh's Sons Co..... 44
Wanted..... 44
Warner, W. F.....
Warren Electric Mfg. Co.....
Warren Electric & Specialty Co... 1
Weiss, W. F..... 41
Wesco Supply Co 29
Westcott, Geo. F 46
Western Electric Co..... 7
Western Electrical Supply Co.....

W
Western Telephone Mfg. Co... ... 49
Westinghouse Air Brake Co.....
Westinghouse Electric & Mfg. Co. 54,55
Westinghouse Machine Co..... 53
Weston Electrical Instrument Co.. 32
Wheeler Reflector Co..... 21
White & Co., J. G.. 46
Whitney Electrical Inst. Co.....

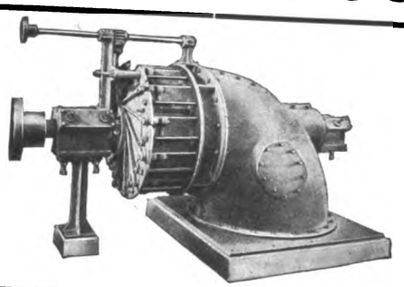
W
Wilmerding, C. H..... 46
Wyckoff Pipe & Creosoting Co... 32

Y
Yost Electric Mfg. Co..... 5

Z
Zimdars & Hunt.....

(*Continued on page 28.*)

SAMSON TURBINE



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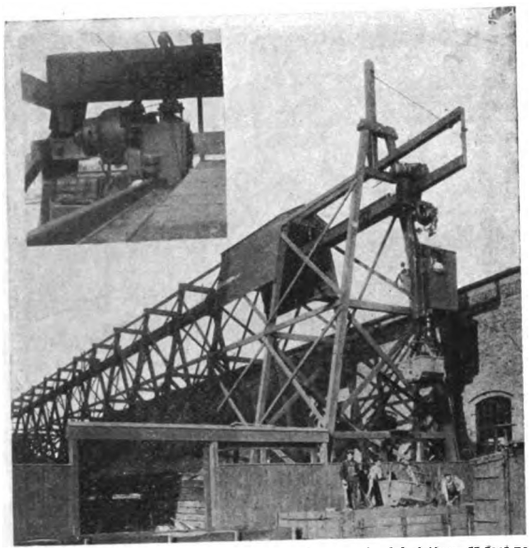
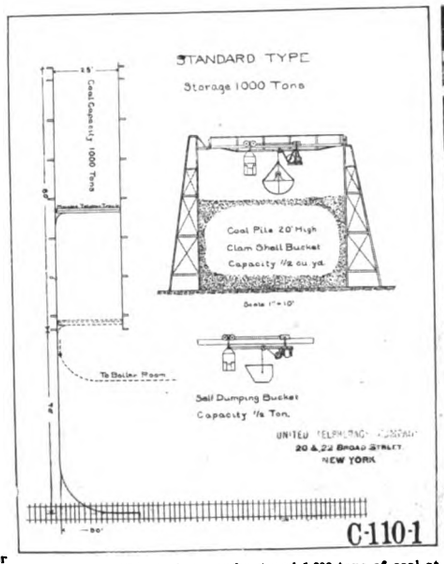
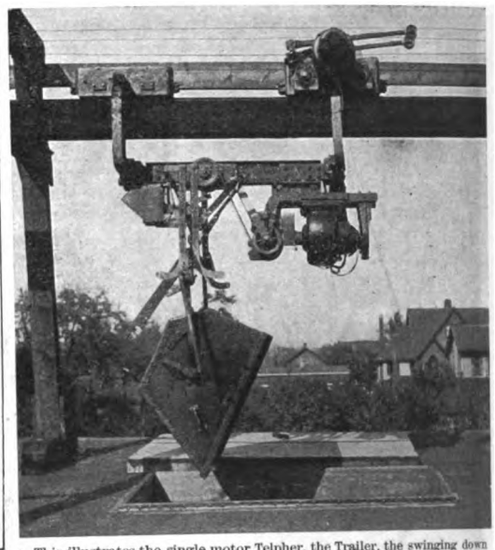


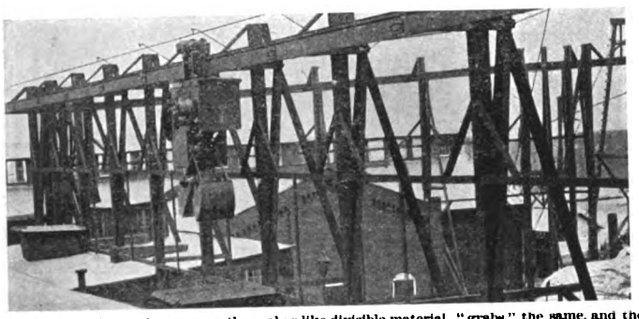
Height of track, 50 feet: load, 2,000 pounds; speed of hoisting, 60 feet per minute; capacity, 200 tons. Operation: Upon closing the switch the coal is elevated, conveyed to any location in the yard, automatically dumped, and the Telpher returns the empty bucket for another load. Electricity does the work. Projecting track may be used over boats as well as over railroad tracks.



In the space, 25 by 80 feet, can be stored 1,000 tons of coal at the minimum of cost. With the clam-shell bucket, one man attends to the work of filling the bucket, hoisting, conveying and dumping. The movable cross Telpher track covers every foot of space.



This illustrates the single motor Telpher, the Trailer, the swinging down comes, the Electric Hoist, minimum headroom, one sheave type, and the Automatic Control. By moving a single switch, located at any convenient point, the Telpher is started, stopped and reversed, and the same is also true of the raising and lowering by means of the Electric Hoist; all that the operator has to do is to move the switch.



The bucket is lowered open upon the coal or like divisible material, "grabs" the same, and the electric hoist closes the bucket and elevates the load, while the Telpher does the conveying. Telpher upon a curve works equally well upon a grade. Load with bucket, three tons. Speed, 1,000 feet per minute. Electricity does the work of eighteen men, one man directing.

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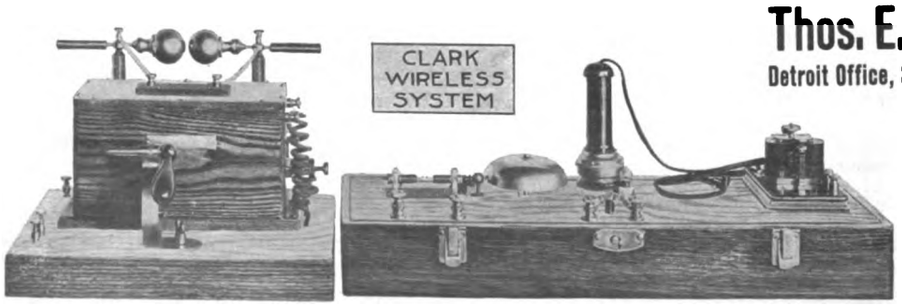

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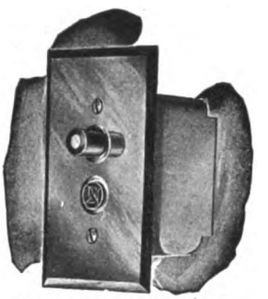

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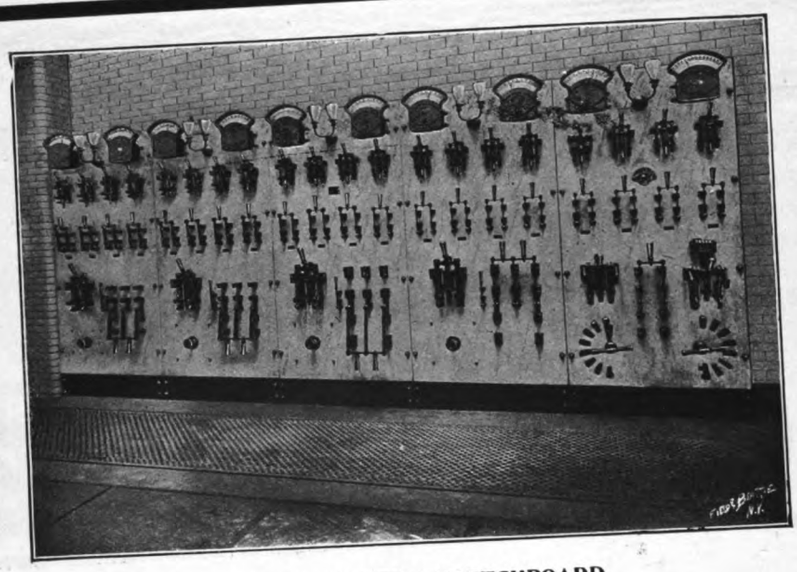

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Adjusters, Incandescent Lamps.
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Alternators.
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Warren Electric Mfg. Co.
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Anchors, Guy.
Matthews & Bros., W. L.
Miller Anchor Co.

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Stanley & Patterson.
Edwards & Co.

Armature Repairs.
Cleveland Armature Works.

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Hubbell, Harvey.

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Ferodowill Mfg. Co.

Batteries, Primary.
American Carbon & Battery Co.
Bunnell & Co., J. H.
Burnley Battery & Mfg. Co.
Eastern Carbon Works.
Edison Mfg. Co.
Gordon Battery Co.
Wesco Supply Co.

Batteries, Storage.
American Battery Co.
Columbus Storage Battery Co.
Dayton Electrical Mfg. Co.
Electric Storage Battery Co.
Gould Storage Battery Co.
National Battery Co.
Reuterdahl Electric Co.
Smith Storage Battery Co.
United States Battery Co.

Bells.
Hill Brass Co., N. N.
Ostrander & Co., W. R.

Belt Dressing.
Dixon Crucible Co., Joseph.

Boilers.
Allis-Chalmers Co.
Babcock & Wilcox Co., The.

Boilers.
Morris Co., I. P.
Stirling & Co., The.
Toomey, Frank.

Boiler Insurance.
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Books, Technical.
Electrical Review Pub. Co.
Powers & Co., E. L.

Brackets.
C. L. Peirce, Jr.

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Barron & Co., Jas. S.

Brushes, Dynamo.
Eastern Carbon Works.
Le Valley Vitae Carbon Brush Co.
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Barron & Co., Jas. S.
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Baker Supply & Construction Co.

Cabling Machines.
New England Butt Co.

Carbons.
American Carbon and Battery Co.
Consumers' Carbon Co.
Dickey-Sutton Carbon Co.
Eastern Carbon Works.
General Incandescent Arc Light Co.
National Carbon Co.
Reisinger, Hugo
Speer Carbon Co.

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Cutler-Hammer Mfg. Co
Cutter Electrical Mfg. Co.
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Hartman Circuit Breaker Co.
Morris Co., I. P.
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Cleaners, Incandescent Lamps.
Incan. Elec. Light Manipulating Co.

Climbers.
Klein & Sons, Mathias.
Smith & Hemenway Co.

Clusters.
Benjamin Electric Mfg. Co.
Hubbell, Harvey.

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Allen & Co., L. B.
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Commutator Segments.
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Condensers (Electric).
Marshall, Wm.

Conduits.
Alphaduct Mfg. Co.
American Circular Loom Co.
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Camp Co., H. B.
Field, C. J.
Gest, G. M.
National Conduit & Cable Co.
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Conduit Benders.
Church, L. H.
Benson & Co., Wm. W

Conduit Rods.
Barron & Co., Jas. S.
Cope, T. J.

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McIntire Co., The C.

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Central Electric Co.
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Fowler, John H.
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Browning Mfg. Co.
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Coho & Co., H. B.
Christensen Engineering Co.
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Dustin Co., Chas. E.
Eck Dynamo & Motor Works.
Elwell-Parker Electric Co.
Emerson Electric Mfg. Co.
Fidelity Electric Co.
Fort Wayne Electric Works.
General Electric Co.
Gen'l Incandescent Arc Light Co
Hobart Electric Mfg. Co.
Johnson, Charles F.
Jordan Bros.
Keystone Electric Co.
Lincoln Electric Co.
National Electric Co.
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(Continued on page 46.)

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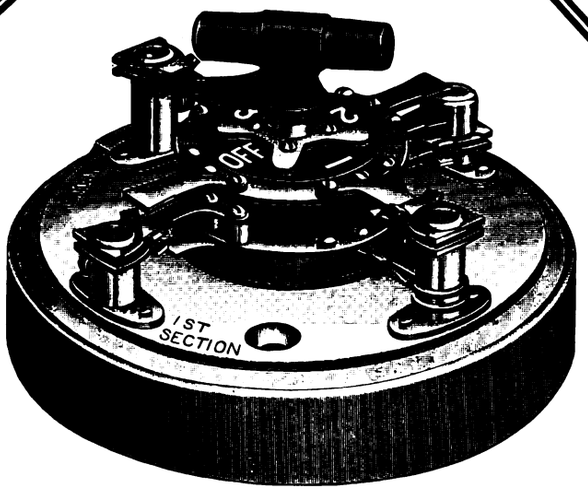


THE HART AND HEGEMAN MFG. CO.

92 Union Place
Hartford, Ct.

Every Good Reason
EXISTS FOR YOU TO KNOW THE ADVANTAGES OF THE "H & H"

HEATER SWITCH

SUCCESSFUL CONTRACTORS HAVE PRONOUNCED IT A1. switch for 500-volt circuits.

"HART" SWITCHES are sought after by men who know what good switches are.

Hence the wonderful growth and popularity of

"H & H"
AND
Hart Switches

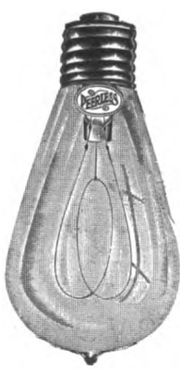
WESCO

A
Peerless Offering

WESCO

by a Peerless Supply House is our celebrated

Peerless Lamp



Most Light and Efficiency

Least Current and Cost

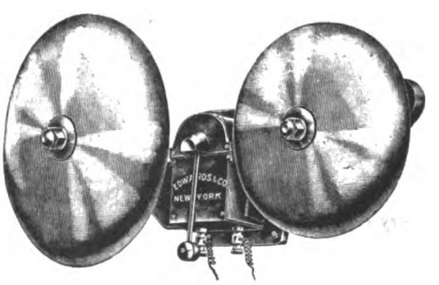
Everything Electrical

WESCO

THE WESCO SUPPLY COMPANY
ST. LOUIS, U. S. A.

WESCO

A Long Distance Ringer



Two Gongs are Struck Alternately

Being different in size, the gongs give different tones so that the sound can be heard from a great distance.
We use the very best grade of cast gongs.
A greater difference in sizes of gongs if desired.

EDWARDS & CO.
NEW YORK
SELLING AGENTS—Western Electric Co., New York, Philadelphia, Chicago, St. Louis, Denver, Pittsburg and Kansas City; American Elect. Co., St. Paul; Standard Elect. Co., Cincinnati; California Electric Works, San Francisco.

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NEW YEAR'S

Literary Features to be presented

January 9, 1904 (9 days after the season's festivities and after the great mass of holiday literature is laid aside), will be the date of the ***New Year's Number*** of the ***Electrical Review,*** in which will be contained a wide range of articles bearing on the engineering, scientific and industrial developments of electricity as reflected by the highest authorities from all parts of the world. The number will be so valuable in editorial features and illustrations as to form a milestone for marking electrical progress.

The plan of the number is such as to give a review of the progress made in electrical industries during the closing year and to show the present status of important engineering and technical accomplishments; also to indicate the general trend of future advance. To that end the co-operation of engineers, each not only eminent in his own especial branch, but recognized for his clear and pleasant style, has been secured for this work.

It is the aim to make this work of more than merely passing value, as it is the desire to have it form an index for future reference. A greatly increased edition will be printed.

PUBLICATION OFFICE:
13 Park Row, New York City

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NUMBER

Attractions for Advertisers in this number

For the January 9, 1904, ***New Year's Number*** of the ***Electrical Review*** such assurances have been received from many leading manufacturers that we are enabled to say that the advertising pages will form an interesting exposition of American manufactured electrical machinery, apparatus and equipments. These advertisements will be in themselves a splendid reflection of the status of the electrical arts in all their multitudinous branches.

Already orders have been received, through special sources, for a large number of extra copies. It is also the purpose, in line with our plan of increasing the circulation of the ***Electrical Review,*** to put a specially marked copy of the ***New Year's Number*** of January 9, 1904, in the hands of persons identified with the electrical industry throughout the world, whose names are not already on our mailing list and who are possible subscribers.

It is aimed to make the advertising a most interesting feature of this issue, which will undoubtedly be preserved for future reference by electrical buyers. Regular advertising rates, only, for space in this number will be charged.

BRANCH OFFICES:

40 Dearborn St., Chicago **42 Old Broad St., London**

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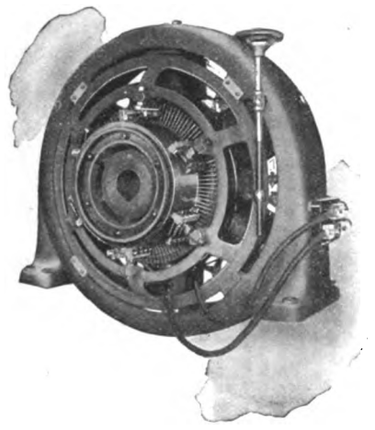
An INCANDESCENT LAMP represents a large investment of capital, ingenuity and skilled workmanship, it is sold at a price so low as to necessitate eternal vigilance in cutting costs to a minimum. A successful lamp manufacturer can not afford to experiment with poor materials. This explains the popularity of

BAKER & CO.'S PLATINUM

408 N. J. R. R. Ave., NEWARK, N. J. 120 LIBERTY ST., NEW YORK

We buy and Refine Platinum Scrap also



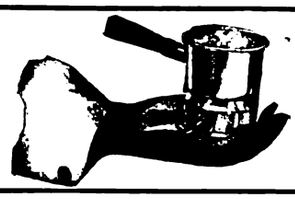
DIRECT CURRENT

GENERATORS FOR LIGHT AND POWER

The design and construction of our generators is such as to meet the requirements of modern practice. They have won an enviable reputation for efficiency, durability and commercial value.

SPRAGUE ELECTRIC CO.

General Offices: 527-531 West 34th Street, New York



PROMETHEUS ELECTRIC HEATING and COOKING APPARATUS

Send for Catalogue and Price List

THE PROMETHEUS ELECTRIC CO.

39 CORTLANDT STREET NEW YORK

NO SOLDERING SALTS — NO ACID — NO RESIN

4 REASONS

WHY YOU SHOULD SPECIFY THE ALLEN SOLDERING STICK

WE SEND A BIG SAMPLE TO DEMONSTRATE ITS SUPERIOR QUALITIES

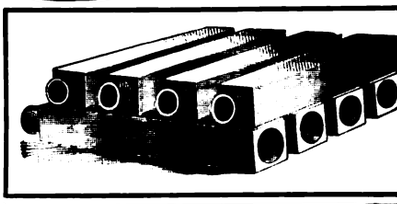
L. B. ALLEN CO., 1335 Columbia Ave. CHICAGO, ILL.

Sterling Extra Insulating Varnish

STERLING EXTRA BLACK FINISHING VARNISH
STERLING BLACK AIR DRYING VARNISH
STERLING BLACK CORE PLATE VARNISH

The Sterling Varnish Co. PITTSBURGH, PA., U. S. A.

The Sterling Varnish Co. BROUGHAM ST., BLACKFRIARS ROAD, MANCHESTER, ENGLAND



THE WYCKOFF PIPE & CREOSOTING CO., Inc.

MANUFACTURERS OF

Wyckoff Wooden Conduits

Poles, Cross-Arms, R. R. Ties & Lumber

OFFICE STAMFORD, CONN. WORKS PORTSMOUTH, VA.

The Hayden Combined Wire Cutter and Pliers

Drop-Forged Handles

No Spring to the Handles

THE BILLINGS & SPENCER CO., Hartford, Conn., U. S. A.

SEE PAGE 42

AMERICAN STORAGE CELLS ARE THE BEST

SEND FOR DESCRIPTIVE CIRCULAR

AMERICAN BATTERY CO.

173 S. CLINTON ST., CHICAGO, ILL.

ESTABLISHED 1890

INDIA MICA

We Import Directly from India and Handle the Output of the Best Mines. A Large Stock Constantly on Hand Enables Us to Make Prompt Shipments ALL OTHER QUALITIES. Prices Low.

EUGENE MUNSELL & CO.

CHICAGO NEW YORK

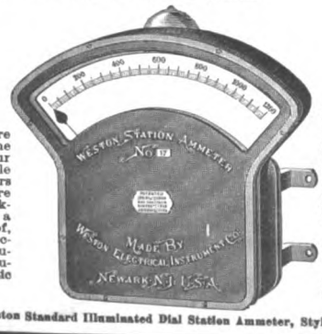
WESTON Electrical Instrument Co.

New York Office, 74 Cortlandt St. WAVERLY PARK, NEWARK, N. J.

BERLIN: European Weston Electrical Instrument Co., No. 88 Ritterstrasse.
LONDON: Elliott Bros., Century Works, Lewisham.
PARIS, FRANCE: E. H. Cadiot, 12 Rue St. Georges.

ILLUMINATED DIAL, STATION INSTRUMENTS

These instruments are constructed upon the same general principle as our regular Standard Portable Direct-Current Voltmeters and Ammeters, but are much larger and the working parts are enclosed in a neatly designed, dust-proof, cast-iron case which effectively shields the instruments from disturbing influences of external magnetic fields.



Weston Standard Illuminated Dial Station Ammeter, Style B.

WESTON STANDARD

Portable, Direct Reading Voltmeters and Millivoltmeters. Ammeters and Milammeters, Wattmeters and Voltmeters, for Alternating and Direct-Current Circuits.

Our portable instruments are recognized as standards throughout the civilized world.

Our Semi-Portable Laboratory Standard Voltmeters and Ammeters are still better.

They are the most reliable, absolute standards for Laboratory use.

EDISON MINIATURE LAMPS

have been for twenty years

THE STANDARD OF THE WORLD

and are to-day more largely used than all other makes combined.

SERVICEABLE, ECONOMICAL, RELIABLE.

Miniature and Candelabra Sockets and Receptacles

EDISON DECORATIVE AND MINIATURE LAMP DEPT.

General Electric Company Harrison, N. J.

8

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List of Electrical Patents Issued Last Week

[Specially reported for this journal by E. S. Duvall, solicitor of patents, Loan and Trust Building, Washington, D. C. Copies of any patent may be secured for 10 cents each.]

ISSUED DECEMBER 15, 1903.

746,669 Current regulator; G. A. Cardwell, New York, N. Y.—Means for varying the duration of the time intervals during which maximum current flows, and means for progressively including resistance in circuit without breaking circuit after maximum current is permitted to flow.

746,671 Insulator; T. Carter, Frankford, Ky.

746,672 Engine-stop; J. H. Cary, Providence, R. I.

746,690 System of telegraphing or telephoning to or from railway vehicles; J. Edgar, Wrexham, England.

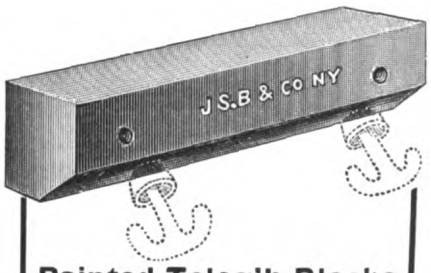
746,695 Automatic electric switch; W. S. Guthrie, Terrell, Tex.

746,697 System of electrical distribution; J. H. Hallberg, New York, N. Y.

(Continued on page 42.)

W. F. WEISS
CERTIFIED PUBLIC ACCOUNTANT
Telephone, 6068 Cortlandt 128 BROADWAY, N. Y.
Special and periodical audits. Investigations on financial conditions. Examinations and reports of accounts and earnings, reorganizations, consolidations and partnership adjustments. Introduction of efficient methods of accounting adapted to special conditions.

HYLO
DONT BUY ELECTRIC LAMPS TILL YOU GET OUR CATALOGUE AND PRICES
THE PHELPS COMPANY
29 ROWLAND ST, DETROIT, MICH.



Painted Teleg'h Blocks
and other wood specialties for Telephone and Telegraph Companies. Ask for quotations.
James S. Barron & Co.
200-206 West Broadway, New York

Transmitters?
Speaking of telephone transmitters, let us send you one of our "Reliance" transmitters? It is a great talker and a much better transmitter than many of the so-called high-grade transmitters. Sent prepaid for a dollar. Be sure and order one to-day.
S. H. COUCH CO.
160 Pearl Street BOSTON, MASS.

NOW IS THE TIME
To go over your line and guy the slack places in preparation for wintry blasts, sleets and snows
THE STOMBAUGH GUY ANCHOR
is the thing to use. Will not work out during the spring thaw

W. N. MATTHEWS & BRO.
Distributers
200 CARLETON BUILDING ST. LOUIS

Successful for over twelve years.
ALLEN SOLDERING SALTS
are not new, but have been making solder flow and stick in all kinds of electrical work for over twelve years.
THAT'S THE BEST INDORSEMENT WE KNOW OF
L. B. ALLEN CO., Inc. 1335 COLUMBIA AVE. CHICAGO, ILL.

CASE BROTHERS
MANUFACTURERS OF
INSULATING AND FULLER BOARDS
All Grades and Thicknesses
Heavy Special Boards to Order
Orders promptly filled from large stock on hand
Correspondence solicited
Highland Park, Conn.

FOR SALE

60 Type K, Single Carbon, Thomson-Houston Series Arc Lamps, 1200 Candle-Power.

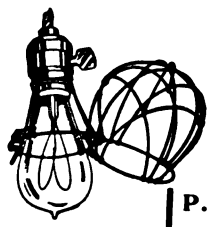
60 M Lamps, 1200 Candle-Power, $2.00 each.

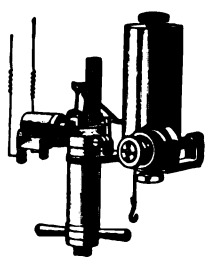
All in good working order.

THE
New England Engineering Co.
WATERBURY, CONN.
100 BROADWAY, N. Y.

MAGNETS AND ALL KINDS OF COIL WINDINGS OF INSULATED OR BARE WIRE FOR EVERY PURPOSE
VARLEY DUPLEX MAGNET COMPANY, PROVIDENCE, RHODE ISLAND

NOW IS THE TIME
TO SUBSCRIBE FOR
The Inventive Age & Patent Index
ONE DOLLAR A YEAR
Replete with matter pertaining to Patent Office and New Inventions
Contains index of all patents issued
ADDRESS
INVENTIVE AGE PUBLISHING CO.
918 F St., Washington, D. C.

LAMP GUARDS
PATENTED

A Good Hinge Guard
Don't Buy Infringements
P. R. WAGOR MFG. CO.
54 Harrison Ave., Springfield, Mass.


THE TABOR IS THE INDICATOR
that is used for efficiency tests by the navies of the United States, Great Britain, Germany, Russia and Japan. This is pretty conclusive proof of its merits.
Our Catalogue gives description and figures
THE ASHCROFT MANUFACTURING COMPANY
85-87-89 Liberty St., NEW YORK

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PATENTS.

(Continued from page 41.)

746,708 Electric time switch; J. M. Joy, New York, N. Y.

746,726 Electrical signal system; U. G. Merrill, Litchfield, Me.

746,751 Current-collecting device for electric railway systems; A. A. Shobe, Jerseyville, Ill.

746,770 Commutor for causing the ignition of the charges in explosion engines; W. G. Wilson, Westminster, England.

746,772 Electrical switch-box apparatus; G. L. Addenbrooke, Westminster, England.

746,775 Producing appropriate phase relationship in alternating-current measuring or other devices; R. Arno, Milan, Italy.

746,830 Electric arc lamp; T. Hamilton-Adams, London, England—The movable carbon, a solenoid, auxiliary poles in the solenoid and a solenoid-core composed of a plurality of parts which engage the carbon so as to grip the same when the solenoid is energized.

746,860 Trolley catcher; H. R. Martin, East Bloomfield, N. Y.

746,903 Electric receiver clock; J. W. H. Uytenbogaart, Utrecht, Netherland.

746,904 Magneto generator; G. E. Wheeler, Burlington, Iowa.

746,920 Conduit for hose, cables, electric wires or the like; J. Burnsen, West Superior, Wis.

746,968 Sparking plug; C. E. L. Lipman, Beloit, Wis.

746,977 Electric railway signaling system; C. W. Mills, Los Angeles, Cal.

746,979 Party-line bell; Leland Moore, Brooklyn, N. Y.

746,998 Programme clock; F. M. Schmidt, New York, N. Y.

747,070 Signaling device for telephone party lines; E. O. Hood, Hingham, Mass.

747,106 Trolley; M. J. Wilson, Painesville, Ohio.

747,142 Railway signal; H. M. Cogan, New York, N. Y.

747,146 Electric feeler for weft-replenishing looms; R. Cowell, Lowell, Mass.

747,155 Trolley switch; L. E. Elwell, Los Angeles, Cal.

747,157 Sphygmograph; W. H. Fahrney, Chicago, Ill.

747,166 Thermostatic circuit closer; R. W. W. Grigsby, Chrisney, Ind.

(Continued on page 44.)

GARTON
Lightning Arresters
ARE OF THE
GOOD KIND
A SEVERE TEST WILL REMOVE ALL DOUBT
FOR PARTICULARS WRITE
GARTON-DANIELS CO.
KEOKUK, IOWA, U. S. A.

ELECTRICAL ENGINEERING TAUGHT BY MAIL
Write for our free illustrated book "CAN I BECOME AN ELECTRICAL ENGINEER?"
We teach Electrical Engineering, Electric Lighting, Electric Railways, etc., at your home by mail. Indorsed by Thos. A. Edison.
ELECTRICAL ENGINEER INSTITUTE
Dept. M, 240-242 West 23d St., New York.

The PACKING that Packs
Have You an INDICATOR?
Do You Need a SEPARATOR
J. L. Robertson & Sons, New York

The Franklin Model Shop
Experimental work for inventors; anything in metal from a single piece to a complete working model. Apparatus for colleges. Exhibition models. Introduction samples of patented articles. Special tools for making metal novelties. Inventions perfected. Drawings and designs worked out from inventors' ideas. Send for circular No. 2.
The FRANKLIN Model Shop
PARSELL & WEED
129-131 West 31st St., New York.

THE SCHWERDTLE STAMP CO.,
STENCILS-BURNING BRANDS
STEEL STAMPS & DIES
SEALS-MACH. PLATES-CHECKS
BRIDGEPORT, CONN.

PROPOSALS will be received at the Bureau of Supplies and Accounts, Navy Department, Washington, D. C., until 12 o'clock noon, December 29, 1903, and publicly opened immediately thereafter, to furnish at the Navy Yard, Washington, D. C., a multivoltage equipment for 16-inch and 14-inch gun lathes, eight lathes in all to be fitted. Blank proposals will be furnished upon application to the Bureau of Supplies and Accounts, Navy Department, Washington, D. C. H. T. B. HARRIS, *Paymaster-General, U. S. N.*

PROPOSALS will be received at the Bureau of Supplies and Accounts, Navy Department, Washington, D. C., until 12 o'clock noon, December 29, 1903, and publicly opened immediately thereafter, to furnish at the Navy Yard, New York, N. Y., a quantity of arc lamps, cable, conduit and fittings, rubber tape, blue denim, bunting, hardware, and hand tools, various machine tools, brass, copper, expanded metal, rivet and structural steel, suction hose, gum gasket, vulcanized rubber, aluminum paint, vermilion, neat's-foot oil, brass and copper pipe, iron pipe, brass and iron pipe fittings, water gauge glasses, valves, pickles, green coffee, condensed milk, syrup, tinned biscuit, canned salmon, tinned corned beef, litmus paper, rubber bands, blank books, memorandum pads, note and typewriter paper, pens, ink, pencils, blue print paper, miscellaneous stationery, parabolic mirrors, varnish brushes, coffee tins, seine twine, lamp wick, harness leather, leather belting, running lights, spruce sticks, glassware, hand and leg irons, oars, bath brick, and flat wooden cars. Blank proposals will be furnished upon application to the navy pay office, New York, N. Y. H. T. B. HARRIS, *Paymaster-General, U. S. N.*

COMPLETE POWER PLANTS
6—500-H.-P. vertical cross-compound
1—500-H.-P. Ball hor. cross-compound
3—150-H.-P. Ball automatic
2—350-H.-P. Boilers, Scotch design
1—200-H.-P. Babcock & Wilcox
Generators from 100 to 500 kw.
CHARLES F. JOHNSON
935 Ellicott Square, Buffalo, N. Y.

DETROIT AND BUFFALO STEAMBOAT CO.
QUEENS OF THE LAKES
Steamers Eastern States and Western States
$3 SAVED
TO ANY POINT WEST
Lv. BUFFALO daily 5.30 P. M., ar. DETROIT 7.30 A. M., connecting with all trains West and S. & C. for Michigan resorts. Lv. DETROIT daily 4.00 P. M., ar. BUFFALO 7.30 A. M. Fare: $3.50 one way, round trip $6.50. Berths $1.00 and $1.50, rooms $2.50, parlors $5.00, each way. Week End Excursions DETROIT and Return, $3.00. Send 2c. for illustrated pamphlet.
Address A. A. SCHANTZ, G. P. T. M., Detroit, Mich.

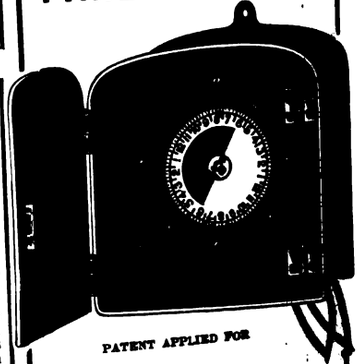
THE ROONEY-WESTBURY ELECTRIC LAMP COMPANY
154 EAST 23D STREET, NEW YORK
We are headquarters for all kinds of Xmas tree outfits and decorative lamps for the holidays.
OUTFIT NO. 1—10 or 15 Lights, Dry Cells, Cord and Receptacles.
OUTFIT NO. 2—30 or 50 Lights, Storage Batteries, Cord and Receptacles.
OUTFIT NO. 3—15 or 30 Lights, A. C. Transformer, Cord and Receptacles. (For use in Multiple on A. Currents only.)
OUTFIT NO. 4—Any number of Lights, 8 in Series, on D. Current, Cord and Receptacles.
Full particulars on request. All styles of miniature and candelabra lamps in stock.

PATENTS
Caveats, Trade-Marks, Copyrights and Designs.
Send your business direct to Washington.
Saves time and insures better service.
PERSONAL ATTENTION
GUARANTEED.
22 YEARS' ACTIVE PRACTICE.
Specialty—
PATENTS THAT PROTECT
Address—
SIGGERS & SIGGERS
PATENT LAWYERS.
Suite 20-25
National Union Bldg. Washington, D. C.

Buy the Standard
BROOKFIELD SCREW-GLASS INSULATORS
We are especially equipped for
HIGH POTENTIAL POWER TRANSMISSION WORK
The Brookfield Glass Company
218-220 Broadway, New York
WORKS: BROOKLYN BOROUGH

WHEN ADDRESSING ADVERTISERS PLEASE MENTION THIS PAPER.

INCORPORATE
—IN—
DISTRICT OF COLUMBIA
By virtue of an Act of Congress of the United States three or more persons may form a corporation. Existence perpetual. May transact business in any part of the world. Meetings may be held outside of District of Columbia, which exercises no supervision over its corporations. Stock may be paid for in property or cash and non-assessable. About one-half the expense of incorporating elsewhere.
Further information on application
EDWARD S. DUVALL, JR.
ATTORNEY-AT-LAW
LOAN & TRUST BLDG.
WASHINGTON, D. C.

THE HARTFORD TIME SWITCH

PATENT APPLIED FOR
FOR CONTROLLING
SHOW WINDOW LIGHTS
STREET LIGHTS
SIGN LIGHTS
APARTMENT HOUSE HALL LIGHTS
MOTORS AND RECEPTACLES
THE HARTFORD
438 Asylum

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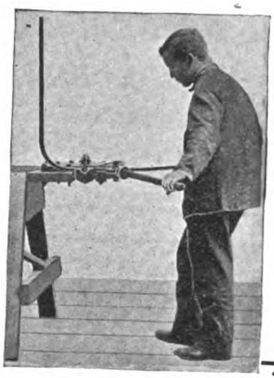
AMERICAN-BALL DUPLEX COMPOUND ENGINE AND DIRECT-CONNECTED GENERATOR

The most economical plant for generating electric currents, and the most compact plant that has yet been produced.

AMERICAN ENGINE CO.
48 Raritan Ave., Bound Brook, N. J.
New York Office, 95 Liberty St.



ELECTRICAL CONTRACTORS
SHOULD INVESTIGATE
THE STANDARD CONDUIT ELBOW FORMER
FORMS PERFECT ELBOWS
BENDS OFFSETS
Send for Circular
L. H. CHURCH
STAMFORD, CONN.

FOR SALE

DIRECT CONNECTED

30-K.W. Eddy dynamo to Watertown engine, 110 volts.
25-K.W direct connected Edison 110 volts to Brotherhood engine.
10-K.W. Westinghouse dynamo to Armington & Sims engine, 110 volts.
10-K.W. Westinghouse dynamo to Westinghouse engine, 110 volts.
80-amp. Edison dynamo to Brotherhood engine, 80 volts.
20-H.P. Elektron 220-volt motor to Morse Williams freight elevator.

BELTED

60-amp. Crocker-Wheeler to Herresoff engine, 110 volts.
2000-volt electro dynamic arc dynamo, 10 amperes.
500-Lt. Edison dynamo, 110 volts.
90-amp. Westinghouse dynamo to Westinghouse engine, 110 volts.
35-amp. Sprague dynamo to Hornby Ackroyd oil engine.
600-Lt. Weston dynamo, 110 volts.
400-Lt. Excelsior dynamo, 110 volts.
45-H.P. C. & C. motor, 230 volts.
30-H.P. C. & C. Motor, 230 volts.
15-H.P. Thomson-Houston motor, 500 volts, with spare armature.
15 General Electric, 2-H.P., 220-volt motors.
12 Siemens & Halske, 5-H.P., 220-volt motors for direct connection, 550 R.P.M.
2 search lights.
Large Stock of smaller dynamos and motors.
Repairing of electrical machinery in all its branches.

JORDAN BROS., 74 Beekman St., N. Y.

STEEL OUTLET AND JUNCTION BOXES
Switchboards, Panel Boards, Switches, Etc.
..MADE BY..
THE HOSSERT ELECTRIC CONSTRUCTION CO.
UTICA, N. Y.

Direct Connected Light and Power Apparatus.

DIRECT CURRENT, 250 Volts.

1—62½-kw. Bullock, direct connected to a horizontal, center crank, high-speed engine.
1—42-kw. Westinghouse, direct connected to horizontal, center crank, automatic, high-speed engine.
2—25-kw. General Electric, each direct connected to a vertical compound engine.

DIRECT CURRENT, 145 Volts.

1—160-kw. General Electric, direct connected to tandem Ball engine.
8—150-kw. General Electric, each direct connected to automatic, tandem compound engine.
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1—60-kw. General Electric, direct connected to a horizontal, center crank, high-speed, automatic engine.
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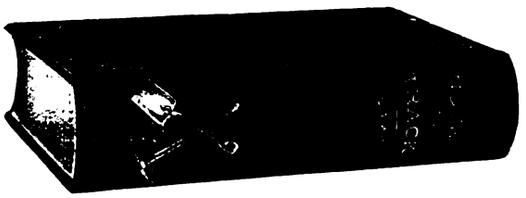

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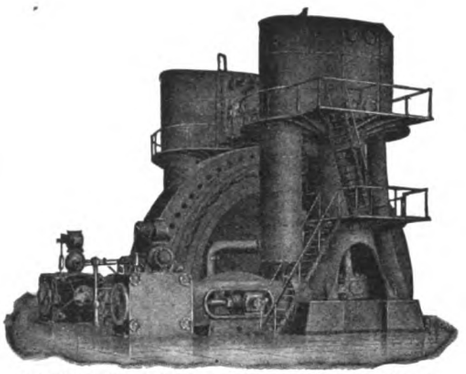

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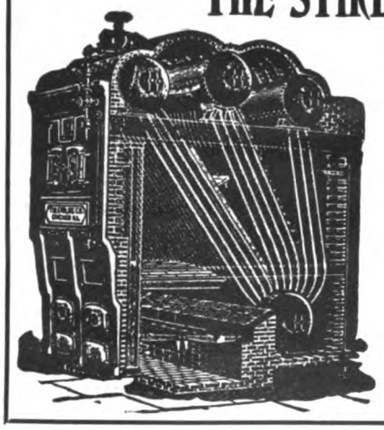

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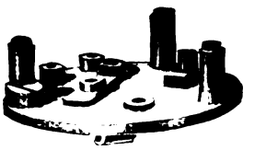

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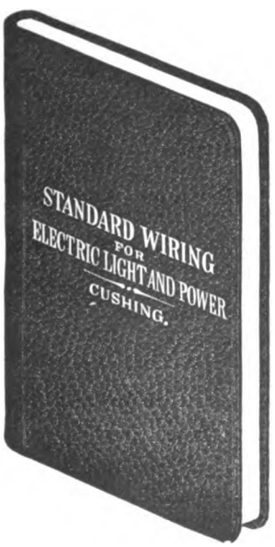

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(Continued from page 46.)

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(Continued on page 52)

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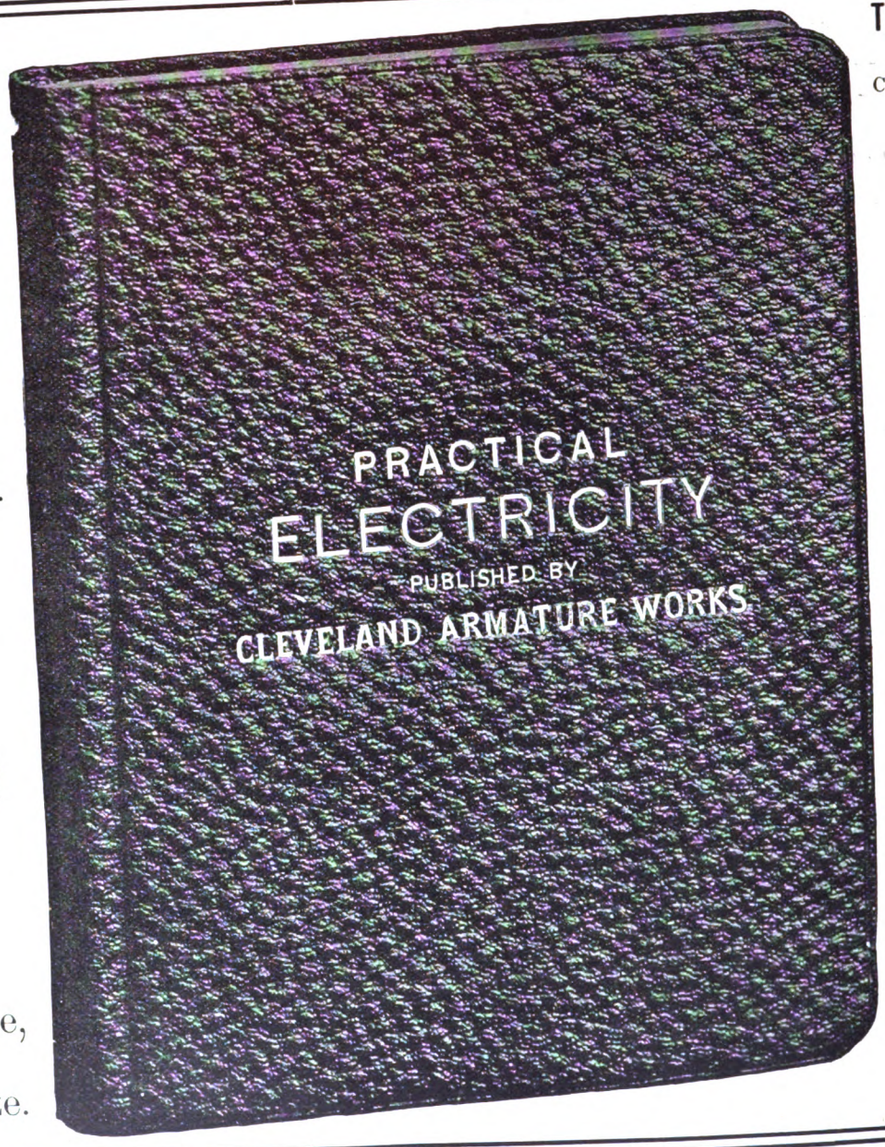

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CHAPTER
I—Wiring.
II—Electric Batteries. Electric Plating.
III—Magnetism.
IV—The Magnetic Circuit.
V—Magnetic Traction.
VI—Magnetic Leakage.
VII—Energy in Electric Circuit.
VIII—Calculation of Size of Wire for Magnetizing Coils.
IX—Calculation of E. M. F.'S in Electric Machines.
X—Counter E. M. F.
XI—Hysteresis and Eddy Currents.
XII—Armature Reaction.
XIII—Sparking.
XIV—Winding of Dynamos and Motors.
XV—Proper Method of connecting Dynamos and Motors—Self-Excitation.
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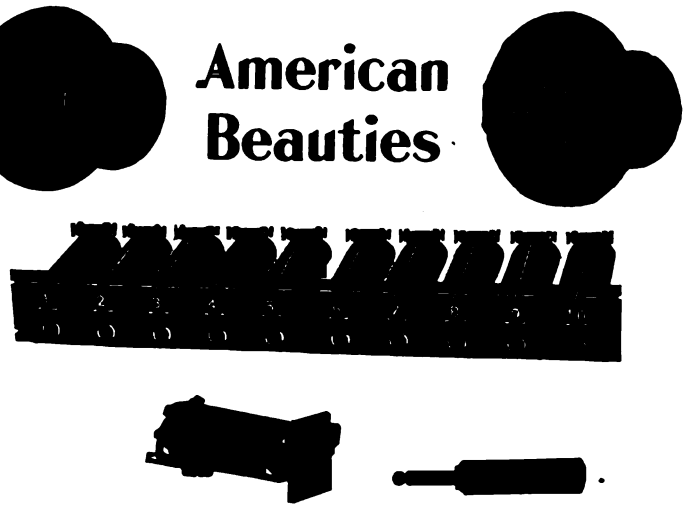

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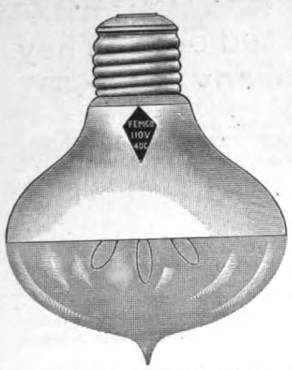

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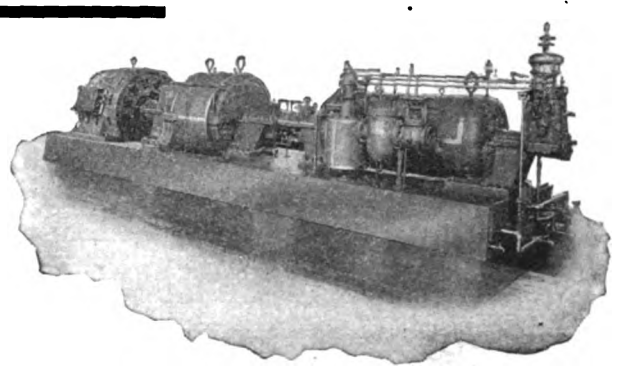

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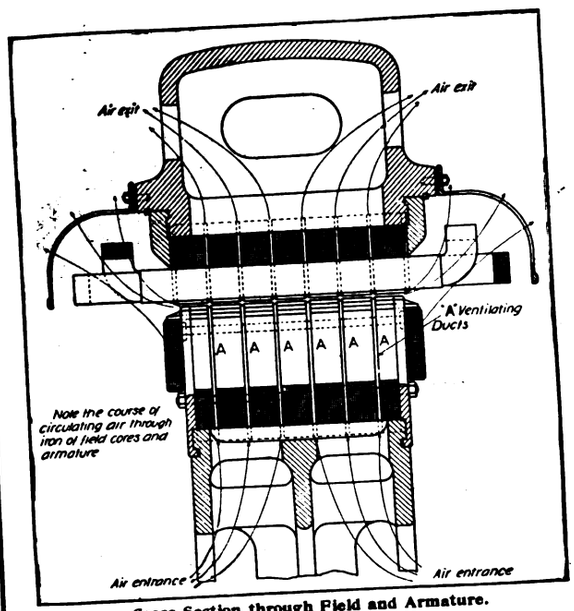
Westinghouse
Revolving Field Alternators



Cross-Section through Field and Armature.

The distinctive feature of Ventilated Field Core and Coil construction, pertaining to Westinghouse Revolving Field Alternators only, increases the value of the machine in many important points.

Point No. 1, "Where Loads of Low Power-Factor must be handled," was enlarged upon in the December 12th, 1903, issue of this publication. The next in order is

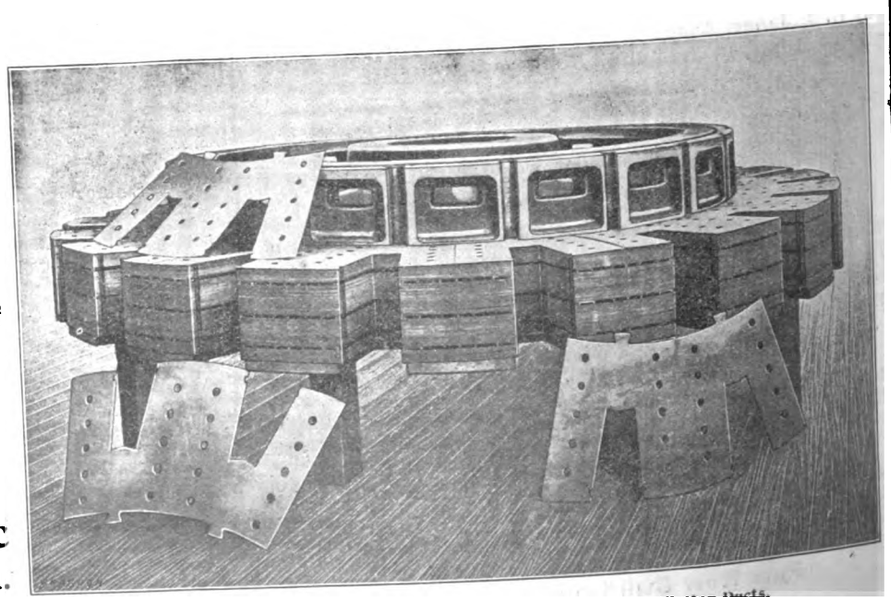
Point No. 2.

"Where heavy overloads must be carried."

Under certain conditions or in an emergency, machines are called upon to carry heavy overloads, resulting in increased loss and increased heating in the field. For example, a machine with unsaturated magnetic circuit operated with 50 per cent overload at 80 per cent power-factor, will require approximately 30 per cent greater field current than at full load and 100 per cent power-factor. This means increased loss and heating in the field of at least 60 per cent, also tending to heat the armature. Results obtained in actual practice have demonstrated the immense value of Westinghouse Field Construction for the above work.

For Point No. 3.

See January 9th, 1904, issue of this publication.



Construction of Revolving Field Pole Pieces showing Ventilating Ducts.

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For Interurban Service

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The Westinghouse Single-Phase Railway System is adapted for lines of twenty-five cycles per second and under.

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For further particulars see same space in next issue.

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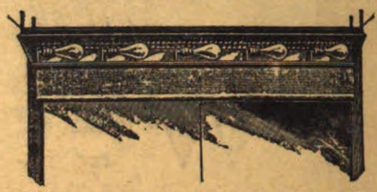

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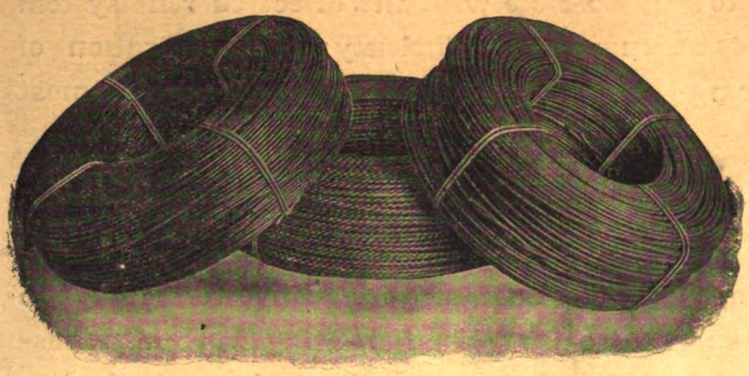

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Fig. 495

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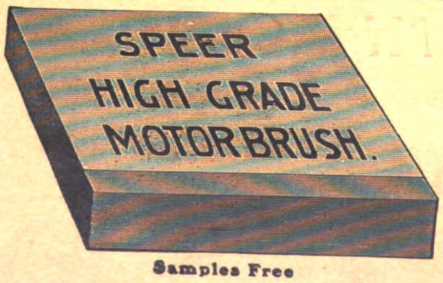

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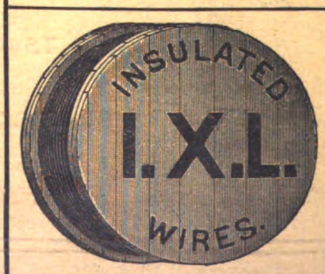

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